# Programme Structure

# Sharda School of Computing Science & Engineering

# Bachelor of Technology
# In
# Computer Science & Engineering – Artificial Intelligence & Machine Learning

**Programme Code: SCS0101**

**Batch: 2026-2030**

## 1.1 Vision, Mission and Core Values of the University

### Vision of the University

**To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.**

### Mission of the University

1. **Transformative educational experience**
2. **Enrichment by educational initiatives that encourage global outlook**
3. **Develop research, support disruptive innovations and accelerate entrepreneurship**
4. **Seeking beyond boundaries**

### Core Values

- **Integrity**
- **Leadership**
- **Diversity**
- **Community**

## Vision of the School

**To become a global institute of higher learning in Computing Science and Engineering, promoting excellence in research, innovation, and entrepreneurship to provide sustainable solutions for the challenges of progressive society.**

## Mission of the School

- **To impart quality education with strong industry and academia collaborations in the expanding and allied fields of Computing Science & Engineering, fostering a conducive and transformative learning environment.**
- **To produce eco-conscious socially and ethically responsible technocrats equipped with professional skills and experiential learning, to empower them for adopting emerging technologies.**
- **To inculcate a culture of multidisciplinary research, disruptive innovation and accelerated entrepreneurship, while providing sustainable solutions to address multifaceted challenges of growing society.**
- **To promote collaborative learning and critical thinking through effective mentoring and counselling, with the aim of creating future leaders to serve communities worldwide.**

## Core Values

- **Industry & Academic Connectivity**
- **Experiential learning**
- **Interdisciplinary research**
- **Global**

### 1.3.1 Programme Educational Objectives (PEO)

**PEO1:** The graduates will establish themselves as professionals by solving real-life problems using exploratory and analytical skills acquired in the field of Computer Science and Engineering.

**PEO2:** The graduates will provide sustainable solutions to ever changing interdisciplinary global problems through their Research & Innovation capabilities.

**PEO3:** The graduates will become employable, successful entrepreneur as an outcome of Industry-Academia collaboration.

**PEO4:** The graduates will embrace professional code of ethics while providing solution to multidisciplinary social problems in industrial, entrepreneurial and research environment to demonstrate leadership qualities

### 1.3.2 Map PEOs with Mission Statements:

| PEO Statements | School Mission 1 | School Mission 2 | School Mission 3 | School Mission 4 |
|---|---|---|---|---|
| **PEO1:** | **3** | **3** | **2** | **2** |
| **PEO2:** | **2** | **3** | **2** | **2** |
| **PEO3:** | **2** | **2** | **3** | **3** |
| **PEO4:** | **2** | **2** | **2** | **3** |

### 1.3.3 Programme Outcomes

| POs | Program Outcome |
|---|---|
| PO1 | Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization. |
| PO2 | Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. |
| PO3 | Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. |
| PO4 | Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. |
| PO5 | Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. |
| PO6 | The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. |
| PO7 | Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. |
| PO8 | Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. |
| PO9 | Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences |
| PO10 | Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments. |
| PO11 | Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. |

### Programme Specific Outcomes

| | |
|---|---|
| PSO1 | Apply core and advanced concepts of Artificial Intelligence and Machine Learning to design, develop, and deploy intelligent systems that can learn from data, adapt to dynamic environments, and solve real-world problems across various domains. |
| PSO2 | Analyze, model, and interpret complex datasets using modern ML techniques, deep learning architectures, optimization algorithms, and statistical tools, enabling data-driven decision-making and innovative research contributions in AI and ML applications. |
| PSO3 | Develop ethical, secure, and scalable AI solutions by integrating cloud platforms, edge computing, natural language processing, computer vision, and responsible AI practices, ensuring alignment with societal needs and Sustainable Development Goals. |

### 1.3.4 Mapping of Programme Outcome Vs Programme Educational Objectives

| | PEO1 | PEO2 | PEO3 | PEO4 |
|---|---|---|---|---|
| PO1 | 3 | 3 | 2 | 1 |
| PO2 | 3 | 3 | 3 | 1 |
| PO3 | 2 | 2 | 3 | 3 |
| PO4 | 2 | 2 | 3 | 2 |
| PO5 | 2 | 3 | 2 | 2 |
| PO6 | 1 | 2 | 2 | 3 |
| PO7 | 1 | 1 | 2 | 3 |
| PO8 | 1 | 1 | 2 | 3 |
| PO9 | 1 | 2 | 3 | 1 |
| PO10 | 1 | 1 | 3 | 2 |
| PO11 | 2 | 3 | 1 | 1 |
| PSO1 | 2 | 3 | 1 | 3 |
| PSO2 | 3 | 3 | 2 | 2 |
| PSO3 | 3 | 3 | 2 | 2 |

**1.3.5 Programme Outcome Vs Courses Mapping Table:**
**1.3.5.1 Course Articulation Matrix**

| Semester-I | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Programme Outcome → | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| Course Code | Course Name | | | | | | | | | | | | | | |
| CSAI1101 | Fundamentals of Computing and Artificial Intelligence | 1.67 | 2.67 | 1.83 | 1.5 | 2 | 1 | – | – | 1.33 | 1.2 | 1.67 | 1.5 | 2.17 | 1.67 |
| EEE1101 | Basics of Electrical and Electronics Engineering | 1.5 | 2.14 | 2.33 | 1.75 | 2.33 | 1.8 | 3 | 2.5 | 1.5 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |
| MTT1113 | Calculus and Abstract Algebra | 3.0 | 3.0 | 2.16 | 2.16 | 2.16 | 1.3 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 3.0 | 3.0 | 2.16 |
| IKT1105 | Human Values and Professional Ethics | 1 | 1 | - | 1 | - | 1.5 | 2 | 2.17 | 1 | 1 | 1 | 1 | 1 | - |
| CSCR1300 | Programming for Problem Solving | 2.5 | 2.14 | 2.33 | 1.75 | 2.33 | 1.8 | 3 | 2.5 | 1.5 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |
| BTT1102 | Introduction to Computational Biology | 3 | 1.5 | 2.0 | 1.6 | 1.5 | 0.83 | 0.5 | 1.00 | 2.3 | 0 | 0 | 2.1 | 1.8 | 1.75 |
| CVT1103 | Environmental Studies | 1.25 | 2.25 | 1.40 | 1.60 | 2.00 | 2.00 | 1.75 | 1.00 | 1.50 | 2.00 | 2.25 | 1.75 | 1.75 | 2.20 |

| Semester-II | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Programme Outcome → | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| Course Code | Course Name | | | | | | | | | | | | | | |
| CSCR1302 | Application based Programming in Python | 2.17 | 1.57 | 1.66 | 1 | 1.62 | 1.5 | 2 | 1.66 | 2 | 1 | 1.75 | 2 | 2.3 | 1.54 |
| CSCR1504 | Design and creativity Lab | 2.83 | 2.33 | 2.5 | 2.4 | 2.8 | 2.2 | 0 | 1.75 | 2.25 | 2.8 | 2 | 2.2 | 0 | 0 |
| CSCR1507 | Digital Prototyping | 2 | 2.5 | 2.4 | – | 2 | – | – | 2.33 | 1.67 | 1.33 | 2.5 | 2 | 2.17 | 2 |
| SKT1100 | Professional Communication | 1.00 | 1.83 | 1.25 | 1.00 | 1.00 | – | – | 2.00 | 2.17 | 3.00 | 2.00 | 2.17 | 2.33 | 1.20 |
| PHT1136 | Engineering Physics | 2.5 | 2.14 | 2.33 | 1.75 | 2.33 | 1.8 | 3 | 2.5 | 1.5 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |
| MTT1214 | Probability and Statistics | 3.00 | 2.50 | 1.60 | 2.16 | 2.16 | 1.33 | 1.00 | 1.00 | 1.00 | 1.33 | 1.00 | 1.50 | 3.00 | 2.50 |
| CSCR1301 | Object Oriented Programming Using Java | 2.38 | 2.5 | 2.5 | 2 | 2.33 | 2 | 2 | 3 | 3 | 3 | 2 | 2.5 | 2.62 | 2.5 |
| IKT1001 | Fundamentals of Indian Knowledge System | 1.5 | 2.17 | 2.17 | 1.33 | 1.83 | 1.67 | 2.17 | 1.83 | 1.83 | 2.5 | 2.83 | 1.83 | 1.5 | 1.83 |
| VAC | Value Added Course | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Semester-III** | | | | | | | | | | | | | | | |
| Programme Outcome → | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| Course Code | Course Name | | | | | | | | | | | | | | |
| CSCR2510 | Computer Network | 2.5 | 2.1 | 2 | 1.8 | 1.9 | 1.8 | 1.67 | 1.5 | 1.5 | 1 | 1.38 | 2.1 | 2.5 | 2.25 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CSCR2111 | Discrete Structures | 2.5 | 2.7 | 2.25 | 2.4 | 2 | – | – | – | – | 1.5 | 1.3 | 2.5 | 2.6 | 1.5 |
| CSCR2512 | Principles of Operating System | 2.5 | 2.14 | 2.33 | 2.25 | 2 | 1.67 | 3 | 2 | 2.2 | 1.86 | 2.29 | 2.38 | 2.25 | 2 |
| CSCF2200 | Concepts of Machine Learning | 2.5 | 2 | 2 | 1.75 | 1.9 | 1.86 | 2 | 1.75 | 1.4 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |
| SKP2301 | Skills & Informatics-1: Professional Skills, Data Structures & Web Technologies | 2.50 | 2.67 | 2.40 | – | 2.17 | – | – | 2.33 | 2.50 | 2.00 | 2.50 | 2.33 | 2.17 | 2.00 |
| CSCR2600 | Project Based Learning (PBL) -1 (Mini-Hackathon Based) | 3 | 2.7 | 0.34 | 1.84 | 0.67 | 0.67 | 0.84 | 0.5 | 3 | 3 | 2 | 1 | 1.4 | 0.5 |
| CSCR2511 | Data Structures | 2.5 | 2.14 | 2.33 | 1.75 | 2.33 | 1.8 | 3 | 2.5 | 1.5 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |
| **Semester-IV** | | | | | | | | | | | | | | | |
| Programme Outcome → | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| Course Code | Course Name | | | | | | | | | | | | | | |
| CSCR2514 | Data Base Management System | 2.7 | 2.7 | 2.5 | 2.6 | 2.5 | 2.1 | - | 2.3 | 2.8 | - | 2.2 | 2.5 | 2.7 | 2.8 |
| CSCR2110 | Theory of Computation & Compiler Design | 2 | 2 | 2.2 | 1.3 | 1 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | 2.2 | 1.3 |
| CSCR2110 | Neural Networks & AI Programming Framework | 2.5 | 2.14 | 2.33 | 1.75 | 2.33 | 1.8 | 3 | 2.5 | 1.5 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |
| CSAI2001 | PE1: System Design - SI (Case Study Based) | 2.83 | 2.83 | 2.83 | 3.00 | 2.83 | 2.67 | 1.83 | 1.83 | 2.33 | 2.33 | 2.00 | 3.00 | 3.00 | 2.83 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CSAI2002 | PE1: Foundations of Ethical Hacking | 3.00 | 2.83 | 2.33 | 3.00 | 2.25 | 3.00 | 3.00 | 2.67 | 2.50 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| CSAI2302 | PE1: Information Security | 2.50 | 2.29 | 2.20 | 2.17 | 2.57 | 1.67 | 2.33 | 2.00 | 1.80 | 1.67 | 2.25 | 2.44 | 2.50 | 2.30 |
| CSAI2004 | PE1; IoT Network Analytics | 1.7 | 1.8 | 2.0 | 2.4 | 1.8 | 1.0 | 1.0 | 1.3 | 2.3 | 1.3 | 1.3 | 1.0 | 2.5 | 1.5 |
| SKP2401 | Skills & Informatics-2: Integrated Professional Communication and Intelligent Computing | 2.00 | 2.50 | 1.83 | 1.75 | 1.60 | 1.0 | 1 | 2.17 | 2.83 | 2.33 | 2.50 | 2.35 | 2.35 | 1.83 |
| CSAI2101 | Machine Learning Operations & Agentic AI | 2.83 | 2.5 | 2.5 | 2.5 | 2.66 | 1.66 | 1.3 | 1.33 | 1.67 | 1.83 | 1.67 | 2.67 | 2.17 | 2.33 |
| CSCR2601 | Project Based Learning (PBL) -2 (AI Applications in Computer Network) | 3 | 2.7 | 0.3 | 1.8 | 0.7 | 0.7 | 0.8 | 0.5 | 3 | 3 | 2 | 1 | 1.3 | 0.5 |
| **Semester-V** | | | | | | | | | | | | | | | |
| Programme Outcome → | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| Course Code | Course Name | | | | | | | | | | | | | | |
| CSAI3301 | Cloud Computing & Databases | 1.5 | 2.13 | 2.25 | 2.13 | 2.63 | 1.11 | 1.33 | 1.67 | 1.89 | 1.57 | 2.3 | 2.56 | 2.6 | 2.3 |
| CSCR3311 | Design and Analysis of Algorithm | 2.5 | 2.14 | 2.33 | 1.75 | 2.33 | 1.8 | 3 | 2.5 | 1.5 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |
| CSCR3110 | Data Mining & Warehousing | 2.33 | 2.33 | 2.25 | 2.2 | 2.5 | 2 | 1 | 1 | 1 | 1 | 1.4 | 2 | 2.5 | 2.25 |
| CSDS3103 | PE2 Big Data Analytics | 2.5 | 2.14 | 2.33 | 1.75 | 2.33 | 1.8 | 3 | 2.5 | 1.5 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CSAI3001 | PE2 Natural Language Processing | 2.34 | 2.5 | 1 | 0.5 | 2.5 | 0.34 | – | 0.67 | - | 0.5 | 2 | 2 | 2 | 2.34 |
| CSCF2300 | PE2 Digital Forensics | 2.83 | 2.83 | 2.33 | 3 | 2.25 | 3 | 3 | 2.67 | 2.5 | 3 | 3 | 3 | 3 | 3 |
| CSAI3302 | PE2 Artificial Intelligence for IoT | 2.7 | 2 | 2.1 | 2 | 2.4 | 2 | 1.7 | 2 | 1.3 | 1.5 | 1.5 | 2.1 | 2.2 | 2.2 |
| SKP3501 | Skills & Informatics-3: Communication, Coding & Career Readiness Skills | 2 | 2.83 | 2.5 | 2.2 | 2.5 | 1.4 | 1.6 | 1.75 | 2.67 | 2.83 | 2.5 | 2.67 | 2.83 | 2.33 |
| CSCR3600 | Project Based Learning (PBL) -3 (Hackathon Based) | 1.8 | 2.3 | 2.2 | 1.6 | 2.5 | 1 | 0 | 1 | 2 | 1.4 | 1.5 | 2.6 | 1.8 | 1 |
| CCP3001 | Community Connect | 1 | 0.83 | 1 | 1 | 0 | 1.2 | 1.2 | 1 | 1.33 | 1.33 | 1.33 | 0 | 1 | 1 |
| CSCR3700 | Summer Internship-I | 1 | 0.7 | 0.5 | 1.2 | 1 | 0.3 | 1.2 | 1 | 1 | 0 | 1 | 1 | 1.3 | 0.7 |
| **Semester-VI** | | | | | | | | | | | | | | | |
| Programme Outcome → | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| Course Code | Course Name | | | | | | | | | | | | | | |
| | Deep Learning and Its Applications | 2.67 | 2.17 | 2.40 | 2.40 | 2.20 | - | - | - | - | - | 1.33 | 1.83 | 1.67 | 2.00 |
| CSAI3101 | Computer Vision & Pattern Recognition | 2.5 | 2.67 | 2.4 | 2.6 | 2.17 | 1 | 1 | - | 1 | 1 | - | 2.83 | 2.83 | 2.5 |
| CSAI3303 | Data Analytics (Using Visualization Tools) | 2.33 | 2.29 | 2.29 | 2 | 2.13 | 1.43 | 3 | 1.67 | 1.60` | 2 | 2.13 | 2.22 | 2.3 | 2.38 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CSAI3003 | PE3 No SQL Database | 2.5 | 2.6 | 2.67 | 3 | 2.5 | 1.67 | – | – | 2 | 2 | 2 | 2.2 | 2.67 | 2.5 |
| CSAI3304 | PE3 Data Pipelines | 2.5 | 2.14 | 2.33 | 1.75 | 2.33 | 1.8 | 3 | 2.5 | 1.5 | 2 | 2.13 | 2.22 | 2.3 | 2.38 |
| CSOT3206 | PE3 Data Analytics for IoT | 2.67 | 2.33 | 2.8 | 2.75 | 1 | – | – | 2 | 2.2 | 1.67 | 2.33 | 2.5 | 2.2 | 1.75 |
| SKP3601 | Skills&Informatics-4: Strategic Professionalism and Computational Informatics | 2.33 | 2.50 | 2.00 | 1.75 | 1.40 | – | – | 2.00 | 2.00 | 2.17 | 2.00 | 2.00 | 2.17 | 2.17 |
| BST3351 | Management for Engineers | 1.0 | 1.5 | 1.8 | - | - | 1.0 | - | 1.0 | 1.0 | 1.0 | 1.5 | - | - | 1.83 |
| CSCR3601 | Project Based Learning (PBL) -4 (Product Based) | 3 | 2.2 | 1 | 1.5 | 1.7 | 0.7 | 1.2 | 2 | 1 | 2 | 1 | 2 | 1.5 | 1.2 |
| | Open Elective – 1 (MOOC) | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Semester-VII** | | | | | | | | | | | | | | | |
| Programme Outcome → | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| Course Code | Course Name | | | | | | | | | | | | | | |
| CSCR4600 | Capstone – 1 | 2.2 | 2.2 | 2 | 1.8 | 2 | - | - | 1 | 2 | 1.6 | 1.5 | 2.8 | 1.8 | 1 |
| CSCR4700 | Summer Internship-II | 1.67 | 2.33 | 1.67 | 1.5 | 1.33 | 1.25 | 1 | 2 | 1.83 | 2 | 2 | 2.33 | 1.25 | 1 |
| CSCR3203 | PE4 LLMs | 2.67 | 2.33 | 2.8 | 2.75 | 1 | – | – | 2.17 | 2.33 | 1.67 | 2.33 | 2.5 | 2.2 | 2 |
| CSAI4001 | PE4 Cyber Security in Blockchain Technology | 2.5 | 2.67 | 2.4 | 2.6 | 2.17 | 1 | 1 | | 1 | 1 | | 2.83 | 2.83 | 2.5 |
| CSAI4002 | PE4 Industrial IoT 4.0 | 2.83 | 3 | 2.5 | 2.33 | 1.2 | - | - | 2 | 2.33 | 1.83 | 1.83 | 2.67 | 2.33 | 1.5 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CSDS4200/4301 | PE5 HealthCare Data Analytics | 2.67 | 2.33 | 2.8 | 2.75 | 1 | – | – | 2 | 2.2 | 1.67 | 2.33 | 2.5 | 2.2 | 1.75 |
| CSAI4003 | PE5 Smart Contract | 2 | 2 | 2.2 | 1.3 | 1 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | 2.2 | 1.3 |
| CSAI4004 | PE5 Blockchain with AI | 2.67 | 2.33 | 2.8 | 2.75 | 1 | – | – | 2 | 2.2 | 1.67 | 2.33 | 2.5 | 2.2 | 1.75 |
| CSAI4005 | PE6 Social Network Analytics | 2.17 | 2.67 | 2.17 | 2.3 | 2.3 | 1 | 0 | 0.17 | 1.3 | 1.5 | 1.5 | 2.17 | 2.67 | 2.17 |
| CSCF4202 | PE6 Digital Water Marking and Steganography | 2 | 2 | 2.2 | 1.3 | 1 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | 2.2 | 1.3 |
| CSAD4217 | PE6 Robotics and Intelligent Systems | 2 | 2 | 2.2 | 2.2 | 1 | 0.8 | 0.9 | 0.7 | 1 | 0.7 | 1.5 | 1 | 2.2 | 2.1 |
| | Open Elective – 2 (MOOC) | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Semester-VIII** | | | | | | | | | | | | | | | |
| Programme Outcome → | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| Course Code | Course Name | | | | | | | | | | | | | | |
| CSCR4601 | Capstone – 2 | 1.83 | 2.0 | 2.33 | 2.0 | 2.83 | 2.0 | 2.0 | 2.0 | 2.33 | 2.0 | 1.5 | 1.5 | 2.5 | 2.5 |
| | Open Elective - 3 (Min. 12 weeks MOOCs) | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Open Elective - 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## Structure of FY UG Programme

**The Semester wise and Broad Course Category-wise distribution of credits of the Undergraduate Programme:**

| Semester | Discipline Core Major (60/80 Credits) | Minor (24/32 Credits) | Inter/Multi - disciplinary courses (09 Credits) | Ability Enhancement courses (AEC) (08 Credits) | Skill Enhancement Courses (SEC) (09 Credits) | Common Value Added Courses (06-08 Credits) | Summer Internship (02-04 Credits) | Research Project (12 Credits) | Total Credits (120/160) | Total Credits (120/160) | (Cummulative Minimum Credits) Required for Award of Diploma / Degree |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | Fundamentals of Computing and Artificial Intelligence (2) Programming for Problem Solving (4)<br>6 | | Basics of Electrical and Electronics Engineering (4), Calculus and Abstract Algebra (4), Introduction to Computational Biology (2)<br>10 | | Human Values and Professional Ethics (2)<br>2 | Environmental Studies (0)<br>0 | | | 18 | 40 | First Minor Core is fixed course for each school.<br>VAC Courses include<br>-Environment<br>-Indian Knowledge System<br>-Mulya Pravah |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| II | Application based Programming in Python (4), Design and creativity Lab (2), Digital Prototyping(2)<br>&<br>Object Oriented Programming Using Java (3) | | Engineering Physics (4)<br>Probability and Statistics (4), | | Professional Communication (3) | Fundamentals of Indian Knowledge System - VAC (0) | | | 22 | | VAC/SEC/Multidis/AEC can be taken from NPTEL |
| | **11** | **0** | **8** | **0** | **3** | **0** | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Students who exit the programme after securing 40 credits will be awarded UG certificate in the relevant Discipline, provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credit from skill - based courses earned during first and second semester** | | | | | | | | | | |
| III | Computer Networks (4), Discrete Structures (3), Principles of Operating System (3), Concepts of Machine Learning (4), Data Structure (4), Project Based Learning (PBL) -1 (Mini-Hackathon Based) (1) | | | | Professional Skills, Data Structures & Web Technologies (3) | | | | 22 | 45 | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **19** | **0** | **0** | **0** | **3** | **0** | **0** | **0** | | | |
| IV | Data Base Management System (4), Theory of Computation & Compiler Design (4), Neural Networks & AI Programming Framework (4), Machine Learning Operations & Agentic AI (3) & Project Based Learning (PBL) -2 (Research Methodology Based) (2) | PE-1 (3) | | | Integrated Professional Communication and Intelligent Computing (3) | | | | 23 | | |
| | **17** | **3** | **0** | **0** | **3** | **0** | **0** | **0** | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Students who exit the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline, provided they secure additional 4 credits in skill based vocational courses offered during first year or second year summer term or Internship** | | | | | | | | | | |
| V | Cloud Computing & Databases (3), Design and Analysis of Algorithm (4),Data Mining & Warehousing (3), Project Based Learning (PBL) -3 (Hackathon Based) (2)<br>**12** | PE-2 (3)<br>**3** | | Community Connect (2)<br>**2** | Communication, Coding & Career Readiness Skills (3)<br>**3** | | Summer Internship-I (2)<br>**2** | **0** | 22 | 45 | 3- Year UG Degree inclusive of optional Apprenticeship |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VI | Deep Learning and Its Applications (4), Computer Vision & Pattern Recognition (3), Data Analytics (Using Visualization Tools) (3), Management for Engineers (3), Project Based Learning (PBL) -4 (Product Based) (2) | Program Elective -3 (3) & Open Elective – 1 (2) | | | Strategic Professionalism and Computational Informatics (3) | | | | 23 | | |
| | **15** | **5** | **0** | **0** | **3** | **0** | **0** | **0** | | | |
| | **Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline / Subject upon securing 120 credits** | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VII | Capstone – 1 (2)<br><br>**2** | Program Elective -4 (3), Program Elective -5 (3), Program Elective -6 (3), Open Elective – 2 (2)<br><br>**11** | | | | | Summer Internship-II (2)<br><br>**2** | | 15 | 30 | ***ONLY for students going for Apprenticeship & requires Minor with Major Degree** |
| VIII | Capstone – 2 (10)<br><br>**10** | Open Elective – 3 (2)<br><br>Open Elective - 4 (min. 12 Week Course) (3)<br><br>**5** | | | | | | | 15 | | 4- Year UG Degree (Honours)<br><br>inclusive of optional Apprenticeship |
| | | | | | | | | | | 160 | |

**Students wil be awarded UG Degree (Honours) with Research in the relevant Discipline / Subject provided they secure min. 160 credits**

**List of Courses: Semester Wise**

| Bachelor of Technology(Artificial Intelligence & Machine Learning) | Credits | Practical/ Theory | Type | Total Credits |
|---|---|---|---|---|
| **Sem-I** | | | | **19** |
| Fundamentals of Computing and Artificial Intelligence | 2 | Theory | Core | |
| Basics of Electrical and Electronics Engineering | 4 | Theory+Practical | MDC | |
| Calculus and Abstract Algebra | 4 | Theory | MDC | |
| Human Values and Professional Ethics | 2 | Theory | MDC | |
| Programming for Problem Solving | 4 | Theory+Practical | Core | |
| Introduction to Computational Biology | 2 | Theory | MDC | |
| Environmental Studies | 0 | Theory | Audit | |
| **Sem-2** | | | | **22** |
| Application based Programming in Python | 4 | Theory+Practical | Core | |
| Design and creativity Lab | 2 | Practical | Practical/Tutorials/Studios | |
| Digital Prototyping | 2 | Practical | Practical/Tutorials/Studios | |
| Professional Communication | 3 | Theory | Minor-Vocactional/Skill Enhancement Course (SEC) | |
| Engineering Physics | 4 | Theory+Practical | MDC | |
| Probability and Statistics | 4 | Theory | MDC | |
| Object Oriented Programming Using Java | 3 | Theory+Practical | Core | |
| Fundamentals of Indian Knowledge System | 0 | Theory | Value added Course (VAC) | |
| **Sem-III** | | | | **22** |
| Computer Network | 4 | Theory+Practical | Core | |
| Discrete Structures | 3 | Theory | Core | |
| Principles of Operating System | 3 | Theory+Practical | Core | |
| Concepts of Machine Learning | 4 | Theory+Practical | Core | |
| Skills & Informatics-1: Professional Skills, Data | 3 | Practical | Minor-Vocactional/Skill Enhancement Course (SEC) | |

| | | | | |
|---|---|---|---|---|
| Structures & Web Technologies | | | | |
| Project Based Learning (PBL) -1 (Mini-Hackathon Based) | 1 | Project | Field Projects/RBL | |
| Data Structures | 4 | Theory+Practical | Core | |
| **Sem-IV** | | | | **23** |
| Data Base Management System | 4 | Theory+Practical | Core | |
| Theory of Computation & Compiler Design | 4 | Theory | Core | |
| Neural Networks & AI Programming Framework | 4 | Theory+Practical | Core | |
| Program Elective-1 | 3 | Theory | Minor-Elective Course | |
| Skills & Informatics-2: Integrated Professional Communication and Intelligent Computing | 3 | Theory | Minor-Vocactional/Skill Enhancement Course (SEC) | |
| Machine Learning Operations & Agentic AI | 3 | Theory | Core | |
| Project Based Learning (PBL) -2 (AI Applications in Computer Network) | 2 | Project | Field Projects/RBL | |
| **Sem- V** | | | | **22** |
| Cloud Computing & Databases | 3 | Theory+Practical | Core | |
| Design and Analysis of Algorithm | 4 | Theory+Practical | Core | |
| Data Mining & Warehousing | 3 | Theory | Core | |
| Program Elective-2 | 3 | Theory | Minor-Elective Course | |
| Skills & Informatics-3: Communication, Coding & Career Readiness Skills | 3 | Practical | Minor-Vocactional/Skill Enhancement Course (SEC) | |
| Project Based Learning (PBL) -3 (Hackathon Based) | 2 | Project | Field Projects/RBL | |
| Community Connect | 2 | Project | Ability Enhancement Courses (AEC) | |
| Summer Internship-I | 2 | Internship | Internship | |
| **Sem- VI** | | | | **23** |
| Deep Learning and Its Applications | 4 | Theory+Practical | Core | |
| Computer Vision & Pattern Recognition | 3 | Theory | Core | |
| Data Analytics (Using Visualization Tools) | 3 | Theory+Practical | Core | |

| | | | | |
|---|---|---|---|---|
| Program Elective-3 | 3 | Theory | Minor-Elective Course | |
| Skills&Informatics-4: Strategic Professionalism and Computational Informatics | 3 | Practical | Minor-Vocactional/Skill Enhancement Course (SEC) | |
| Management for Engineers | 3 | Theory | Ability Enhancement Courses (AEC) | |
| Project Based Learning (PBL) -4 (Product Based) | 2 | Project | Field Projects/RBL | |
| Open Elective – 1 | 2 | MOOC | Minor-Elective Course | |
| **Sem-VII** | | | | **15** |
| Capstone - 1 | 2 | Project | Dissertation/Capstone Project | |
| Summer Internship-II | 2 | Internship | Internship | |
| Program Elective-4 | 3 | Theory | Minor-Elective Course | |
| Program Elective-5 | 3 | Theory | Minor-Elective Course | |
| Program Elective-6 | 3 | Theory | Minor-Elective Course | |
| Open Elective – 2 | 2 | MOOC | Minor-Elective Course | |
| **Sem-VIII** | | | | **15** |
| Capstone - 2 | 10 | Project | Dissertation/Capstone Project | |
| Open Elective - 3 (Min. 12 weeks MOOCs) | 3 | MOOC | Minor-Elective Course | |
| Open Elective - 4 | 2 | MOOC | Minor-Elective Course | |

**Programme wise Credit Distribution**

| **Course Category** | **Programme wise Credit Distribution** | |
|---|---|---|
| | **Bachelor of Technology (Computer Science & Engineering – Artificial Intelligence & Machine Learning)** | |
| | **4 Year** | |
| | **No. of Courses** | **Total credits** |
| Core Courses (CC) | 19 | 66 |
| Multidisciplinary Courses | 6 | 20 |
| Minor Electives | 10 | 27 |
| Dissertation/Capstone Project | 2 | 12 |
| Ability Enhancement Courses (AEC) | 2 | 5 |
| Skill Enhancement Courses (SEC)/ Vocational Courses | 5 | 15 |
| Practical/Tutorials/Studios | 2 | 4 |

| | | |
|---|---|---|
| Internship | 2 | 4 |
| Field Projects/RBL | 4 | 7 |
| VAC | 1 | 0 |
| Audit Courses | 2 | 0 |
| **Total** | **55** | **160** |

| Type | Courses x Credits | Credits | Total Credits |
|---|---|---|---|
| Core | 10x4=40, 8x3=24, 2x1=2 | 66 | 113 |
| Dse-Discipline Specific Elective | 6x3 | 18 | |
| Ge-General Elective/Open Elective | 3x2=6, 1x3=3 | 9 | |
| Aecc-Ability Enhancement Compulsory Courses | 1x3=3, 1x2=2 | 5 | |
| Sec-Skill Enhancement Courses | 5x3 | 15 | |

# Course Modules

| Semester 1, Credits: 18 | |
|---|---|
| **COURSE CODE** | **COURSE NAME** |
| CSAI1101 | Fundamentals of Computing and Artificial Intelligence |
| EEE1101 | Basics of Electrical and Electronics Engineering |
| MTT1113 | Calculus and Abstract Algebra |
| IKT1105 | Human Values and Professional Ethics |
| CSCR1300 | Programming for Problem Solving |
| BTT1102 | Introduction to Computational Biology |
| CVT1103 | Environmental Studies |

# COURSE PLAN

## Fundamental of Computing and Artificial Intelligence (CSAI1101)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VI | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE - Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | I |
| **Course Code:** | CSAI1101 | **Course Type:** | Core - Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI1101 |
| 2 | **Course Title** | **Fundamental of Computing and Artificial Intelligence** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-0-2 (Theory: 30 hrs. Classroom + 30 hrs. Self learning = 60 hrs. total) |

| | | |
|---|---|---|
| 5 | **Course Status** | **Core - Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | The course aims to build a strong foundation in computer systems, develop problem-solving skills using visual and algorithmic approaches, and introduce fundamental concepts of Artificial Intelligence and Machine Learning for real-world applications. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L2)<br>Explain the fundamental concepts of computer systems, including hardware components, data representation techniques, and the evolution of programming languages.<br>CO2 (Apply– L3)<br>Apply visual thinking techniques and problem-solving strategies using tools such as mind maps, flowcharts, and pseudocode to analyze computational problems.<br>CO3 (Apply– L3)<br>Develop algorithms and represent logical solutions using flowcharts, decision tables, and step-by-step execution tracing for given problems.<br>CO4 (Understand – L2)<br>Describe the fundamental concepts, principles, and applications of Artificial Intelligence, including intelligent agents and problem-solving approaches.<br>CO5 (Apply– L3)<br>Apply basic machine learning concepts such as classification and clustering using appropriate algorithms for solving simple real-world problems.<br>CO6 (Analyze – L4)<br>Analyze and compare traditional problem-solving approaches with AI and machine learning techniques based on efficiency, applicability, and outcomes. |
| 8 | **Course Description** | This course introduces the fundamental concepts of Computer Science and Engineering, including hardware, data representation, and the evolution of programming languages. It develops problem-solving and computational thinking skills using visual tools such as flowcharts, diagrams, and pseudocode. The course emphasizes algorithm design, logical reasoning, and process visualization through decision tables and execution tracing. It also introduces the core principles of Artificial Intelligence, including intelligent systems and problem-solving approaches. The course further covers the basics of Machine Learning, including learning paradigms, classification, and clustering techniques. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 30 hrs \| Self Learning (SL): 30 hrs \| Total: 60 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1. Peter Norton, Introduction to Computers, Tata McGraw Hill, Edition 6.<br>2. Russell S & Norvig P, Artificial Intelligence: A Modern Approach, Prentice Hall |
| 12 | **References** | 1. Rich E & Knight K, Artificial Intelligence, Tata McGraw Hill, Edition 3<br>2. Dan W. Patterson, Artificial Intelligence & Expert Systems, Pearson Education with Prentice Hall India. Indian Edition.<br>3. Virtual Labs, https://ps-iiith.vlabs.ac.in/ |

## 3. Outline Syllabus with CO Mapping

*All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Hardware aspect of Computer Science & Engineering** | |
| A | **History of Computing Systems, Computer Basics and Computer Organization.** | **CO1** |
| B | **Data Representation in Computers: Number System with Conversion, Binary codes** | **CO1** |
| C | **Evolution of Programming Languages: Low Level Languages, High Level, Machine, Assembly Languages** | **CO1** |
| | **Unit 2:** Visual Thinking and Problem Understanding | |
| A | Introduction to problem visualization: mental models vs external representations, benefits for computational thinking | **CO2** |
| B | Types of visual tools: sketches, mind maps, lists, tables, timelines, storyboards | |
| C | Introduction to Algorithms & Pseudo code: Problem Solving Approach | |
| | **Unit 3: Visualizing Processes and Logic** | |
| A | Flowchart fundamentals: symbols, control structures, branching, loops, input-output | **CO2, CO3** |
| B | Decision tables and truth tables for logical conditions | |
| C | Step-by-step execution tracing: dry runs, state tables, variable tracking, Test cases | |
| | **Unit 4: Introduction to Artificial Intelligence** | |
| A | **Fundamental concepts and principles of AI , Objectives and goals of intelligent systems , Historical evolution and milestones in AI development** | **CO4, CO6** |
| B | **Overview of the AI curriculum and core domain, learning pathway for AI development, Real-world applications of AI across diverse domains** | |
| C | **AI-based vs traditional problem-solving techniques, Rational agents and intelligent behaviour, Philosophical and practical perspectives of AI systems** | |
| | **Unit 5: Introduction to Machine Learning** | |
| A | **Role and significance of machine learning within AI, Types of learning paradigms (supervised, unsupervised, reinforcement learning)** | **CO5, CO6** |

| | | |
|---|---|---|
| B | Core concepts of classification and clustering, Basic algorithms and their working principles (Supervised Learning Algorithms) | |
| C | Applications of ML in various domains | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | ✓ | | | |
| 3 | 1.C | ✓ | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | ✓ | ✓ | ✓ | | |
| 7 | 3.A | | ✓ | ✓ | ✓ | | |
| 8 | 3.B | | ✓ | ✓ | ✓ | ✓ | |
| 9 | 3.C | | ✓ | ✓ | ✓ | | |
| 10 | 4.A | ✓ | ✓ | | | | |
| 11 | 4.B | | ✓ | ✓ | ✓ | | |
| 12 | 4.C | | ✓ | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | ✓ | ✓ | |
| 14 | 5.B | | ✓ | ✓ | ✓ | | ✓ |
| 15 | 5.C | | ✓ | ✓ | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

*Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | Affective (A1–A5) | Psychomotor (P1–P7) |
|---|---|---|---|

| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | | | ✓ | ✓ | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | ✓ | ✓ | | | | | ✓ | | | | |
| CO3 | | ✓ | ✓ | | | | | ✓ | ✓ | | | | | ✓ | | | | |
| CO4 | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | |
| CO5 | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | | ✓ | | | |
| CO6 | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | | | | |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

*Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Smart Contract Basics | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Computing Systems and History of Computers | UNIT-1 | 6 |
| DD/MM/YY | Computer Basics and Organization (CPU, Memory, I/O) | | |
| DD/MM/YY | Number Systems and Conversions (Binary, Decimal, etc.) | | |
| DD/MM/YY | Binary Codes and Data Representation Techniques | | |
| DD/MM/YY | Evolution of Programming Languages (Machine & Assembly) | | |
| DD/MM/YY | High-Level Languages and Language Generations | | |
| DD/MM/YY | Introduction to Visual Thinking and Problem Understanding | UNIT-2 | 6 |
| DD/MM/YY | Mental Models vs External Representations | | |
| DD/MM/YY | Types of Visual Tools (Mind maps, Sketches, Tables) | | |
| DD/MM/YY | Problem Visualization using Real-world Examples | | |
| DD/MM/YY | Introduction to Algorithms and Problem-Solving Approach | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Writing Pseudocode for Simple Problems | | |
| DD/MM/YY | Flowchart Fundamentals and Symbols | UNIT-3 | 6 |
| DD/MM/YY | Control Structures (Sequence, Selection, Iteration) | | |
| DD/MM/YY | Designing Flowcharts for Problem Solving | | |
| DD/MM/YY | Decision Tables and Truth Tables | | |
| DD/MM/YY | Dry Run and Execution Tracing Techniques | | |
| DD/MM/YY | Test Case Design and Debugging Techniques | | |
| DD/MM/YY | Introduction to Artificial Intelligence and History | UNIT-4 | 6 |
| DD/MM/YY | Goals, Applications, and Domains of AI | | |
| DD/MM/YY | AI Learning Pathway and Core Domains | | |
| DD/MM/YY | Intelligent Agents and Rational Behavior | | |
| DD/MM/YY | AI vs Traditional Problem Solving | | |
| DD/MM/YY | Philosophical and Practical Aspects of AI | | |
| DD/MM/YY | Introduction to Machine Learning and its Role in AI | UNIT-5 | 6 |
| DD/MM/YY | Types of Learning (Supervised, Unsupervised, Reinforcement) | | |
| DD/MM/YY | Classification Concepts and Algorithms (Supervised) | | |
| DD/MM/YY | Clustering Concepts and Techniques | | |
| DD/MM/YY | Working Principles of Basic ML Algorithms | | |
| DD/MM/YY | Applications of Machine Learning in Various Domains | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

*Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Fundamentals of Computing and Digital Systems | Understanding of computer fundamentals, evolution of computing, number systems, data representation, and programming language basics | CO1 \| L1–L2 | CA \| MTE \| ETE |
| TS2 | Computational and Visual Thinking Skills | Ability to apply computational thinking, visual representation techniques, problem decomposition, and algorithmic approaches for solving problems | CO2 \| L2–L3 | CA \| MTE \| ETE |
| TS3 | Algorithm Design and Logical Problem Solving | Application of algorithms, pseudocode, flowcharts, decision tables, and execution tracing for structured problem solving | CO3 \| L3 | CA \| MTE \| ETE |
| TS4 | Artificial Intelligence Concepts and Intelligent Systems Analysis | Analysis of AI principles, intelligent agents, AI problem-solving approaches, and real-world AI applications | CO4 \| L4–L5 | CA \| ETE |
| TS5 | Machine Learning Fundamentals and Model Interpretation | Understanding and evaluation of machine learning paradigms, classification, clustering, and supervised learning concepts | CO5 \| L3–L5 | CA \| ETE |
| TS6 | AI and ML Application-Oriented System Design | Ability to analyze and design basic AI/ML-enabled systems for real-world applications using computational intelligence concepts | CO6 \| L5–L6 | CA \| ETE |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

*Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Smart Contract Fundamentals & Conceptual Recall | TS2 Ethereum Platform Understanding & Comparative Interpretation | TS3 Smart Contract Development & Solidity Application | TS4 Smart Contract Analysis & Security Evaluation | TS5 Decentralization & Blockchain System Evaluation | TS6 Smart Contract Platforms & Future Application Analysis |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | M | M | M | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

*CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 Assignments | **10** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Assessments 1–2 (Theory / Application-based)** | **2 Assessments (Assessment 1 (10 Marks) + Assessment 2 (5 Marks))** | **15** | CO1, CO2, CO3, CO4, CO5,CO6 | TS1, TS2, TS3, TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

## 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2 concepts: Computer fundamentals, data representation, number systems, visual thinking, computational thinking, algorithms, and pseudocode | CO1, CO2,CO3 | TS1,TS2,TS3 | 7h SL | Evaluated based on conceptual understanding, problem-solving approach, algorithm development, flow representation, and assignment submission quality |
| **Assignment 2** | Unit 3, Unit 4, and Unit 5 concepts: Flowcharts, logical tracing, AI fundamentals, intelligent systems, machine learning paradigms, classification, and clustering | CO3, CO4, CO5,CO6 | TS3,TS4,TS5,TS6 | 7h SL | Evaluated based on logical analysis, AI/ML concept interpretation, comparative explanation, execution tracing, application-oriented thinking, and report presentation |

## 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2 concepts: Fundamentals of computing, computer organization, number systems, visual thinking, problem-solving techniques, algorithms, and pseudocode | CO1, CO2,CO3 | TS1,TS2,TS3 | 8h SL | Evaluated based on conceptual understanding, computational thinking ability, algorithm formulation, logical reasoning, and structured problem-solving approach |
| **Assessment 2** | Unit 3, Unit 4, and Unit 5 concepts: Flowcharts, execution tracing, AI fundamentals, intelligent systems, machine learning paradigms, classification, clustering, and AI applications. | CO3, CO4, CO5, CO6 | TS3,TS4,TS5, TS6 | 8h SL | Evaluated based on analytical thinking, AI/ML concept interpretation, execution tracing accuracy, comparative analysis, application-oriented understanding, and real-world problem analysis |

## 10. Mid Term Examination (MTE) - 15 Marks (Units 1–2)

*MTE covers Units 1–2 and CO1-CO6 are assessed in ETE. MTE maps to TS1–TS3.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| **TS1 — Fundamentals of Computing and Digital Systems**<br>**TS2 — Computational and Visual Thinking Skills** | **CO1, CO2** | Short-answer questions: explain computer organization, number systems, binary representation, evolution of programming languages, visual thinking concepts, problem decomposition, and computational thinking approaches |
| **TS3 — Algorithm Design and Logical Problem Solving** | **CO3** | **Application/problem-solving questions: develop algorithms, write pseudocode, draw flowcharts, prepare decision tables, and perform execution tracing for computational problems** |
| TS1–TS3 | **CO1–CO3** | Units 1–2 only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

*ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 40/100 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Fundamentals of Computing and Digital Systems TS2 — Computational and Visual Thinking Skills | CO1, CO2 | Short-answer conceptual questions on computer organization, number systems, programming language evolution, computational thinking, visual tools, algorithms, and pseudocode concepts |
| TS3 — Algorithm Design and Logical Problem Solving TS4 — Artificial Intelligence Concepts and Intelligent Systems Analysis | CO3, CO4 | Medium-length questions involving flowcharts, decision tables, execution tracing, AI principles, intelligent agents, traditional vs AI-based problem-solving approaches, and real-world AI applications |

| | | |
|---|---|---|
| TS5 — Machine Learning Fundamentals and Model Interpretation | CO5 | Analytical and application-oriented questions on machine learning paradigms, supervised and unsupervised learning, classification, clustering, and basic learning algorithms |
| TS6 — AI and ML Application-Oriented System Design | CO6 | Long-answer and case-study-based questions requiring comparative analysis of AI and ML approaches, intelligent system design concepts, and evaluation of AI/ML applications in real-world domains |
| TS1–TS6 (All) | CO1–CO6 | Comprehensive coverage of all units with balanced cognitive progression from understanding to analysis |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Explain computer fundamentals, hardware components, data representation, and programming language evolution | ✓ | ✓ | ✓ | TS1 | PO1, PO2 |
| **CO2** | Apply visual thinking and computational problem-solving techniques using algorithms and pseudocode | ✓ | ✓ | ✓ | TS2 | PO1, PO2, PO3 |
| **CO3** | Develop logical solutions using flowcharts, decision tables, and execution tracing techniques | ✓ | ✓ | ✓ | TS3 | PO2, PO3, PO4 |
| **CO4** | Describe AI concepts, intelligent systems, rational agents, and AI problem-solving approaches | ✓ | — | ✓ | TS4 | PO1, PO2, PO5 |
| **CO5** | Apply basic machine learning concepts including classification and clustering techniques | ✓ | — | ✓ | TS5 | PO2, PO3, PO5 |
| **CO6** | Analyze and compare traditional approaches with AI and ML-based intelligent systems | ✓ | — | ✓ | TS6 | PO2, PO4, PO5, PO11 |

*CO5 and CO6 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

*Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | – | – | – | – | – | – | 2 | 1 | 1 |
| CO2 | 2 | 3 | 2 | 1 | 1 | – | – | – | – | 1 | – | 2 | 2 | 1 |
| CO3 | 1 | 3 | 3 | 2 | 1 | – | – | – | – | 1 | – | 2 | 3 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 3 | 1 | – | – | 1 | 1 | 1 | 1 | 2 | 2 |
| CO5 | 1 | 3 | 2 | 1 | 3 | – | – | – | 1 | 1 | 1 | 1 | 3 | 2 |
| CO6 | 1 | 3 | 2 | 3 | 3 | – | – | – | 2 | 2 | 3 | 1 | 2 | 3 |
| Avg | 1.67 | 2.67 | 1.83 | 1.5 | 2 | 1 | – | – | 1.33 | 1.2 | 1.67 | 1.5 | 2.17 | 1.67 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | | M | | |
| CO2 | M | H | M | | | | | | | M | | M | M | |
| CO3 | | H | H | M | | | | | | M | | M | H | |
| CO4 | M | M | | | H | M | | | M | M | M | | M | M |
| CO5 | | H | M | | H | | | | M | M | M | | H | M |
| CO6 | | H | M | H | H | | | | M | M | H | | M | H |
| Avg | 1.7 | 2.7 | 1.8 | 1.5 | 2 | 0.5 | – | – | 1.3 | 1.2 | 1.67 | 1.5 | 2.17 | 1.67 |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 14. Self-Learning Activities (SL: 30 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | Assignment Writing assignments based on computing fundamentals, algorithms, AI concepts, and machine learning basics) | 2 assignments × 7 hrs each Total = 14 hrs | CO1–CO4 TS1–TS4 | Evaluated based on conceptual understanding, logical problem-solving ability, algorithm design, computational thinking, and assignment presentation quality |
| 2 | Technical Video-Based Learning related to the subject (e.g., Computer Organization, Flowcharts, Artificial Intelligence, Machine Learning Applications, Computational Thinking) | Video viewing: 3 hrs, Report preparation: 3 hrs, Presentation: 2 hrs Total = 8 hrs | CO2, CO4, CO5 TS2, TS4, TS5 | Presentation based on understanding of computational techniques, AI concepts, machine learning applications, and visual problem-solving methods |
| 3 | Real-World Case Studies (e.g., AI applications in healthcare, smart assistants, recommendation systems, intelligent automation, machine learning applications in daily life) | Data collection/study: 3 hrs, Report preparation: 5 hrs Total = 8 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on analytical thinking, comparative analysis, technical understanding, AI/ML application interpretation, and real-world problem-solving approach |
| | TOTAL Self-Learning Hours | 30 Hours | CO1–CO6 | All activities are compulsory. Submission deadlines will be communicated at the beginning of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

*OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

*Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | ≥ 40 / 100 | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**CSAI1101- Fundamental of Computing and Artificial Intelligence Summary**

*Theory-Only Course | 6 COs (CO1–CO6) | 2 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A

CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B

CO5–CO6: Evaluate/Create → TS5, TS6 → CA + ETE Sec B/C

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

# COURSE PLAN

## Basics of Electrical and Electronics Engineering (EEE1101)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | II |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | EEE1101 |
| 2 | **Course Title** | **Basics of Electrical and Electronics Engineering** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-1-2-3 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | To provide the students with an introductory concept in the field of electrical and electronics engineering to facilitate better understanding of the devices, techniques and equipment used in engineering applications. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Analyze – L4): Analyze DC and AC electrical circuits using Ohm's law, KCL, KVL, nodal/mesh methods, and network theorems to compute circuit parameters.<br>CO2 (Understand – L2): Explain the construction, working principles, losses, and efficiency of transformers and DC motors for suitable engineering applications. |

| | | |
|---|---|---|
| | | CO3 (Analyze – L4): Analyze the V–I characteristics of PN junction diodes and apply them in rectifier and clipper circuits with ripple factor calculation.<br>CO4 (Understand – L2): Interpret MOSFET characteristics and explain the role of CMOS technology and IC fabrication concepts.<br>CO5 (Analyze – L4): Simplify and design switching circuits using number systems, logic gates, Boolean algebra, and Karnaugh maps.<br>CO6 (Analyze – L4): Analyze electrical, electronics, and digital logic concepts to design and evaluate basic arithmetic and comparator circuits for engineering applications.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Conduct experiments on DC circuits, network theorems, transformer, DC motor, PN junction diode, rectifier circuits, and MOSFET simulation using standard laboratory instruments; record observations and verify theoretical concepts through measured values.<br>CO8 (Create – L5/L6): Design and implement CMOS inverter, logic gate circuits, adder, and subtractor circuits using simulation tools and IC components; tabulate results and validate the logical operation through experimental outputs.<br>CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible practices; perform skill self-assessment; reflect on learning to cultivate lifelong professional growth.<br>CO10 (Apply – L3): Collaborate and communicate effectively in team-oriented lab activities; plan, implement, and present programming solutions; apply project management principles. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs +Tutorial(T1)15 hrs + Lab Instructions (LI) 15 hrs + Self Learning (SL) 60 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 60 hrs)** | 1. Circuit Simulation Problems (LTspice/Multisim/Proteus) — *Minimum 15 circuit problems* covering KCL, KVL, nodal/mesh analysis, superposition, rectifier, clipper, MOSFET, CMOS inverter, logic gates, adder/subtractor, and comparator circuits.<br>2. Virtual Labs (IIT Virtual Labs) — *Electrical and Electronics experiments* such as KCL/KVL verification, transformer efficiency test, DC motor characteristics, PN diode V–I, rectifier, MOSFET, CMOS inverter, and logic gates.<br>3. MOOC Course (NPTEL/SWAYAM) — *Any one course* on Basic Electrical Circuits / Electrical Machines / Electronic Devices and Circuits / Digital Circuits for concept strengthening. |
| 11 | **References** | 1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.<br>2. S. K. Bhattacharya, “Basic Electrical and Electronics Engineering”, Pearson Publication.<br>3. Robert L Boylestad, “Electronic Devices and Circuit Theory” Pearson Education, 2009<br>4. "Digital Logic and Computer Design" by M. Morris Mano. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | Basics of Electrical Circuits (6-3-12-6 = 27 hrs) | |
| **A** | Introduction to electrical circuits: Voltage, Current, Resistance, and Power, Types of components-active, passive, unilateral, bilateral, Ohm’s Law, Types of sources-voltage, current, independent, dependent. Source transformation. | CO1,CO6 |
| **B** | Series and Parallel circuits, Kirchhoff’s Laws (KVL and KCL), Basic circuit analysis (nodal and mesh) techniques with DC source. Superposition Theorem. | |

| | | |
|---|---|---|
| C | Representation of AC signal, peak, average and rms values, real power, reactive power, apparent power, power factor | |
| Tools Used | Breadboard, Resistors, DC supply, Function generator, Multimeter, CRO/DSO, Circuit simulation tools (LTspice/Multisim), Virtual Labs. | |
| Activities | **Objective:** To understand and analyze basic DC/AC circuits using fundamental laws and theorems.<br><br>• Verification of Ohm's Law, KCL and KVL using measured values.<br>• Perform nodal and mesh analysis for given DC circuits.<br>• Demonstrate Superposition theorem through circuit setup/simulation.<br>• Measure RMS, peak values and compute power factor for AC signals. | |
| **Unit 2** | Transformer and DC Motor (4-3-8-6 = 21 hrs) | |
| A | Construction, working principle and applications of transformer, Types of transformer-step-up and step-down. | CO2, CO6 |
| B | EMF equation of transformer, Losses observed in transformer, Efficiency of transformer | |
| C | Construction, working principle and applications of DC motor. | |
| Tools Used | Transformer , DC motor setup, Ammeter, Voltmeter, Wattmeter, Tachometer, Virtual Labs. | |
| Activities | **Objective:** To understand working principles, losses and efficiency of electrical machines<br>• Observe transformer operation and identify losses.<br>• Calculate efficiency under different loading conditions.<br>• Demonstrate DC motor operation and direction control. | |
| **Unit 3** | **PN junction Diode and its applications (8-3-16-6 = 33 hrs)** | |
| A | Formation of PN junction and depletion layer, Forward and reverse biasing of PN junction diode, V-I characteristics of ideal and practical diodes. | CO3, CO6 |
| B | Half and Full Wave rectification using PN junction diodes, calculation of ripple factor. | |
| C | Application of diode as clipper circuit. | |
| Tools Used | Diodes, Breadboard, CRO/DSO, Function generator, Multimeter, Simulation tools, Virtual Labs. | |

| | | |
|---|---|---|
| **Activities** | **Objective:** To analyze diode characteristics and apply them in rectifier and clipper circuits.<br>•Plot V–I characteristics of PN junction diode.<br>•Construct rectifier circuits and compute ripple factor.<br>• Implement clipper circuits and observe waveform shaping. | |
| **Unit 4** | **MOS Transistors (6-3-12-6 = 27 hrs)** | |
| **A** | Introduction to MOSFET, depletion and enhancement type, drain characteristics and transfer characteristics. | CO4, CO6 |
| **B** | Introduction to CMOS technology | |
| **C** | Introduction to IC technology and role of transistors as a basic building block of ICs, CMOS inverter | |
| **Tools Used** | Simulation tools (LTspice/Proteus), Virtual Labs. | |
| **Activities** | **Objective:** To interpret MOSFET characteristics and understand CMOS/IC concepts.<br>• Plot MOSFET drain and transfer characteristics using simulation.<br>•Demonstrate CMOS inverter operation.<br>• Study IC building blocks using MOS technology. | |
| **Unit 5** | **Introduction to switching circuits (6-3-12-6 = 27 hrs)** | |
| **A** | Number System Concepts- Number base conversion, 1's Complement and 2's Complement, Fundamentals of Logic Gates, Universal logic gates, BCD and Gray codes. | CO5, CO6 |
| **B** | SOP and POS simplification of Boolean expressions using Karnaugh map (up to four variables), concept of don't care condition. | |
| **C** | Classification of digital circuits, Arithmetic circuits design-adder and subtractor, one-bit magnitude comparator. | |
| **Tools Used** | Logic gate trainer kit, ICs (7400 series), Breadboard, LEDs, Simulation tools, Virtual Labs. | |
| **Activities** | **Objective:** To design and simplify switching circuits using Boolean algebra and K-maps<br>• Verify logic gate operations using ICs.<br>• Simplify Boolean expressions using K-maps.<br>• Design and test adder, subtractor, and comparator circuits. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | ✔ | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✔ | ✓ | | | |
| 5 | 2.B | | | ✓ | ✔ | | |
| 6 | 2.C | | ✔ | ✓ | | | |
| 7 | 3.A | | ✔ | ✓ | ✓ | | |
| 8 | 3.B | | | ✓ | ✔ | | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | ✔ | ✓ | ✓ | | |
| 11 | 4.B | ✔ | ✔ | | | | |
| 12 | 4.C | ✔ | ✔ | ✔ | | | |
| 13 | 5.A | ✔ | ✔ | ✔ | | | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | | ✓ | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | | | | ✔ | | | | | | | | | | | | | | |
| CO2 | | ✔ | | | | | | | | | | | | | | | | |
| CO3 | | | | ✔ | | | | | | | | | | ✓ | ✓ | | | |
| CO4 | | ✔ | | | | | | | | | | | | ✓ | ✓ | | | |
| CO5 | | | | ✔ | | | | | | | | | | | ✓ | ✓ | | |
| CO6 | | | | ✔ | ✔ | | | | ✔ | | | | | | ✓ | ✓ | | |
| CO7 | | | ✓ | ✔ | | | | ✔ | | | | | ✓ | ✓ | ✓ | | | |
| CO8 | | | | | ✔ | | | ✔ | | | | | ✓ | ✓ | ✓ | ✓ | | |
| CO9 | | ✔ | ✓ | | | | ✔ | ✔ | ✔ | | | | ✓ | ✓ | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO10 | | | ✓ | | ✔ | | | ✓ | ✔ | | | | ✓ | ✔ | ✓ | | | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Voltage, Current, Resistance, Power; Active/Passive, Unilateral/Bilateral elements; Ohm's Law. | Unit 1 | 6 |
| DD/MM/YY | Types of sources: Voltage/Current, Independent/Dependent; Source transformation | | |
| DD/MM/YY | Series and Parallel circuits | | |
| DD/MM/YY | Kirchhoff's Laws (KCL, KVL) | | |
| DD/MM/YY | Nodal and Mesh analysis; Superposition theorem | | |
| DD/MM/YY | AC signals: Peak, Average, RMS; Real, Reactive, Apparent power; Power factor | | |
| DD/MM/YY | Construction and working principle of transformer; | Unit 2 | 6 |
| DD/MM/YY | Types of transformer | | |
| DD/MM/YY | EMF equation, losses in transformer | | |
| DD/MM/YY | efficiency calculation | | |
| DD/MM/YY | Construction and working principle of DC motor | | |
| DD/MM/YY | Applications of DC motor | | |
| DD/MM/YY | Formation of PN junction and depletion layer | Unit 3 | 6 |
| DD/MM/YY | Forward and reverse biasing of PN junction diode | | |
| DD/MM/YY | V–I characteristics of ideal and practical diode | | |
| DD/MM/YY | Half-wave Rectifier: Ripple factor | | |
| DD/MM/YY | Full-wave rectifiers; Ripple factor | | |
| DD/MM/YY | Diode clipper circuits and applications | | |
| DD/MM/YY | Introduction to MOSFET, depletion type | Unit 4 | 6 |
| DD/MM/YY | Enhancement type, drain characteristics and transfer characteristics | | |
| DD/MM/YY | Introduction to CMOS technology | | |
| DD/MM/YY | Introduction to IC technology | | |
| DD/MM/YY | Role of transistors as a basic building block of ICs | | |
| DD/MM/YY | CMOS inverter | | |
| DD/MM/YY | Number System Concepts- Number base conversion | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | 1's Complement and 2's Complement, Fundamentals of Logic Gates | Unit 5 | 6 |
| DD/MM/YY | Universal logic gates, BCD and Gray codes | | |
| DD/MM/YY | SOP and POS simplification of Boolean expressions using Karnaugh map (up to four variables) | | |
| DD/MM/YY | concept of don't care condition. | | |
| DD/MM/YY | Classification of digital circuits, Arithmetic circuits design-adder and subtractor, one-bit magnitude comparator. | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Configure DC circuit on breadboard; measure voltage & current | CO7 | 3.0 |
| | S-1.2 | Verify KCL & KVL using measured values | CO7 | |
| W2 | S-2.1 | Verify Superposition Theorem using experimental setup | CO7 | 3.0 |
| | S-2.2 | Compare theoretical and experimental results | CO7 | |
| W3 | S-3.1 | Determine transformer losses and calculate efficiency | CO7 | 3.0 |
| | S-3.2 | Study cut-section of transformer and observe construction | CO7 | |
| W4 | S-4.1 | Start DC motor and observe direction control | CO7 | 3.0 |
| | S-4.2 | Study DC motor parts and working | CO7 | |
| W5 | S-5.1 | Plot V–I characteristics of PN junction diode | CO7 | 3.0 |
| | S-5.2 | Design Half-wave rectifier and compute ripple factor | CO7 | |
| W6 | S-6.1 | Design Full-wave rectifier and compare performance | CO7 | 3.0 |
| | S-6.2 | Record readings and validate theoretical values | CO7 | |
| W7 | S-7.1 | MOSFET simulation: Plot drain & transfer characteristics | CO8 | 3.0 |
| | S-7.2 | Interpret simulation graphs and tabulate results | CO8 | |
| W8 | S-8.1 | CMOS inverter simulation and verify logic levels | CO8 | 3.0 |
| | S-8.2 | Analyze voltage transfer characteristics | CO8 | |
| W9 | S-9.1 | Implement logic gates using IC 74 series | CO8 | 3.0 |
| | S-9.2 | Verify AND, OR, NOT, NAND, NOR, XOR truth tables | CO8 | |
| W10 | S-10.1 | Design and implement Half Adder | CO8 | 3.0 |
| | S-10.2 | Verify truth table and outputs | CO8 | |

| | | | | |
|---|---|---|---|---|
| **W11** | S-11.1 | Design and implement Full Adder | **CO8** | 3.0 |
| | S-11.2 | Verify logical operation experimentally | **CO8** | |
| **W12** | S-12.1 | Design and implement Half Subtractor | **CO8** | 3.0 |
| | S-12.2 | Verify outputs and compare with theory | **CO8** | |
| **W13** | S-13.1 | Integrate diode, MOSFET, and logic circuit into a mini application | **CO8/CO10** | 3.0 |
| | S-13.2 | Team-based circuit implementation and documentation | **CO10** | |
| **W14** | S-14.1 | Lab record audit, safety compliance check, ethical handling of instruments | **CO9** | 3.0 |
| | S-14.2 | Self-assessment and reflection on experimental learning | **CO8/CO10** | |
| **W15** | S-15.1 | Mini project presentation: Design & demonstrate digital circuit | **CO8/CO10** | 3.0 |
| | S-15.2 | Final lab assessment, viva, record verification, presePeer review, teamwork evaluation, final lab submissionntation | **CO9/CO10** | |

ℹ *Instructions: Perform the experiment using standard electrical and electronics laboratory instruments and simulation tools. Record all observations, tabulations, circuit diagrams, measured readings, and calculated results in the lab record. The lab record (aim, apparatus required, circuit diagram, procedure, observation table, calculations, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | Factual Recall & Electrical Fundamentals | Recall definitions of voltage, current, resistance, power, circuit elements, types of sources, AC terms (peak/avg/RMS), and basic laws | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| **TS2** | Conceptual Understanding of Electrical Machines | Explain construction, working principles, EMF equation, losses, efficiency, and applications of transformers and DC motors | CO2 \| L2-L3 | MTE Sec A \| ETE Sec A |
| **TS3** | Circuit Analysis & Theorem Application | Apply Ohm's law, KCL, KVL, nodal/mesh methods, superposition theorem, AC power, and power factor to compute circuit parameters | CO1 \| L3-L4 | MTE Sec B \| ETE Sec B |

| | | | | |
|---|---|---|---|---|
| **TS4** | Electronic Device Characteristics & Applications | Analyze PN junction diode V–I characteristics; evaluate rectifier, clipper circuits, ripple factor; interpret MOSFET and CMOS inverter characteristics | CO3,CO4 \| L3-L4 | MTE Sec B \| ETE Sec B |
| **TS5** | Logic Simplification & Switching Theory | Simplify Boolean expressions using K-maps; analyze number systems, logic gates, codes, and switching concepts | CO5 \| L4 | ETE Sec B |
| **TS6** | Digital Circuit Design & Evaluation **Design** | Design and evaluate adder, subtractor, and comparator circuits using digital logic and electronics fundamentals | CO6 \| L4 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short answers: definitions, laws (Ohm's, KCL, KVL), AC terms (RMS, PF), transformer/DC motor construction, losses, efficiency |
| **Sec B** | **6** | TS3 — Procedural Application TS4 — Analytical Reasoning | **CO3, CO4** | Numerical/problem solving: nodal/mesh/superposition, AC power calculations; diode V–I analysis, ripple factor, rectifier/clipper; MOSFET/CMOS interpretation |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions: definitions, laws (Ohm's, KCL, KVL), AC terms (RMS, power factor), transformer/DC motor construction, losses, efficiency, diode/MOSFET basics, logic gate concepts (all units) |
| **Sec B** | **50** | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Numerical/problem solving: nodal/mesh/superposition, AC power; diode V–I, ripple factor, rectifier/clipper; MOSFET/CMOS interpretation; Boolean simplification using K-map; logic design and comparison |
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long/design questions: design switching/logic circuits (adder, subtractor, comparator); justify design choices; integrate electrical/electronic concepts in complete solutions |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | **CA1** — Define aim with circuit/device attributes, variables, and success criteria<br>**CA2** — Experimental setup, instrument selection, and connections<br>**CA7** — Circuit diagram / procedure / observation plan | **1.0**: Clear aim + proper design \| **0.5**: Partial setup/plan \| **0**: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | **CA3** — Correct execution; proper use of breadboard, meters, CRO/simulator<br>**CA4** — Accuracy of readings; tabulation; repeatability | **1.0**: Correct & accurate \| **0.5**: Minor errors \| **0**: Incorrect/failed | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | **CA5** — Analysis of readings; verification with theory (laws/characteristics)<br>**CA6** — Result interpretation and conclusion<br>**CA8** — Complete lab record; viva understanding | **0.75**: Thorough \| **0.5**: Adequate \| **0.25**: Partial \| **0**: Absent | CO8, CO9 |

| | | | | |
|---|---|---|---|---|
| **Professional Attitude & Ethical Conduct** | **0.25** | **CO9** — Responsible handling of instruments, neat wiring, safety<br>**PO7** — Professional and ethical conduct in lab | **0.25**: Consistent \| **0.10**: Occasional \| **0**: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| **CA1** | **Problem Definition & Metrics** | Define the experiment aim; identify measurable electrical/electronic parameters (V, I, R, waveforms, losses, ripple, logic states) and success criteria | CO7, CO8 |

| | | | |
|---|---|---|---|
| CA2 | Experimental Design & Tool Setup | Plan the experiment; select and configure breadboard, meters, CRO, power supply, ICs, and simulation tools | CO7 |
| CA3 | Code Implementation & Execution | Correct circuit connections / simulation setup; proper instrument usage to obtain expected readings | CO7 |
| CA4 | Computational Efficiency & Optimization | Accuracy of observations; repeatability; minimizing wiring/measurement errors | CO7 |
| CA5 | Output Analysis & Result Interpretation | Analyze readings/waveforms; explain deviations; verify laws/characteristics with evidence | CO8 |
| CA6 | Documented Outcome with Verification | Record observations, calculations, graphs, and final result; verify with theory | CO7, CO8 |
| CA7 | Algorithmic Design & Solution Planning | Draw circuit diagram/truth table/procedure before execution; justify design choices | CO7, CO8 |
| CA8 | Lab Record Maintenance & Viva-Voce | Maintain complete lab record; demonstrate conceptual understanding and professional practice | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | SDG Alignment & Social Relevance | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | Problem Scoping & Requirements | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | Communication & Testing Strategy | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | Innovative Solution Proposal | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | Professional Toolchain | Select and justify development tools; configure professional project environment | CO7 \| PO5 |
| P6 | End-to-End Implementation | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |

| | | | |
|---|---|---|---|
| P13 | **Professional Attitude, Ethics & Responsibility** | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | M | | M | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | | | | | H | H | H | M | | M | H | H | | | | M | H | H | H | | M | | | M | H |
| CO8 | | | | | | | M | | M | | H | H | H | H | M | H | | H | M | H | M | H | H | M | | H | M |
| CO9 | | | | | | | | | | | | | | H | | | H | | | | | | | H | | H | H |
| CO10 | | | | | | | | | | | | | H | H | | M | H | H | | M | H | M | H | H | | H | H |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

**PART IV**

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | – | – | – | – | – | – | – | – | 1 | – | – | – |
| CO2 | 3 | 2 | – | – | – | – | – | – | 1 | – | 2 | – | – | – |
| CO3 | 3 | 3 | 2 | – | 2 | 1 | – | – | 1 | – | 2 | – | – | – |
| CO4 | 2 | 3 | 2 | 2 | 2 | – | – | – | – | – | 2 | – | – | – |
| CO5 | 2 | 3 | 3 | 2 | 3 | – | – | – | – | – | 2 | – | – | – |
| CO6 | 2 | 2 | 3 | 2 | 3 | 2 | – | 2 | 1 | 1 | 3 | – | – | – |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | – | – | – |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | – | – | – |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | – | – |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | – | – | – |
| Avg | 1.50 | 2.14 | 2.33 | 1.75 | 2.33 | 1.80 | 3.00 | 2.50 | 1.50 | 2.00 | 2.13 | 2.22 | 2.30 | 2.38 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |
| CO2 | H | M | | | | | | | M | | |
| CO3 | M | H | M | | M | M | | | M | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | M | | H | H | H | M | |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in electrical, electronics, and digital fundamentals; promotes analytical thinking and lifelong learning through theory (CO1–CO6) and reflective lab practice (CO9) |
| SDG 7 | Affordable & Clean Energy | 3 (High) | Covers transformers, AC power, power factor, and efficiency (CO1, CO2) that are essential for energy-efficient systems and power utilization. |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops practical skills in circuit analysis, machines, devices, and tool usage (CO7, CO8) relevant to core engineering industries. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables design of rectifiers, MOSFET/CMOS circuits, logic gates, and arithmetic circuits (CO3–CO6, CO8, CO10) supporting innovation in electronics and infrastructure. |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Encourages efficient circuit design, optimal component usage, and ethical lab practices (CO7, CO9) promoting responsible engineering. |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Calculus and Abstract Algebra (MTT1113)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | I |
| **Course Code:** | MTT1113 | **Course Type:** | Core — Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **MTT1113** |
| 2 | **Course Title** | **Calculus and Abstract Algebra** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P)** | 3-1-0- (Theory: 40 hrs Classroom = 40 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |

| | | |
|---|---|---|
| 6 | **Course Objectives** | 1. To develop a clear understanding of the fundamental concepts of **Calculus** and **Linear Algebra**.<br>2. To equip students with mathematical methods and techniques for solving engineering and scientific problems.<br>3. To enhance analytical, logical, and problem-solving skills through the application of mathematical concepts.<br>4. To provide a strong foundation for advanced studies and real-world applications in engineering and related fields. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Define the concept of differential calculus and illustrate Maxima, minima and saddle points.<br>CO2 (Explore – L2/L3): Explore the basic concept of sets, relation, functions, groups, Rings and Field<br>CO3 (Apply – L3): Apply the rank method to evaluate system of linear equation and inverse of a matrix.<br>CO4 (Analyze – L4/L5): Integrate and Analyze the vector space. Determine linear dependence and independence of vectors. Evaluate basis and dimension of vector spaces. Understand linear transformations (maps).<br>CO5 (Analyze – L4/L5): Analyze various memory to Evaluate inverse of a linear transformation. Determine the matrix representation of linear maps.<br>CO6 (Analyze – L2/L4): Interpret the inner product spaces and build Gram-Schmidt orthogonalization process**.** |
| 8 | **Course Description** | This course is an introduction to the fundamental of Mathematics. The primary objective of the course is to develop the basic understanding of differential and integral calculus, linear Algebra and Abstract Algebra. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 30 hrs \| Self Learning (SL): 30 hrs \| Total: 60 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.<br>2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. |
| 12 | **References** | 1. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.<br>2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.<br>3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.<br>4. V. Krishnamurthy, V.P. Mainra and J.L. Arora, An introduction to Linear Algebra, Affiliated East–West press, Reprint 2005. |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Calculus** | |

| | | |
|---|---|---|
| A | Differentiation, Successive differentiation Taylor's and Maclaurin theorems, indeterminate forms, L' Hospital's rule | CO1 |
| B | Partial derivatives, Total derivative, Euler's theorem for homogeneous function, Maxima and minima for function of two variables | CO1 |
| C | Evaluation of double integration, Applications of double integral | CO1 |
| | **Unit 2: Basic Algebra** | |
| A | Sets, relations and functions | CO1, CO2 |
| B | Basics of groups, Subgroups | CO1, CO2 |
| C | Cyclic groups, basics of Rings and Field | CO1, CO2 |
| | **Unit 3: Matrices** | |
| A | Matrices: Addition, subtraction and scalar multiplication, matrix multiplication, Symmetric, Skew-Symmetric and orthogonal Matrices | CO1, CO2 |
| B | Determinants, rank of a matrix, Systems of linear equations, linear Independence and dependence. Cramer's Rule | CO1, CO2, CO3, CO4 |
| C | Inverse of a matrix by using elementary transformation, Gauss elimination and Gauss-Jordan elimination, Eigenvalues, Eigenvectors, Diagonalization | CO1, CO2, CO3, CO4 |
| | **Unit 4: Vector Space and Linear Transformation** | |
| A | Vector Space, linear dependence and Independent of vectors, basis, dimension | CO1, CO2, CO3, CO5 |
| B | Introduction to linear transformations (maps) | CO1, CO2, CO3, CO5 |
| C | Range and kernel space of a linear transformation, rank and nullity of L.T. | CO1, CO2, CO3, CO5 |
| | **Unit 5: Inverse of Linear and Gram Schmidt Orthonormalization** | |
| A | Inverse of a linear transformation, Matrix associated with a L.T. | CO1, CO2, CO3, CO6 |
| B | Basic introduction of Inner product spaces | CO1, CO2, CO3, CO4, CO6 |
| C | Gram-Schmidt orthogonalization | CO1, CO2, CO3, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | | | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | ✓ | ✓ | ✓ | | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | | | | | | | ✓ | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | | | | | | | | | |
| CO5 | | | | ✓ | ✓ | | | ✓ | | | | | | | | | | |
| CO6 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 56 Lectures / 56 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Differentiation: Basic concepts and standard rules of differentiation | UNIT-1 | 9 |
| DD/MM/YY | Successive Differentiation and higher-order derivatives | | |
| DD/MM/YY | Taylor's Theorem and its applications | | |
| DD/MM/YY | Maclaurin's Theorem and series expansions | | |
| DD/MM/YY | Indeterminate Forms and introduction to L'Hospital's Rule | | |
| DD/MM/YY | Applications of L'Hospital's Rule in evaluating limits | | |
| DD/MM/YY | Partial Derivatives and their geometrical interpretation | | |
| DD/MM/YY | Maxima and Minima of Functions of Two Variables | | |
| DD/MM/YY | Applications of Double Integrals (Area, Volume, and Engineering Applications | | |
| DD/MM/YY | Introduction to Sets: Types of Sets, Set Operations | UNIT-2 | 8 |
| DD/MM/YY | Relations: Definition, Types of Relations, and Properties | | |
| DD/MM/YY | Functions: Definition, Types of Functions, and Composition of Functions | | |
| DD/MM/YY | Algebraic Structures and Introduction to Groups | | |
| DD/MM/YY | Groups: Definition, Examples, and Basic Properties | | |
| DD/MM/YY | Subgroups: Definition, Tests for Subgroups, and Examples | | |
| DD/MM/YY | Cyclic Groups: Examples and Applications | | |
| DD/MM/YY | Basics of Rings: Definition, Examples, and Fundamental Properties | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Introduction to Matrices: Addition, Subtraction, and Scalar Multiplication | UNIT-3 | 8 |
| DD/MM/YY | Special Matrices: Symmetric, Skew-Symmetric, and Orthogonal Matrices | | |
| DD/MM/YY | Rank of a Matrix and its Computation | | |
| DD/MM/YY | Systems of Linear Equations; Linear Independence and Dependence | | |
| DD/MM/YY | Cramer's Rule and Applications | | |
| DD/MM/YY | Inverse of a Matrix using Elementary Transformations | | |
| DD/MM/YY | Eigenvalues and Eigenvectors: Definitions, Properties, and Computation | | |
| DD/MM/YY | Diagonalization of Matrices and Applications | | |
| DD/MM/YY | Introduction to Vector Spaces: Definition, Examples, and Basic Properties | UNIT-4 | 7 |
| DD/MM/YY | Subspaces of a Vector Space and Related Examples | | |
| DD/MM/YY | Tests for Linear Dependence and Independence | | |
| DD/MM/YY | Basis of a Vector Space: Definition and Properties | | |
| DD/MM/YY | Introduction to Linear Transformations (Maps): Definition and Examples | | |
| DD/MM/YY | Properties of Linear Transformations and Matrix Representation | | |
| DD/MM/YY | Range Space and Kernel (Null Space) of a Linear Transformation | | |
| DD/MM/YY | Review of Linear Transformations and Conditions for Invertibility | UNIT-5 | 8 |
| DD/MM/YY | Inverse of a Linear Transformation | | |
| DD/MM/YY | Examples of an inverse Linear Transformation | | |
| DD/MM/YY | Finding the Inverse of a Linear Transformation with Examples | | |
| DD/MM/YY | Matrix Associated with a Linear Transformation | | |
| DD/MM/YY | Introduction to Inner Product Spaces: Definition and Examples | | |
| DD/MM/YY | Properties of Inner Products, Norms, and Orthogonality | | |
| DD/MM/YY | Gram–Schmidt Orthogonalization Process | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Calculus and Multivariable Analysis** | Ability to apply differential and integral calculus techniques to analyze functions, solve optimization problems, and evaluate double integrals in theoretical and practical contexts. | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| **TS2** | **Set Theory and Algebraic Structures** | Ability to apply concepts of sets, relations, functions, groups, subgroups, cyclic groups, rings, and fields to analyze and solve mathematical problems. | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| **TS3** | **Matrices and Linear Systems** | Ability to perform matrix operations, solve systems of linear equations, determine matrix properties, and apply eigenvalue, eigenvector, and diagonalization techniques to mathematical and engineering problems. | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| **TS4** | **Vector Spaces and Transformations** | Analyze vector spaces, determine linear dependence and independence, identify bases and dimensions, and apply concepts of linear transformations to mathematical problems. | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | **Linear Transformation Analysis** | Analyze to determine the range, kernel, rank, and nullity of linear transformations, find inverses, and represent linear transformations using matrices | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | **Inner Product Spaces and Orthogonality** | Analyze to inner product spaces and apply the Gram–Schmidt orthogonalization process to obtain orthogonal and orthonormal bases. | CO6 \| L2–L4 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Process Interpretation | TS3 Algorithmic Application | TS4 Performance Evaluation | TS5 Memory System Analysis | TS6 File & Disk Evaluation |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | M | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **25** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5, TS6 |
| **TOTAL** | — | **25** | | |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 concepts: Differential Calculus and Double Integration | CO1 | TS1 | 6h | Report submission + evaluation |
| **Assignment 2** | Fundamentals of Abstract Algebra and Set Theory | CO2 | TS2 | 6h | Numerical problems on process management |

| | | | | | |
|---|---|---|---|---|---|
| **Assignment 3** | Matrices and Linear Algebra | CO2, CO3 | TS2, TS3 | 6h | Numerical computation + comparison |
| **Assignment 4** | Vector Spaces and Linear Transformations | CO3, CO4 | TS3, TS4 | 6h | Step-by-step numerical trace required |
| **Assignment 5** | Inverse of a Linear Transformation and IPS | CO3, CO4, CO5 | TS3, TS4, TS5 | 6h | Algorithm application + performance analysis |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **10** | TS1 — Conceptual Recall & Identification TS2 — Conceptual Explanation & Process Interpretation | **CO1, CO2** | Short-answer: define differentiation, maxima and minima, Evaluate double integrals over given regions, ring, field |
| **Section B** | **15** | TS3 — Algorithmic Application TS4 — Algorithmic Analysis & Performance Evaluation | **CO2, CO3, CO4** | Numerical problems: Compute eigenvalues and eigenvectors of matrices. Diagonalize matrices and verify diagonalization |
| **TOTAL** | **25** | TS1–TS4 | **CO1–CO4** | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1 — Conceptual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions (all units): definitions, define differentiation, maxima and minima, Evaluate double integrals over given regions, ring, field |
| **Section B** | **25** | TS3 —matrix and linear system of equations TS4 — Vector space TS5 — Linear transformation Analysis | **CO3, CO4, CO5** | Medium questions: system of linear transformation and vector space |

| | | | | |
|---|---|---|---|---|
| **Section C** | **10** | TS5 — Inverse of L.T. TS6 — Gram Schmidt orthonormalization | **CO5, CO6** | Long/evaluation questions: Construct orthonormal basis. |
| **TOTAL** | **50** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Understand basic concepts, differentiation and integration | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| **CO2** | Explain the basic concept of sets, relation, functions, groups, Rings and Field | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| **CO3** | Apply the rank method to evaluate system of linear equation and inverse of a matrix | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Analyze the vector space. Determine linear dependence and independence of vectors. Evaluate basis and dimension of vector spaces | ✓ | ✓ | ✓ | TS4 | PO9, PO10, PO11 |
| **CO5** | Evaluate inverse of a linear transformation. Determine the matrix representation of linear maps | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Interpret the inner product spaces and build Gram-Schmidt orthogonalization process | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO6 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| Avg | 3.0 | 3.0 | 2.16 | 2.16 | 2.16 | 1.3 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 3.0 | 3.0 | 2.16 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | H | H | | | | M | M | M | M | H | M | M |
| CO2 | H | M | H | H | | | | M | M | M | M | M | H | M |
| CO3 | H | H | H | H | | | | M | M | M | H | H | M | M |
| CO4 | M | M | M | M | M | | | M | H | H | H | M | M | M |
| CO5 | M | M | H | | | | | H | H | M | M | H | | |
| CO6 | H | M | | | | | | | | M | H | M | M | |

## 14. Self-Learning Activities (SL: 30 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Numerical Assignment Writing (5 assignments, problem-based, one per unit focus area)** | 5 assignments × 6 hrs each<br>Total = 30 hrs | CO1–CO6 TS1–TS6 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance |

| | | | | |
|---|---|---|---|---|
| | **TOTAL Self-Learning Hours** | **30 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**MTT1113 — Calculus and Abstract Algebra**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

| | | | |
|---|---|---|---|
| **School: SSCSE** | | **Batch : 2026-2030** | |
| **Program: B.Tech.** | | **Current Academic Year: 2026-27** | |
| **Branch: CSE-AIML** | | **Semester: I** | |
| 1 | Course Code | IKT1105 | |
| 2 | Course Title | Human Values and Professional Ethics | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 2-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of Existence | |
| 6 | Course Outcomes | 1. Understand that the technical education without study of human values can generate more problems than solutions.<br>2. Define the principles and ideals, which help in making the judgement of what is more important.<br>3. See that 'I' and 'Body' are two realities, and most of their desires are related to 'I' and not body, while their efforts are mostly centred on the fulfilment of the needs of the body assuming that it will meet the needs of 'I' too.<br>4. Appreciate the importance of harmony in the self, family and the society for mutual fulfilment.<br>5. Understand the importance of harmony among human beings, other living beings and entire nature for universal equilibrium and mutual co-existence.<br>6. Know and practice the ethical approach in profession for continuous happiness and sustained prosperity. | |
| 7 | Course Description | Human values and embedded in all human beings it is important to sensitize them towards these values that they can use in their life to attain mutual happiness and mutual prosperity. Professional ethics will enlighten them about the value addition that can be done within the framework of ethical behavior. | |
| 8 | Outline syllabus | | CO Mapping |
| | Unit 1 | The Need and Process for Value Education | |
| | A | The need, basic guidelines, content, and process for Value Education | CO1 |
| | B | Concept of 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration; Continuous Happiness and Prosperity- A look at basic Human Aspirations | CO1,CO2 |
| | C | Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment aspirations of every human being with their correct priority | CO1,CO2 |
| | Unit 2 | Understanding Harmony in the Human Being - Harmony in Myself | |
| | A | Human being as a co-existence of the sentient 'I' and the material 'Body' | CO3 |

| | | | |
|---|---|---|---|
| | | | |
| | B | The needs of Self ('I') and 'Body' ; Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) | CO3 |
| | C | The characteristics and activities of 'I' and harmony in 'I' ; Understanding the harmony of I with the Body: Correct appraisal of Physical needs, meaning of Prosperity in detail | CO3 |
| | Unit 3 | Harmony in the Family and Society | |
| | A | Values in human-human relationship; Trust and Respect as the foundational values of relationship | CO4 |
| | B | Understanding the meaning of Trust; Difference between intention and competence; The meaning of Respect; Difference between respect and differentiation; the other salient values in relationship | CO4 |
| | C | Harmony in the society (society being an extension of family; Visualizing a universal harmonious order in society - from family to world family | CO4 |
| | Unit 4 | Harmony in the Nature and Existence | |
| | A | The harmony in the Nature | CO5 |
| | B | Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature | CO5 |
| | C | Understanding Existence as Co-existence of mutually interacting units in all-pervasive space | CO5 |
| | Unit 5 | Competence in professional ethics | |
| | A | Ability to utilize the professional competence for augmenting universal human order | CO6 |
| | B | Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, | CO6 |
| | C | Ability to identify and develop appropriate technologies and management patterns for above production systems. | CO6 |
| | Mode of examination | Theory | |
| | Weight age Distribution | CA (25%) — ESE (75%) | |
| | | Assessment 1 (10) \| Assessment 2 (5) \| Assignment 1 (5) \| Assignment 2 (5) | |
| | Text book/s* | 1. R.R Gaur, R Sangal, G P Bagaria, "A foundation course in Human Values and professional Ethics", Excel books, New Delhi | |
| | Other References | 1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow.<br>2. A.N. Tripathy, 2003, Human Values, New Age International Publishers.<br>3. PL Dhar, RR Gaur, Science and Humanism, Commonwealth Publishers. Starting out with Python, Tony Gaddis, Pearson | |

COURSE ARTICULATION MATRIX

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 1 | 0 | 0 |
| **CO2** | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 |
| **CO3** | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| **CO4** | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 0 |
| **CO5** | 0 | 1 | 0 | 1 | 0 | 2 | 2 | 2 | 0 | 1 | 0 | 0 | 1 | 0 |
| **CO6** | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 1 | 1 | 0 | 1 | 0 |

| **Avg. Attainment** | 1 | 1 | - | 1 | - | 1.5 | 2 | 2.17 | 1 | 1 | 1 | 1 | 1 | - |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

# COURSE PLAN

## Programming for Problem Solving (CSCR1300)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I**

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Shadra School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | I |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR1300 |
| 2 | **Course Title** | **Programming for Problem Solving** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-4-2 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | To introduce the fundamentals of programming using C and develop problem-solving skills through structured lab practice, design exercises, ethical coding, and collaborative project work. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Remember – L1): Recall and list fundamental concepts of C programming such as keywords, data types, operators, and syntax.<br>CO2 (Understand – L2): Explain the working of operators, control structures, functions, arrays, and preprocessing directives in C programming.<br>CO3 (Apply – L3): Develop C programs using control statements, functions, arrays, and strings to solve basic computational problems.<br>CO4 (Analyze – L4): Analyze and debug C programs involving pointers, recursion, structures, and dynamic memory allocation.<br>CO5 (Evaluate – L5): Evaluate different programming approaches and optimize C programs using appropriate data structures, file handling, and memory management techniques.<br>CO6 (Create – L6): Design, implement, and demonstrate complete C-based solutions by integrating functions, pointers, structures, and file handling to solve real-world problems.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Implement C programs using professional tools (gcc, Linux CLI, debuggers); configure experimental setups; demonstrate system operation; maintain structured lab records.<br>CO8 (Create – L5/L6): Design and develop modular C applications addressing real-world problems with societal awareness; propose solutions with planning considerations; evaluate outcomes analytically.<br>CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible practices; perform skill self-assessment; reflect on learning to cultivate lifelong professional growth.<br>CO10 (Apply – L3): Collaborate and communicate effectively in team-oriented lab activities; plan, implement, and present programming solutions; apply project management principles. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 60 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |

| | | |
|---|---|---|
| 10 | **Self Learning (SL: 30 hrs)** | 1. Coding Problems on HackerRank/LeetCode — 15 coding problems minimum. 2. Virtual Labs (NPTEL): C programming experiments. 3. MOOC course on C/Data Structures (SWAYAM/Coursera). |
| 11 | **References** | Textbook: Kernighan, B. & Ritchie, D. — The C Programming Language (2nd Ed.), Prentice Hall.<br>Reference: Balagurusamy, E. — Programming in ANSI C (8th Ed.), McGraw-Hill.<br>Reference: Kanetkar, Y. — Let Us C (17th Ed.), BPB Publications. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction to C Programming (4-0-10-6 = 20 hrs)** | |
| **A** | Introduction to C language, Variables, Constants, Identifiers and Keywords | CO1, CO2, CO3 |
| **B** | Data Types: Format specifiers, modifiers, type casting | |
| **C** | Operators: Category, Expressions: Associativity & Precedence | |
| **Tools Used** | Linux Environment, Whiteboards, sticky notes, gcc compiler, Virtual Labs | |
| **Activities** | **Objective:** To familiarize students with Linux commands and develop a clear understanding of the C programming environment along with its basic tokens.<br>• Study of Linux Commands<br>  ○ Working with Directories<br>  ○ Handling Files<br>  ○ Understanding of gcc compiler, writing code in C, compiling and executing on Linux Environment.<br>• Demonstration and use of different data types, variables, constants, Operators<br>• Implementing some programs based on mathematical expression with the consideration of associativity and precedence. | |
| **Unit 2** | **Control Statements (6-0-12-6 = 24 hrs)** | |
| **A** | Decisions: if, if-else, Nested if-else, if-else-if ladder, Switch Case | CO3, CO4 |
| **B** | Iterations: While, Do While, For Loop, Nested Looping, Pattern Printing | |
| **C** | Execution Sequence: GOTO, Break, Continue | |

| | | |
|---|---|---|
| **Tools Used** | Linux Environment, Competitive coding platforms (Leetcode, Hackerrank, etc.), Virtual Labs, whiteboards, online compilers, GitHub. | |
| **Activities** | **Objective:** To apply decision-making and iterative constructs for designing efficient solutions with appropriate program control flow.<br>• Identify the suitability of selection statements (if, if-else, conditional operator) and implement programs by applying more suitable form of selection statement.<br>• Demonstrate the use of switch statement with the help of menu-driven programs. | |
| **Unit 3** | **Functions & Arrays (8-0-16-6 = 30 hrs)** | |
| **A** | Functions: Definition, Declaration/Prototyping, Calling, Types, Recursion, Storage Classes | CO2, CO3, CO4, CO5, CO6 |
| **B** | Pre-processors: Directives, Operators (#, ##, \), Macros: Types, Use, Predefined Macros | |
| **C** | Arrays: 1D & 2D — Declaration, Initialization, Traversal, Manipulation | |
| **Tools Used** | Linux Environment, Competitive coding platforms (Leetcode, Hackerrank, etc.), Virtual Labs, whiteboards, online compilers, GitHub. | |
| **Activities** | **Objective:** To understand the concept of functions, recursive solution, recursion and Arrays, manipulating array elements, arrays of unknown or varying size.<br>• Apply Top-Down approach for finding solutions and implement it with the help of functions.<br>• Identify need of manipulating actual parameters and demonstrate call by value and call by reference.<br>• Implementation of recursive functions for various recursively defined problems.<br>• Implementing one dimensional array: Initialization, manipulation, traversing.<br>• Implement programs to search and sort a given array.<br>• Writing some problems based on matrix manipulation.<br>• Analyze need of partial compilation, named constants and function like Macros. Demonstrate use of them with the help of suitable problem statements. | |
| **Unit 4** | **Pointers & Strings (6-0-12-6 = 24 hrs)** | |
| **A** | Pointer: Introduction, Declaration, Pointer arithmetic, Array of Pointers, Pointer to Pointer | CO3, CO4, CO5 |
| **B** | Dynamic Memory Allocation (malloc, calloc, realloc, free), Call by Reference, Passing/Returning Arrays | |
| **C** | Strings: Introduction, Predefined string functions, Manipulation, Command Line Arguments | |

| | | |
|---|---|---|
| **Tools Used** | Linux Environment, Competitive coding platforms (Leetcode, Hackerrank, etc.), Virtual Labs, whiteboards, online compilers, GitHub. | |
| **Activities** | **Objective:** To understand addresses, pointers, dynamic memory allocation, and strings, and apply these concepts for efficient string handling and implementation of string functions.<br>• Demonstration of pointer arithmetic and indirection operator.<br>• Manipulation on strings (extraction, matching, concatenation)<br>• Implement dynamic memory allocation to create array of variable size. | |
| **Unit 5** | **User-Defined Data Types & File Handling (6-0-10-6 = 22 hrs)** | |
| **A** | Structures, Unions, typedef & Enumeration: Introduction, Declaration, Differences, Application | CO2, CO3, CO4, CO5, CO6 |
| **B** | Nested structure, self-referential structure, Array of structures, Passing structures to functions | |
| **C** | Files: Introduction, I/O Streaming, Sequential/Random access, Creating, Opening, Closing, R/W operations | |
| **Tools Used** | Linux Environment, Competitive coding platforms (Leetcode, Hackerrank, etc.), Virtual Labs, whiteboards, online compilers, GitHub. | |
| **Activities** | **Objective:** To understand file operations, sorting algorithms, and user-defined structures, and apply them for efficient data organization and processing.<br>• Implementation of binding heterogeneous/composite information for a single entity using structure.<br>• Implementation of organizing data as Linked node with the help of self-referential structures.<br>• Demonstrate the use of Union in memory sharing.<br>• Creation and manipulation of data stored in a file on auxiliary memory.<br>• Demonstration of reading data from file and execution of program to perform operations. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | | ✓ | | | |
| 5 | 2.B | | | ✓ | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | | | ✓ | ✓ | | ✓ |
| 8 | 3.B | | ✓ | ✓ | | ✓ | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | | | |
| 13 | 5.A | | ✓ | ✓ | | ✓ | ✓ |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | | ✓ | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | | | | | | | | | ✓ | | |
| CO6 | | | | | | ✓ | | | ✓ | | | | | | | ✓ | ✓ | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | |
| CO8 | | | | | ✓ | ✓ | | | ✓ | | | | | | ✓ | ✓ | ✓ | |
| CO9 | | | ✓ | | | | | | | ✓ | ✓ | | | | | | | |
| CO10 | | | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | |

*Legend: ✓ = Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|

| | | | |
|---|---|---|---|
| DD/MM/YY | Introduction to C language, Variables, Constants, Identifiers, Keywords | Unit 1 | 4 |
| DD/MM/YY | Data Types: Format specifiers, modifiers, type casting | | |
| DD/MM/YY | Operators: Category | | |
| DD/MM/YY | Operators: Expressions — Associativity & Precedence | | |
| DD/MM/YY | Decisions: if, if-else, Nested if-else | Unit 2 | 6 |
| DD/MM/YY | Decisions: if-else-if ladder, Switch Case | | |
| DD/MM/YY | Iterations: Importance of iterative construct, While | | |
| DD/MM/YY | Iterations: For Loop, Do While | | |
| DD/MM/YY | Iterations: Nested Looping, Pattern Printing | | |
| DD/MM/YY | Execution Sequence: GOTO, Break, Continue | | |
| DD/MM/YY | Functions: Definition, Declaration/Prototyping, Calling, Types | Unit 3 | 8 |
| DD/MM/YY | Functions: Parameter passing — Call by value, Recursion | | |
| DD/MM/YY | Recursive Functions, Tail Recursion, Storage Classes | | |
| DD/MM/YY | Pre-processors: Directives, Operators (#, ##, \) | | |
| DD/MM/YY | Macros: Types, Use, Predefined Macros | | |
| DD/MM/YY | Arrays: Definitions, Concepts, Memory representation | | |
| DD/MM/YY | Arrays: 1D and 2D — Declaration, Initialization | | |
| DD/MM/YY | Arrays: Array manipulation | | |
| DD/MM/YY | Pointer: Introduction, Declaration, demonstration of memory address | Unit 4 | 6 |
| DD/MM/YY | Pointer: Arithmetic, Array of Pointers, Pointer to Pointer | | |
| DD/MM/YY | Dynamic Memory Allocation: malloc, calloc, realloc, free | | |
| DD/MM/YY | Call by Reference, Passing and Returning Arrays from Functions | | |
| DD/MM/YY | Strings: Introduction, Predefined string functions | | |
| DD/MM/YY | Strings: Manipulation of text data, Command Line Arguments | | |
| DD/MM/YY | Structures: Introduction, Declaration, Application | Unit 5 | 6 |
| DD/MM/YY | Unions, typedef & Enumeration: Introduction, Declaration | | |
| DD/MM/YY | Nested structure, self-referential structure, Array of structures | | |
| DD/MM/YY | Files: Introduction, I/O Streaming, Sequential and Random access | | |
| DD/MM/YY | Files: Creating, Opening, Closing; I/O operations | | |
| DD/MM/YY | Files: Retrieving and updating files in Sequential/Random mode | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Setting up environment: Linux commands, gcc, first C program — professional tool setup | CO7 | 3.0 |
| | S-1.2 | Calculate average of three integers; Four-fours digit problem | CO7 | |
| W2 | S-2.1 | Currency denominations (Rs. 10, 50, 100); Gross salary calculator | CO7 | 3.0 |
| | S-2.2 | Reverse a 5-digit number; Interchange contents of two variables | CO7 | |
| W3 | S-3.1 | Calculate area of triangle; Area & circumference of circle | CO7 | 3.0 |
| | S-3.2 | Bitwise operations on a number: set, check, toggle, and clear a bit | CO7 | |
| W4 | S-4.1 | Character classification; Find roots of quadratic equation | CO7 | 3.0 |
| | S-4.2 | Find youngest of three (Ram, Shyam, Ajay); Leap year check | CO7 | |
| W5 | S-5.1 | Check vowel/consonant via Switch-Case; Calculator for +, −, ×, ÷ | CO7 | 3.0 |
| | S-5.2 | Income tax calculator with personal allowance and child allowance slabs | CO7 | |
| W6 | S-6.1 | Check if a number is Armstrong (e.g., 153 = $1^3+5^3+3^3$) | CO7 | 3.0 |
| | S-6.2 | Print star patterns up to Nth line: pyramid and diamond shapes | CO7 | |
| W7 | S-7.1 | Calculate Permutation & Combination; refactor into modular functions | CO7 | 3.0 |
| | S-7.2 | Recursive function for sum of array; recursive exponentiation | CO7 | |
| W8 | S-8.1 | Menu-driven 1D array: display, sum, average | CO7 | 3.0 |
| | S-8.2 | Extend W8.1: minimum, maximum, search, bubble sort — all via functions | CO7 | |
| W9 | S-9.1 | Menu-driven 2D arrays: row sums, column sums, diagonal sums | CO7 | 3.0 |
| | S-9.2 | Extend W9.1: matrix addition and multiplication via functions | CO7 | |
| W10 | S-10.1 | Dynamic 1D array; functions for insert and delete operations | CO7 | 3.0 |
| | S-10.2 | Extend W10.1: Linear Search vs Binary Search with performance comparison | CO7 | |
| W11 | S-11.1 | Extract characters at Fibonacci index positions from string; name formatter | CO7 | 3.0 |
| | S-11.2 | Count character frequency; word count in a string; print frequency table | CO7 | |
| W12 | S-12.1 | Dynamic array of size n1; expand by n2; print all values | CO7 | 3.0 |
| | S-12.2 | Dynamic array with auto-doubling at 75% occupancy — efficiency analysis | CO7 | |
| W13 | S-13.1 | Structure 'product': name, price, qty, amount — real-world application with SDG context | CO8 | 3.0 |
| | S-13.2 | Structure 'student_record' with nested 'date'; array of structures — societal relevance discussion | CO8 | |
| W14 | S-14.1 | Complex number ADT using structures: design, document, and reflect — CO9 reflection form submitted | CO8/CO9 | 3.0 |
| | S-14.2 | Implement simple linked list — team implementation, role assignment, peer review session | CO8/CO10 | |

| | | | | |
|---|---|---|---|---|
| W15 | S-15.1 | Merge & sort files — ethical data handling; skill self-assessment form submitted | CO8/CO9 | 3.0 |
| | S-15.2 | Text file to lowercase; frequency counts — team code review, final presentation, group reflection | CO9/CO10 | |

ℹ *Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Factual Recall & Conceptual Recognition | Recall keywords, data types, operators, I/O constructs, and syntax; identify correct terminology | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| TS2 | Conceptual Explanation & Logical Interpretation | Explain constructs and working; interpret program flow; predict output through step-by-step reasoning | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| TS3 | Procedural Application & Problem Solving | Apply constructs to write correct programs solving standard computational problems | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| TS4 | Analytical Reasoning & Program Tracing | Trace execution manually; detect bugs; assess correctness; explain algorithmic behaviour | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| TS5 | Comparative Evaluation & Algorithmic Justification | Compare approaches; evaluate time/space trade-offs; justify optimal choice with evidence | CO5 \| L5 | ETE Sec B/C |
| TS6 | Synthesis & Holistic Design | Design well-structured, modular, documented C programs for complex specifications | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | 4 | TS1 — Factual Recall TS2 — Conceptual Explanation | CO1, CO2 | Short-answer: definitions, output prediction, syntax identification |

| | | | | |
|---|---|---|---|---|
| **Sec B** | **6** | TS3 — Procedural Application TS4 — Analytical Reasoning | **CO3, CO4** | Program writing; program tracing — detect errors and trace execution |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions: definitions, syntax, output tracing, concept MCQs (all units) |
| **Sec B** | **50** | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Medium questions: program writing, debugging, algorithm comparison, complexity analysis |
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long/design questions: design modular solutions, justify choices, complete application |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |

| | | | | |
|---|---|---|---|---|
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define experiment problem; identify measurable attributes, parameters, success criteria | CO7, CO8 |
| CA2 | **Experimental Design & Tool Setup** | Plan experiment; configure development environment (gcc, IDE, Linux CLI, debugger) | CO7 |
| CA3 | **Code Implementation & Execution** | Write correct code; compile and execute to produce expected output | CO7 |
| CA4 | **Computational Efficiency & Optimization** | Evaluate time/space complexity; identify bottlenecks; propose optimizations | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Analyse output critically; explain deviations; draw evidence-based inferences | CO8 |
| CA6 | **Documented Outcome with Verification** | Record final outcome formally; verify against the problem statement | CO7, CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Produce algorithm/flowchart/pseudocode before coding; justify design choices | CO7, CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records; demonstrate conceptual understanding orally | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | **SDG Alignment & Social Relevance** | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |

| | | | |
|---|---|---|---|
| P2 | Problem Scoping & Requirements | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | Communication & Testing Strategy | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | Innovative Solution Proposal | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | Professional Toolchain | Select and justify development tools; configure professional project environment | CO7 \| PO5 |
| P6 | End-to-End Implementation | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

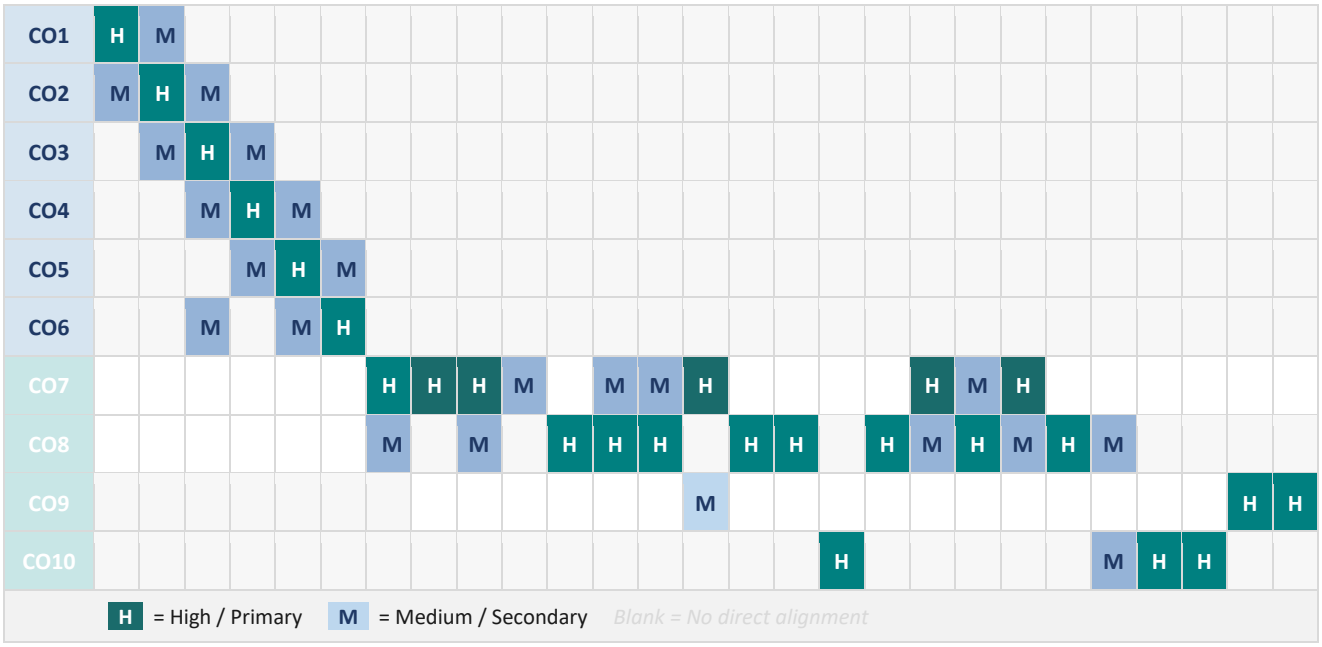
## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |




PART IV

## COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

### 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | – | – | – | – | – | – | – | – | 1 | 2 | 1 | – |
| CO2 | 3 | 2 | – | – | – | – | – | – | 1 | – | 2 | 2 | 2 | – |
| CO3 | 3 | 3 | 2 | – | 2 | 2 | – | – | 1 | – | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 2 | – | 2 | 1 | 1 | 3 | 3 | 3 | 3 |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| Avg | 2.50 | 2.14 | 2.33 | 1.75 | 2.33 | 1.80 | 3.00 | 2.50 | 1.50 | 2.00 | 2.13 | 2.22 | 2.30 | 2.38 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |
| CO2 | H | M | | | | | | | M | | |
| CO3 | M | H | M | | M | M | | | M | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | | M | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in computational thinking and structured programming; aligned with lifelong learning (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant programming and professional tool skills (CO7) directly applicable to employment in technology sectors. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables development of efficient software solutions; fosters innovation through real-world application design (CO6, CO8) and team-based projects (CO10). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts | A1 — Receiving: Awareness, willingness to attend | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act |

| | | |
|---|---|---|
| L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Introduction to Computational Biology (BTT1102)

*Sharda School of Computing Science & Engineering (SCSE) | B.Tech CSE | Semester IV | Batch 2018–2022*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | II |
| **Course Code:** | BTT1102 | **Course Type:** | Core — Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | BTT1102 |
| 2 | **Course Title** | Introduction to Computational Biology |
| 3 | **Credits** | 2 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-0-2 (Theory: 30 hrs Classroom + 30 hrs Self Learning = 60 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | 1. Introduction of fundamental biological concepts and their applications in computational sciences, bioinformatics, and artificial intelligence (AI).<br>2. It provides computer science students with an understanding of how biology integrates with modern technological advancements.<br>3. It allows to use of AI in big data analysis, and nanotechnology.<br>4. It provides concept of using AI for modern disease detection, diagnostics and agricultural biotechnology. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br><br>CO1 (Understand – L1/L2): Understand the fundamental principles of biology and their relevance to computational sciences.<br>CO2 (Explore – L2/L3): Analyze the molecular basis of biological systems and their computational modeling.<br>CO3 (Apply – L3): Examine genetic principles and their applications in AI and machine learning.<br>CO4 (Analyze – L4/L5): Explore AI-driven medical and agricultural biotechnologies.<br>CO5 (Analyze – L4/L5): Investigate the role of bioinformatics in modern biology and healthcare.<br>CO6 (Analyze – L2/L4): Apply computational tools for genomics, drug discovery, and disease modeling. |

| | | |
|---|---|---|
| 8 | **Course Description** | This course covers essential biological principles from a computational perspective, focusing on applications in bioinformatics, AI-driven medical research, and systems biology. Topics include molecular biology, genetic algorithms, AI applications in genomics, and the role of computational modeling in disease prediction and drug discovery. The course integrates interdisciplinary approaches to solving biological problems using modern technological tools. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 30 hrs \| Self Learning (SL): 30 hrs \| Total: 60 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). Molecular Biology of the Cell. Garland Science, USA.<br>2. Lesk, A. M. (2019). Introduction to Bioinformatics. Oxford University Press, UK.<br>3. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, USA.<br>4. Baldi, P., & Brunak, S. (2001). Bioinformatics: The Machine Learning Approach. MIT Press, USA.<br>5. Karp, G. (2013). Cell and Molecular Biology: Concepts and Experiments. Wiley, USA. |
| 12 | **References** | 1. Alberts, B. et al. Essential Cell Biology, 2018 Garland Publishing, Inc. (ISBN: 081533480X) 4. |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MSE, and ESE.*

| | Topic | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction to Biology and Computational Biology** | |
| **A** | Characteristics of living organisms | **CO1, CO6** |
| **B** | Cell theory; Structure of Prokaryotic and Eukaryotic Cells | **CO1, CO6** |
| **C** | Introduction to Computational Biology and its interdisciplinary applications | **CO1, CO6** |
| **Unit 2** | **Biomolecules and Computational Biology** | |

| | | |
|---|---|---|
| A | Introduction to Biomolecules | CO1, CO2 |
| B | Amino acid, Overview of protein structure: Primary, secondary, tertiary, and quaternary structures | CO1, CO2, C06 |
| C | Bioinformatics tools and techniques for analyzing biological datasets from large-scale data, | CO1, CO2, C06 |
| **Unit 3** | **Introduction to Biological databases and their applications** | |
| A | Nucleic acid sequence databases-GenBank, EMBL, DDBJ | CO1, CO3 |
| B | Protein sequence databases-UniProt, TrEMBL, GenPept | CO1, CO2, CO3, CO6 |
| C | Structural databases – PDB, NDB, PubChem, and Zinc | CO1, CO2, CO3, CO6 |
| Unit 4 | **AI in Medical Biotechnology** | |
| A | Genetic Diseases and Personalized Medicine | CO1, CO4 |
| B | Applications of AI in Gene therapy | CO1, CO2, CO3, CO4, CO6 |
| C | Cancer: Causes, Diagnostics, and Role of Computational Biology in Treatment | CO1, CO2, CO3, CO4, CO6 |
| Unit 5 | **AI in Biotechnology** | |
| A | Artificial Intelligence in Biotechnology: AI in Genomics and Precision Medicine | CO1, CO2, CO5, CO6 |
| B | AI in Agriculture: Precision Farming, Crop Monitoring, and Automated Disease Detection, Robotics | CO1, CO2, CO5, CO6 |
| C | AI in Bioinformatics: Big Data Analysis in Genomics and Proteomics | CO1, CO3, CO4, CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | ✓ | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | ✓ | ✓ | ✓ | | | |
| 6 | 2.C | | ✓ | ✓ | | | |
| 7 | 3.A | ✓ | ✓ | ✓ | | | |
| 8 | 3.B | | ✓ | | ✓ | | |
| 9 | 3.C | | ✓ | | ✓ | ✓ | |
| 10 | 4.A | ✓ | ✓ | | | | |
| 11 | 4.B | | ✓ | ✓ | | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | ✓ | ✓ | | ✓ | | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | ✓ | ✓ | | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | ✓ | | | ✓ | | | | | | | | | | |
| CO4 | | | | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | |
| CO5 | | | | | ✓ | | | ✓ | ✓ | | | | | | | ✓ | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | ✓ | | ✓ | ✓ | | | | | | ✓ | | | | | | | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Characteristics of living organisms | UNIT-1 | 4 |
| DD/MM/YY | Cell theory | | |
| DD/MM/YY | Structure of Prokaryotic and Eukaryotic Cells | | |
| DD/MM/YY | Introduction to Computational Biology and its interdisciplinary applications | | |
| DD/MM/YY | Introduction to Biomolecules | UNIT-2 | 6 |
| DD/MM/YY | Types of Amino acid, amide bonds | | |
| DD/MM/YY | Overview of protein structure: Primary, secondary, tertiary, and quaternary structures | | |
| DD/MM/YY | Types of Bioinformatics tools from large-scale data | | |
| DD/MM/YY | Biological datasets | | |
| DD/MM/YY | Techniques for analyzing biological datasets | | |
| DD/MM/YY | Concept of Nucleic acid databases | UNIT-3 | 8 |
| DD/MM/YY | Role of different types of Nucleic acid sequence databases- GenBank | | |
| DD/MM/YY | EMBL, DDBJ | | |
| DD/MM/YY | Concept of Protein sequence databases | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Uses of UniProt, TrEMBL | | |
| DD/MM/YY | GenPept Structural databases | | |
| DD/MM/YY | Structural databases – PDB | | |
| DD/MM/YY | Deadlock Detection & Recovery Algorithms | | |
| DD/MM/YY | Concept of Genetic Diseases | UNIT-4 | 6 |
| DD/MM/YY | Concept of gene therapy, Personalized Medicine | | |
| DD/MM/YY | Introduction of cancer | | |
| DD/MM/YY | Types of cancer and Diagnostics | | |
| DD/MM/YY | Role of AI in cancer detection and treatment | | |
| DD/MM/YY | Artificial Intelligence in Biotechnology | | |
| DD/MM/YY | Artificial Intelligence in Biotechnology | UNIT-5 | 6 |
| DD/MM/YY | AI in Genomics and Precision Medicine | | |
| DD/MM/YY | AI in Agriculture Precision Farming, Crop Monitoring | | |
| DD/MM/YY | AI in Automated Disease Detection, Robotics | | |
| DD/MM/YY | AI in Bioinformatics: Big Data Analysis in Genomics | | |
| DD/MM/YY | AI in Bioinformatics: Big Data Analysis in Proteomics | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

■ **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MSE, and ESE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Conceptual Recall & OS Identification** | Recall fundamental OS terminology, types, structures, and functional components; identify the appropriate OS type or mechanism for a given computing scenario | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | **Conceptual Explanation & Process Interpretation** | Explain process management concepts including process states, IPC, synchronization mechanisms, and scheduler types; interpret and describe working of concurrency solutions | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | **Algorithmic Application & Implementation** | Apply CPU scheduling, deadlock handling, and memory management algorithms to compute correct outcomes for given inputs; trace algorithm execution step-by-step | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | **Algorithmic Analysis & Performance Evaluation** | Analyze the effectiveness and efficiency of scheduling and resource management algorithms; compare performance on given criteria; evaluate trade-offs between competing approaches | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| TS5 | **Memory System Analysis & Virtual Memory Evaluation** | Analyze memory management strategies including paging, segmentation, virtual memory, and page replacement algorithms; evaluate performance metrics such as page fault rate and turnaround | CO5 \| L4–L5 | ETE Sec B/C |
| TS6 | **File System & Disk Management Evaluation** | Analyze file system structures, directory organizations, I/O modes, and disk scheduling algorithms; evaluate comparative efficiency; apply techniques to case study contexts | CO6 \| L2–L4 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Process Interpretation | TS3 Algorithmic Application | TS4 Performance Evaluation | TS5 Memory System Analysis | TS6 File & Disk Evaluation |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO5 | | | | M | H | M |
| CO6 | | M | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| **Real-World Case Study (Report)** | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 concepts: Biology system, | CO1 | TS1 | 5h SL | Report submission + evaluation |
| **Assignment 2** | Living organisms, Cell theory | CO2 | TS2 | 5h SL | Subjective questions on living organisms |
| **Assignment 3** | Computational Biology and its interdisciplinary applications | CO2, CO3 | TS2, TS3 | 5h SL | Subjective + Objective |
| **Assignment 4** | Biomolecules, Data bases | CO3, CO4 | TS3, TS4 | 5h SL | Step-by-step trace required |
| **Assignment 5** | Diseases and solution with AI | CO3, CO4, CO5 | TS3, TS4, TS5 | 5h SL | Algorithm application + performance analysis |

| | | | | | |
|---|---|---|---|---|---|
| **Video Learning Report** | Technical video on Biotechnology (min 3 hrs); structured report + class presentation | CO2, CO3 | TS2, TS3 | 9h SL | Report: learning outcomes, key concepts, self-reflection. Presentation: 10 min |
| **Case Study Report** | AI case study (in-depth analysis report) | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Technical depth, data collection, fact finding, comparative analysis |

## 10. Mid Sem Examination (MSE) — 15 Marks (Units 1–3)

ℹ *MSE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ESE only. ME maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **10** | TS1 — Biology system and Identification<br>TS2 — Conceptual Explanation of biomolecules | **CO1, CO2** | Short-answer: define living organisms, explain cell theory importance of biomolecules |
| **Section B** | **15** | TS3 — Data bases TS4 — Uses of various databases | **CO2, CO3, CO4** | Various data bases: structural and functional |
| **TOTAL** | **25** | TS1–TS4 | **CO1–CO4** | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Sem Examination (ESE) — 60 Marks (All Units, All COs)

ℹ *ESE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1 — Conceptual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions (all units): definitions, living system, identification |
| **Section B** | **25** | TS3 — Subjective analysis TS4 — Disease analysis with AI TS5 — Data base Analysis | **CO3, CO4, CO5** | Units of biomolecules, amino acids, proteins, types of data bases |
| **Section C** | **10** | TS5 — AI Analysis<br>TS6 — Precision Medicine | **CO5, CO6** | Genetic diseases, cancer, AI in medical science |

| | | | | |
|---|---|---|---|---|
| **TOTAL** | **50** | TS1–TS6 (all) | **CO1–CO6** | AI in agricultural sciences, biotechnology |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Understand basic concepts, types, structures, living system | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| **CO2** | Units of organisms — Biomolecules | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| **CO3** | Biological databases | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Diseases and uses of AI | ✓ | ✓ | ✓ | TS4 | PO9, PO10, PO11 |
| **CO5** | AI in biotechnology | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Understand biology system utilize bio data bases | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | - | 1 | - | - | - | 1 | 3 | - | - | 3 | 3 | 2 |
| **CO2** | 3 | - | - | 1 | - | - | - | - | 3 | - | - | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | - | - | - | 2 | - | - | 2 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | - | - | 1 | - | - | - | 2 | 2 | 2 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 3 | - | 3 | 1 | - | 2 | 2 | 2 | 3 | - | - | 2 | - | - |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | - | - | 1 | 2 | - |
| **Avg** | **3** | **1.5** | **2.0** | **1.6** | **1.5** | **0.83** | **0.5** | **1.00** | **2.3** | **0** | **0** | **2.1** | **1.8** | **1.75** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | | | M | | | | M | H | | | H | H | M |
| CO2 | H | | | M | | | | | H | | | M | H | M |
| CO3 | H | H | H | M | H | | | | M | | | M | M | M |
| CO4 | H | H | H | M | H | | | M | | | | M | M | M |
| CO5 | H | | H | M | | M | M | H | H | | | M | | |
| CO6 | H | H | H | H | H | H | M | M | H | | | M | M | |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 30 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Subjective Assignment Writing (5 assignments, problem-based, one per unit focus area)** | 5 assignments × 3 hrs each<br>Total = 15 hrs | CO1–CO4 TS1–TS4 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of cell system |
| 2 | **Technical Video-Based Learning related to the subject (e.g., folding of proteins, data bases)** | Video viewing: 3 hrs<br>Report preparation: 3 hrs<br>Presentation: 3 hrs<br>Total = 9 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, personal reflections |
| 3 | **Real-World Case Studies (e.g., Cell structure, biomolecules, AI in biotechnology)** | Data collection/study: 4 hrs<br>Report preparation: 2 hrs<br>Total = 6 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, and analytical conclusions drawn |

| | | | | |
|---|---|---|---|---|
| | **TOTAL Self-Learning Hours** | **30 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **ESE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ESE paper required; failing ESE means failing the course regardless of CA + MSE |
| **Overall Total (CA + MSE + ESE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MSE 25 + ESE 50 = 100; 40% overall minimum required |

**BTT1102— MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks

| | | |
|---|---|---|
| **School: SSCSE** | | **Batch: 2026-2030** |
| **Program: B.Tech.** | | **Current Academic Year: 2026-27, Sem-I** |
| Branch | | CSE-AIML |
| 1 | Course Code | CVT1103 |
| 2 | Course Title | Environmental Science |
| 3 | Credits | 0 |
| 4 | Contact Hours (L-T-P) | 2-0-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. Enable students to learn the concepts, principles and importance of environmental science<br>2. Provide students an insight of various causes of natural resource depletion and its conservation<br>3. Provide knowledge of layers of atmosphere with an insight of role of climatic elements in dispersion of pollutants<br>4. Provide detailed knowledge of causes, effects and control of different types of environmental pollution, solid waste management and its effect on climate change, global warming and ozone layer depletion<br>5. Provide and enrich the students about social issues such as R&R, water conservation and sustainability. |
| 6 | Course Outcomes | CO1.Understand the scope of environmental science with knowledge about various types of natural resources and its conservation |

| | | | |
|---|---|---|---|
| | | CO2. Study about the structure and composition of atmosphere and factors affecting weather and climate<br>CO3. Study about pollution causes, effects and control and solid waste management<br>CO4. Effect of global warming and ozone layer depletion<br>CO5.Understand sustainable development, resettlement and rehabilitation, impact of population explosion on environment<br>CO6.Understand overall environmental issues and its management | |
| 7 | Course Description | Environmental Science emphasises on various factors as<br>1. Importance and scope of environmental science<br>2. Natural resource conservation<br>3. Pollution causes, effects and control methods and solid waste management<br>4. Social issues associated with environment | |
| 8 | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | **General Introduction** | |
| | A | Definition, principles and scope of environmental science | CO1 |
| | B | Water Resources, Land Resources, Food Resources | CO1 |
| | C | Mineral Resources, Energy Resources, Forest Resources | CO1 |
| | **Unit 2** | **Atmosphere and meteorological parameters** | |
| | A | Structure and composition of atmosphere | CO2 |
| | B | Meteorological parameters: Pressure, Temperature, Precipitation, Humidity, | CO2 |
| | C | Radiation, Wind speed and direction, Wind Rose | CO2 |
| | **Unit 3** | **Environmental Pollution (Cause, effects and control measures)** | |
| | A | Air, water, Noise and Soil pollution | CO3 |
| | B | Case studies on pollution | CO3 |
| | C | Solid waste management: Causes, effects and control measures of urban and industrial wastes. | CO3, CO6 |
| | **Unit 4** | **Climate Change and its impact** | |
| | A | Concept of Global Warming and greenhouse effect | CO4 |
| | B | Ozone layer Depletion and its consequences | CO4 |
| | C | Climate change and its effect on ecosystem, Kyoto protocol and IPCC concerns on changing climate | CO4 |
| | **Unit 5** | **Social Issues and the Environment** | |
| | A | Concept of sustainable development, Water conservation | CO5, CO6 |
| | B | Resettlement and rehabilitation of people; its problems and concerns, Case studies | CO5, CO6 |
| | C | Population explosion and its consequences | CO5, CO6 |
| | Mode of examination | Theory | |
| | Weight age Distribution | CA(25) / ESE(75) | |
| | Text book/s* | 1. Joseph, Benny, "Environmental Studies", Tata Mcgraw-Hill.<br>2. .Howard S. Peavy, Donald R. Rowe, George Tchobanoglous. Environmental engineering Mc Graw-Hill, 1985 | |

| | | | |
|---|---|---|---|
| | Other References | | |

**CO-PO Mapping**

| CO↓ PO→ | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | | | 2 | 3 | 1 | 1 | 3 |
| CO2 | 1 | 3 | 2 | 2 | 1 | 3 | 1 | 1 | 2 | | 3 | 3 | 2 | 2 |
| CO3 | | 2 | 2 | 2 | | 2 | 2 | | 1 | | 1 | | 1 | 3 |
| CO4 | 1 | | 1 | 2 | 3 | | | | 2 | 3 | | 2 | | |
| CO5 | | 3 | | 1 | 2 | 3 | 2 | 1 | | 2 | 2 | 1 | 3 | 1 |
| CO6 | 2 | | 1 | | | 1 | | | 1 | 1 | | | | 2 |

***Average of non-zeros entry in following table (should be auto calculated).***

| Course Code/ Name | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineering Knowledge | Problem Analysis | Design/Development of Solutions | Conduct Investigations of | Engineering Tool Usage | The Engineer and The World | Ethics | Individual and Collaborative | Communication | Project Management and | Life-Long Learning | Familiarity and practical | Understand, analyze and | Apply standard Software |
| CVT1103 | 1.25 | 2.25 | 1.40 | 1.60 | 2.00 | 2.00 | 1.75 | 1.00 | 1.50 | 2.00 | 2.25 | 1.75 | 1.75 | 2.20 |

***Strength of Correlation: 24.5***

***1.*** Addressed to ***Slight (Low=1) extent*** ***2.*** Addressed to***Moderate (Medium=2) extent***
***3.*** Addressed to ***Substantial (High=3) extent***

| | | |
|---|---|---|
| **School:** | | **Sharda School of Humanities & Social Sciences** |
| **Department** | | **Humanities & Social Sciences** |
| **Program Code** | | **SHS0127** |
| **Program Name** | | **Bachelor of Arts (History)** |
| **Specialization/ Minor** | | **IKS** |
| **Batch: 2026-2030** | | **Semester: I** |
| 1 | Course Code | **IKT1108** |
| 2 | Course Name | **Introduction to Indian Knowledge System** |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P) | 2-0-0 |
| | Course Type | VAC (Credited) |
| 5 | Course Objective | 1. To introduce students to the fundamental principles and introductory aspects of Indian Knowledge Systems (IKS).<br>2. To enable students to interpret select ancient texts and encourage them to develop their perspectives.<br>3. To highlight the importance of Indian Spiritual tradition in resolving contemporary issues in various fields.<br>4. To understand the importance of traditional Indian food and lifestyle in maintaining good health & well-being.<br>5. To guide students in evaluating the philosophical, cultural, and spiritual dimensions of ancient Indian texts, providing them with a deeper appreciation of values and ideas that have shaped Indian thought.<br>6. To recognize the vast corpus of knowledge traditions of India while developing an appreciation for it and discuss its evolution through multidisciplinary lens. (SDG 3: Good Health and Well Being & SDG 4: Quality Education) |

| | | | |
|---|---|---|---|
| 6 | Course Outcomes | The students will be able to:<br>CO1: Identify the meaning, nature, and scope of IKS<br>CO2: Explain the key components of Ancients Indian literature<br>CO3: Apply the importance of Indian tradition of spirituality and ethics to modern times.<br>CO4: To analyse the diversity in traditional Indian food and lifestyle.<br>CO5: Examine the contribution of IKS in the field of mathematics, astronomy, Science & technology.<br>CO6: Develop an appreciation for IKS for modern times. (SDG 3: Good Health and Well Being & SDG 4: Quality Education) | |
| 7 | Course Description | This course provides an in-depth exploration of the Indian Knowledge System (IKS), encompassing its meaning, nature, and scope. Students will | |
| | | engage with the Vedic corpus and other classical texts, interpreting them through their<br>perspectives while developing critical thinking skills. The course emphasizes the application of traditional knowledge to contemporary times, encouraging | |
| 8 | Syllabus | | **CO-Mapping** |
| | **Unit 1** | **Indian Knowledge System: An Introduction** | |
| | A | Indian Knowledge System: Meaning and Nature | CO1, CO6 |
| | B | IKS: Disciplines and Scope | CO1, CO6 |
| | C | Historicity of IKS | CO1, CO6 |
| | **Unit 2** | **Introduction to Ancient Indian Literature** | |
| | A | Vedas: Rigveda, Samaveda, Yajurveda, and Atharvaveda. | CO2, CO6 |
| | B | Epics: Mahabharata and Ramayana | CO2, CO6 |
| | C | Scripture: Bhagavad Gita | CO2, CO6 |
| | **Unit 3** | **Spirituality & Ethics in Indian Tradition** | |
| | A | Importance of Spirituality in current times | CO3, CO6 |
| | B | Spirituality & Social Responsibility | CO3, CO6 |
| | C | Using ethics in a technologically volatile world: leading an ethical modern life | CO3, CO6 |
| | **Unit 4** | **Introduction to traditional Indian food & lifestyle** | |
| | A | Importance of Indian food & spices for good health | CO4, CO6 |
| | B | Adapting Ancient Indian Lifestyle of Yoga | CO4, CO6 |
| | C | Traditional Indian Sports (Martial Arts) | CO4, CO6 |
| | **Unit 5** | **Introduction to Ancient Indian Science & Technology** | |

| | | | | |
|---|---|---|---|---|
| | A | Arithmetic & Logic | | CO5, CO6 |
| | B | Astronomy: India's contribution to the world | | CO5, CO6 |
| | C | Indian Notion of Time & Space | | CO5, CO6 |
| | Mode of Examination | Theory | | |
| | Weightage Distribution | **CA: 25** | **MSE: 15** | **ESE: 60** |
| | | 10 marks for Assignments (2 | 30 MCQs | 60 MCQs |

| | | | | |
|---|---|---|---|---|
| | | Assignments of 5 marks each);<br>15 marks for Project Based Assessment) | | |
| | **Text book/s*** | • Kapoor, K. & Singh, A.K. (2005). Indian Knowledge System. Vol 1, 2. DK Print World Ltd.<br>• Kumar, M.J. (2024). Forging Connections: Integrating Indian Knowledge System in Higher Education. IETE Technical Review, 41(3), 271-273, https://doi.org/10.1080/02564602.2024.2342625 | | |

COURSE ARTICULATION MATRIX

| **POs/COs** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | - | - | - | - | - | 1 | - | - | - | 2 | - | - |
| **CO2** | 1 | 1 | - | - | - | - | - | 2 | 1 | 1 | - | 1 | - | - |
| **CO3** | - | 1 | - | 2 | - | 2 | - | 2 | - | 1 | - | 1 | 1 | - |
| **CO4** | - | 1 | - | 1 | - | 2 | 1 | 1 | - | - | - | - | 1 | - |
| **CO5** | 2 | 1 | - | - | 1 | - | - | - | - | - | - | 1 | - | 2 |
| **CO6** | - | 1 | - | 2 | - | 2 | - | 2 | - | 1 | - | 1 | 1 | - |

3: High 2: Medium 1: Low

| Semester 2, Credits: 22 | |
|---|---|
| **COURSE CODE** | **COURSE NAME** |
| CSCR1302 | Application based Programming in Python |
| CSCR1504 | Design and creativity Lab |
| CSCR1507 | Digital Prototyping |
| SKT 1100 | Professional Communication |
| PHT1136 | Engineering Physics |
| MTT1214 | Probability and Statistics |
| CSCR1301 | Object Oriented Programming Using Java |
| IKT1001 | Fundamentals of Indian Knowledge System |
| | Value Added Course |

# COURSE PLAN

## Application Based Programming in Python (CSCR1302)

*School of Computing Science & Engineering (SSCSE) | B.Tech. CSE-AIML | Semester II | Batch 2026–2030*

*Integrated Course Plan - Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech. | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | II |

## 2. Course Details

*Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR1513 |
| 2 | **Course Title** | **Application Based Programming in Python** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-4-2 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | This course aims to develop students' problem-solving ability through Python programming and application-based development. The course provides practical exposure to control structures, data structures, functions, object-oriented programming, file handling, modules, and data analysis libraries so that students can design and implement real-world solutions using Python. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs - Assessed via MTE + ETE:**<br>CO1 (Remember/Understand - L1/L2): Identify and classify Python programming constructs including variables, data types, operators, conditional statements, and loops and trace the execution of basic Python programs. |

| | | |
|---|---|---|
| | | CO2 (Apply - L3): Construct and manipulate Python built-in data structures (lists, tuples, strings, sets, and dictionaries) to store, retrieve, and process structured data for given problem scenarios.<br>CO3 (Apply - L3): Write modular Python programs by defining user-defined and anonymous functions with appropriate argument types, and handle runtime exceptions using try-except-finally to produce fault-tolerant applications.<br>CO4 (Apply - L3): Execute file handling operations (read, write, append, CSV, JSON) and integrate standard library modules and third-party packages to extend and modularize Python applications.<br>CO5 (Analyze - L4): Examine and differentiate object-oriented programming constructs like classes, objects, inheritance, encapsulation, and polymorphism by tracing class hierarchies and identifying design choices in given OOP programs.<br>CO6 (Create - L6): Construct end-to-end Python solutions that apply NumPy, Pandas, and Matplotlib to load, clean, analyze, and visualize datasets, and implement searching and sorting algorithms to solve real-world computational problems.<br>**LAB COs - Assessed via Laboratory Assessment only:**<br>CO7 (Apply - L3): Set up and operate professional Python development environments (Anaconda, Jupyter Notebook, VS Code/PyCharm, GitHub); execute, test, and document a minimum of 10 lab programs with structured lab records demonstrating correct outputs.<br>CO8 (Apply - L3): Demonstrate adherence to professional coding standards (PEP8), ethical practices (original code, proper attribution), and self-directed learning by completing a reflective skill-assessment log documenting measurable competency growth across the semester<br>CO9 (Create - L6): Design, develop, and demonstrate a Python mini-project that integrates at least three course concepts (data structures, OOP, file handling, or libraries) to address a real-world or socially relevant problem with clearly documented objectives, code, and evaluated outcomes.<br>CO10 (Create – L6): Execute team-based project activities by distributing tasks, using version control (GitHub), and delivering a structured oral/demo presentation within stipulated timelines, demonstrating collaborative problem-solving and communication skills. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 60 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | 1. Coding Problems on Replit/Programiz/Colab - Develop 5 small coding-based problems related to Python concepts - 5 problems × 3 hrs = 15 hrs. Based on code correctness, efficiency, and documentation. 2. Virtual Labs (NPTEL): implement complex algorithms for practical problems - Algorithm design & documentation 10 hrs + verification & explanation 5 hrs = 15 hrs. 3. Logical correctness, efficiency, and documentation quality. |
| 11 | **Textbooks** | **Textbook:** Reema Thareja - Python Programming: Using Problem Solving Approach (1st Ed.), Oxford University Press.<br>**Reference:** Eric Matthes - Python Crash Course: A Hands-on, Project-based Introduction to Programming, No Starch Press.<br>Reference: Wes McKinney - Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter (3rd Ed.), O'Reilly. |
| 12 | **References** | |

## 3. Outline Syllabus - Theory Units with CO Mapping (CO1-CO6)

*Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7-CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction to Python (6-0-10-4 = 20 hrs)** | |

| | | |
|---|---|---|
| **A** | Python Environment, Variables, Data Types, Operators | CO1 |
| **B** | Conditional Statements: if, if-else, nested if-else; Looping: for, while, nested loops | |
| **C** | Control Statements: break, continue, pass, comments | |
| **Tools Used** | Linux Environment, Python 3.8+, Jupyter Notebook, VS Code/PyCharm, Anaconda Distribution, Online Python compilers (Replit, Trinket, Programiz), Competitive Coding Platforms (Replit/Programiz/Colab) | |
| **Activities** | **Objective: To familiarize students with Python programming environment and develop understanding of basic syntax, operators, and control flow structures.**<br>• Installation and configuration of Python environment and IDEs.<br>• Practice basic Python syntax and program structure with print statements<br>• Implementation of arithmetic, logical, relational operators with precedence demonstration.<br>• Creating decision-making programs using if-else, nested if, and switch alternatives Implementing some programs based on mathematical expression with the consideration of associativity and precedence.<br>• Implementing iterative programs using while, for loops, and nested loop patterns.<br>• Writing programs for mathematical computations (factorial, Fibonacci, sum of series).<br>• Pattern printing programs using nested loops.<br>• Solving basic input/output problems on competitive coding platforms. | |
| **Unit 2** | **List, Tuple and Dictionaries (6-0-12-6 = 24 hrs)** | |
| **A** | Lists and nested lists: introduction, accessing list, operations, working with lists, library functions and methods | CO2 |
| **B** | Strings and tuples: introduction, access, operations, methods | |
| **C** | Sets and dictionaries: introduction, operations, functions, and data access | |
| **Tools Used** | Python IDE (PyCharm/VS Code), Jupyter Notebook, Anaconda Navigator, Git/GitHub for version control, Online data structure visualizers | |
| **Activities** | **Objective:** To construct and manipulate Python data structures for efficient data storage and retrieval<br>• List operations: creation, slicing, appending, extending, sorting, reversing.<br>• Nested list operations and matrix representation using lists.<br>• String manipulation: slicing, methods (split, join, replace, find), immutability.<br>• Tuple operations: packing/unpacking, nested tuples, tuple methods.<br>• Set operations: union, intersection, difference, symmetric difference.<br>• Dictionary operations: key-value pairs, nested dictionaries, dictionary methods.<br>• Data structure comparison programs (list vs tuple vs set performance).<br>• Implementing common algorithms using appropriate data structures. | |
| **Unit 3** | **Functions and Exception Handling (6-0-12-6 = 24 hrs)** | |
| **A** | Defining and calling functions, types of functions, function arguments | CO3 |
| **B** | Anonymous functions, global and local variables | |

| | | |
|---|---|---|
| **C** | Exception handling using try, except, finally, and user-defined exceptions | |
| **Tools Used** | Python IDE with debugger, Jupyter Notebook, pylint code analyzer, Unit testing frameworks (unittest, pytest) | |
| **Activities** | **Objective:** To write modular and fault-tolerant Python code using functions and structured exception handling.<br>• Function definition with different parameter types (positional, keyword, default).<br>• Lambda functions for one-liner operations and higher-order functions.<br>• Scope resolution: local vs global variables, nonlocal keyword.<br>• Recursive function implementations (factorial, Fibonacci, GCD).<br>• Exception handling: try-except-finally blocks for different exception types.<br>• Custom exception classes and exception propagation.<br>• Function documentation and type hints practice.<br>• Unit testing basic functions using unittest framework. | |
| **Unit 4** | **OOP and File Handling (6-0-14-8 = 28 hrs)** | |
| **A** | OOP concepts: class, object, attributes, abstraction, encapsulation, polymorphism, inheritance | CO4, CO5 |
| **B** | Static and final keyword, access modifiers and specifiers, scope of a class | CO4 |
| **C** | File handling: introduction and file operations (r, w, a, rb, wb); CSV and JSON handling | CO5 |
| **Tools Used** | Python IDE with refactoring tools, UML design tools (PyUML, PlantUML), pylint, mypy for static analysis, GitHub for collaboration | |
| **Activities** | **Objective:** To examine OOP design structures and execute file-based persistence operations in Python programs.<br>• Class creation with attributes, methods, and special methods (__init__, __str__).<br>• Inheritance hierarchies: single, multiple, multilevel inheritance.<br>• Polymorphism demonstration using method overriding and duck typing.<br>• Encapsulation using private attributes (_var, __var) and property decorators.<br>• File operations: reading (r, rb), writing (w, wb), appending (a), with statement.<br>• CSV file handling using csv module. - JSON file operations using json module.<br>• Context managers and file object best practices. | |
| **Unit 5** | **Application Based Programming (6-0-12-6 = 24 hrs)** | |
| **A** | Modules and packages: importing module, math module, random module, creating modules | CO5, CO6 |
| **B** | Introduction to NumPy, Pandas, and Matplotlib | CO6 |
| **C** | Applications: linear search, binary search, bubble sort, data analysis pipeline | CO6 |
| **Tools Used** | Anaconda Distribution, Jupyter Notebook, Google Colab, NumPy, Pandas, Matplotlib, Seaborn libraries, Kaggle datasets, UCI ML Repository | |
| **Activities** | **Objective:** To construct end-to-end data analysis solutions using Python scientific computing libraries.<br>• NumPy array operations: creation, indexing, broadcasting, vectorization. | |

| | | |
|---|---|---|
| | • Pandas DataFrame operations: loading CSV/Excel, filtering, grouping, merging.<br>• Data cleaning: handling missing values, outliers, data type conversion.<br>• Statistical analysis: mean, median, correlation, group statistics.<br>• Matplotlib basic plotting: line, bar, scatter, histogram, pie charts.<br>• Data visualization best practices and customization.<br>• Algorithm implementations: linear search, binary search, bubble/selection/insertion sort.<br>• Complete data analysis pipeline: load → clean → analyze → visualize. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | ✓ | ✓ | | | | |
| 4 | 2.A | | | ✓ | | | |
| 5 | 2.B | | | ✓ | | | |
| 6 | 2.C | | | ✓ | | | |
| 7 | 3.A | | | ✓ | | | |
| 8 | 3.B | | | ✓ | | | |
| 9 | 3.C | | | ✓ | | | |
| 10 | 4.A | | | | ✓ | | |
| 11 | 4.B | | | | ✓ | | |
| 12 | 4.C | | | ✓ | | | |
| 13 | 5.A | | | ✓ | | | |
| 14 | 5.B | | | | | | ✓ |
| 15 | 5.C | | | | | | ✓ |

## 5. CO vs Bloom's Taxonomy - All Three Domains (Updated for 10 COs)

*Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | | ✓ | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | | | ✓ | | | | | | | | | | | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | | | |
| CO5 | | | ✓ | | | | | ✓ | | | | | | | | | |
| CO6 | | | | | | ✓ | | | | | | | | ✓ | ✓ | | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | | | |
| CO8 | | | | | | ✓ | | | | | | | | ✓ | ✓ | | |
| CO9 | | | ✓ | | | | ✓ | | | ✓ | | | | | | | |
| CO10 | | | ✓ | | | | | | | | ✓ | | | ✓ | | | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory - 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Python environment setup; identify variables, keywords, data types | Unit 1 | 6 |
| DD/MM/YY | Classify and trace operator precedence and expression evaluation | | |
| DD/MM/YY | Trace conditional statements: if, if-else, nested if-else | | |
| DD/MM/YY | Trace looping constructs: for, while, nested loops | | |
| DD/MM/YY | Classify control statements: break, continue, pass; comment types | | |
| DD/MM/YY | Revision + Trace execution: Basic Python programs and pattern printing | | |
| DD/MM/YY | Construct and traverse lists; nested list operations | Unit 2 | 6 |
| DD/MM/YY | Apply list methods and library functions | | |
| DD/MM/YY | Construct and manipulate strings: slicing, methods, immutability | | |
| DD/MM/YY | Construct tuples: packing, unpacking, operations | | |
| DD/MM/YY | Apply set operations: union, intersection, difference | | |
| DD/MM/YY | Construct dictionaries: key-value pairs, nested dicts, methods | | |
| DD/MM/YY | Define and invoke functions: parameter types, return values | Unit 3 | 6 |
| DD/MM/YY | Write lambda functions; resolve global and local variable scope | | |
| DD/MM/YY | Write recursive functions: factorial, Fibonacci, GCD | | |
| DD/MM/YY | Write try-except-finally blocks for multiple exception types | | |
| DD/MM/YY | Define custom exception classes; trace exception propagation | | |
| DD/MM/YY | Revision + Write: Functions & Exception Handling programs | | |
| DD/MM/YY | Examine OOP concepts: class, object, attributes, encapsulation | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Trace inheritance hierarchies and polymorphism | Unit 4 | 6 |
| DD/MM/YY | Differentiate static methods, access modifiers, class scope | | |
| DD/MM/YY | Execute file operations: read, write, append using with statement | | |
| DD/MM/YY | Execute CSV and JSON file handling operations | | |
| DD/MM/YY | Revision + Trace: OOP class hierarchy problems | | |
| DD/MM/YY | Integrate modules and packages; apply math and random modules | Unit 5 | 6 |
| DD/MM/YY | Create custom modules; resolve import paths | | |
| DD/MM/YY | Construct NumPy arrays; apply indexing and mathematical operations | | |
| DD/MM/YY | Construct Pandas DataFrames; execute filter, sort, groupby operations | | |
| DD/MM/YY | Construct Matplotlib charts: line, bar, scatter, histogram | | |
| DD/MM/YY | Implement linear search, binary search, bubble sort; trace execution | | |

## 7. Lab Session Plan - List of Experiments (Updated CO7- CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | **Python Environment Setup & Basic Programs:** Install Python 3.8+, configure IDE (PyCharm/VS Code/Jupyter); write "Hello World" with comments; write programs for arithmetic operations (+, –, ×, /, %); use *input()* function for user input (name, age, marks) | CO7 | 3.0 |
| | S-1.2 | **Operator Precedence & Type Conversion:** Write programs demonstrating operator precedence; execute explicit/implicit type casting examples; write programs with mixed data types (int+float=float) | CO7 | |
| W2 | S-2.1 | **Decision Making - if-else**: Write grade calculator (marks → A/B/C/D/F); write simple calculator using conditional statements; write BMI calculator with weight categories | CO7 | 3.0 |
| | S-2.2 | **Nested Loops & Patterns:** Write programs to print pyramid, diamond, right triangle patterns; write Floyd's triangle, number patterns; write factorial and sum-of-digits programs using loops | CO7 | |
| W3 | S-3.1 | **List Operations - Real World Applications:** Construct student marks list management programs; write shopping cart using lists; write matrix representation using nested lists | CO7 | 3.0 |
| | S-3.2 | **String & Tuple Operations**: Write palindrome checker and anagram detection programs; execute text processing (word count, vowel count); write tuple packing/unpacking applications | CO7 | |
| W4 | S-4.1 | **Set & Dictionary Operations:** Execute set operations: union, intersection, difference; write dictionary-based phonebook/contact management; write dictionary frequency counter | CO7 | 3.0 |

| | | | | |
|---|---|---|---|---|
| | S-4.2 | **Data Structure Applications:** Construct Student Record Management System (CRUD); write word frequency analyzer from text file; compare data structure performance | **CO7** | |
| **W5** | S-5.1 | **Functions - Modular Programming:** Write function library for mathematical operations; write programs with positional, keyword, default parameters; write recursive factorial and Fibonacci | **CO7** | 3.0 |
| | S-5.2 | **Lambda Functions & Variable Scope:** Write lambda functions for sorting and filtering; execute *map()*, *filter()*, *reduce()* applications; trace global/local variable scope | **CO7** | |
| **W6** | S-6.1 | **Exception Handling – Basic:** Write handlers for divide-by-zero and invalid input; execute multiple exception types with try-except-finally; write file-not-found exception handler | **CO7** | 3.0 |
| | S-6.2 | **Advanced Exception Handling:** Define custom exception classes (InvalidAgeException); trace exception propagation; write comprehensive error logging system | **CO7** | |
| **W7** | S-7.1 | **Classes & Objects - Real World Modeling:** Define Student class with attributes and methods; define BankAccount class (deposit, withdraw, balance); define Rectangle class (area, perimeter) | **CO7** | 3.0 |
| | S-7.2 | **Inheritance & Polymorphism:** Construct Shape hierarchy: Circle, Rectangle extends Shape; trace method overriding; write multiple inheritance example | **CO7** | |
| **W8** | S-8.1 | **OOP Advanced Concepts:** Write programs demonstrating encapsulation with private attributes (_var, __var); apply property decorators (@property); differentiate class methods and static methods | **CO7** | 3.0 |
| | S-8.2 | **File Handling Operations:** Execute text file read/write operations; process CSV files using csv module; execute JSON file handling using json module | **CO7** | |
| **W9** | S-9.1 | **Advanced File Operations:** Write student record management with file persistence; write file merging and splitting utilities; write log file analyzer | **CO7** | 3.0 |
| | S-9.2 | **Modules & Packages:** Create custom module and import it; apply math module functions; write simulations using random module | **CO7** | |
| **W10** | S-10.1 | **NumPy Array Operations:** Construct NumPy arrays; apply indexing, slicing, and reshaping; execute mathematical operations on arrays | **CO7** | 3.0 |
| | S-10.2 | **Pandas DataFrame Basics:** Load CSV/Excel data into DataFrames; execute filtering, sorting, groupby; compute basic statistical measures | **CO7** | |
| **W11** | S-11.1 | **Data Visualization with Matplotlib:** Construct line plots, bar charts, and histograms; construct scatter plots and pie charts; apply customization and labeling | **CO7** | 3.0 |
| | S-11.2 | **Searching Algorithms:** Implement linear search and trace execution; implement binary search on sorted arrays; compare performance of both | **CO7** | |

| | | | | |
|---|---|---|---|---|
| **W12** | S-12.1 | **Sorting Algorithms:** Implement bubble sort, selection sort, insertion sort; compare Python's sorted() vs custom implementations; trace time complexity | **CO7** | 3.0 |
| | S-12.2 | **Data Analysis Pipeline:** Construct complete data analysis workflow; execute dataset loading and cleaning; perform exploratory data analysis | **CO7** | |
| **W13** | S-13.1 | **Mini Project - Problem Definition & Design:** Teams define real-world Python application (data analysis / OOP-based tool); construct system design using UML; document scope, methodology, and expected outcomes | **CO8** | 3.0 |
| | S-13.2 | **Mini Project - Development Phase:** Implement and integrate core modules; combine data structures, OOP, and file handling; execute mid-project review and code feedback | **CO8** | |
| **W14** | S-14.1 | **Ethics, Professionalism & Reflective Practice:** Examine open-source licensing, code plagiarism, data privacy issues; complete self-assessment rubric; write personal learning reflection log measuring competency growth | **CO9** | 3.0 |
| | S-14.2 | **Skill Self-Assessment & Code Documentation:** Execute peer code review; write docstrings and type hints; apply PEP8 code formatting standards | **CO9** | |
| **W15** | S-15.1 | **Team Project - Final Integration & Testing:** Integrate full system; execute unit testing and debugging as a team; manage GitHub branches and resolve conflicts | **CO10** | 3.0 |
| | S-15.2 | **Team Project - Presentation & Viva:** Deliver project demonstrations; respond to individual viva-voce; execute peer evaluation; submit final project report | **CO10** | |

*Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) - CO1 through CO6

**THEORY COs (CO1–CO6) - Assessed exclusively via MTE and ETE only**

*Six theory skill dimensions - one per Bloom's level L1–L6 - correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **TS1** | **Identification of syntax elements & Classification of Data Types** | Identify Python syntax elements, classify data types, keywords, and built-in constructs; trace program output for simple programs | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| **TS2** | **Construction of programs & Manipulation** | Construct Python programs using data structures (lists, tuples, sets, dictionaries); apply built-in methods for data processing. | CO2 \| L3 | MTE Sec A \| ETE Sec A |
| **TS3** | **Modular Writing & Fault Tolerance** | Write modular programs using functions with varied argument types; write exception-handling blocks for specified error scenarios | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| **TS4** | **Examination and Differentiation** | Examine class hierarchies; differentiate OOP constructs (inheritance types, access specifiers); trace method resolution in given programs | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| **TS5** | **Execution & Integration** | Execute file I/O operations; integrate standard and third-party modules to build extended applications | CO5 \| L3 | ETE Sec B/C |
| **TS6** | **End-to-End Construction** | Construct complete data analysis solutions using NumPy, Pandas, and Matplotlib; implement searching and sorting algorithms with documented complexity | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure - MTE and ETE

### 9.1 Mid Term Examination (MTE) - 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1, TS2 | **CO1, CO2** | Short answer: Identify and classify Python constructs, trace/predict output of basic programs |
| **Sec B** | **6** | TS3, TS4 | **CO3, CO4** | Program writing: Construct programs using data structures, write functions and exception handlers |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–4 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) - 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1, TS2 | **CO1, CO2** | Short questions: Identify, classify, construct across all units |
| **Sec B** | **50** | TS3, TS4, TS5 | **CO3, CO4, CO5** | Descriptive/program writing: Write functions, examine OOP designs, execute file operations |
| **Sec C** | **25** | TS5, TS6 | **CO5, CO6** | Long/design questions: Construct complete Python programs using libraries; implement algorithms |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme - Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation - no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) - Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each - assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection - all 4 Lab COs (CO7–CO10) |
| **TOTAL** | - | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each - Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 - Problem definition: attributes, metrics, success criteria<br>CA2 - Experimental design and tool configuration<br>CA7 - Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 - Execution correctness; output matches expected<br>CA4 - Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 - Output analysis and result interpretation<br>CA6 - Documented outcome with verification<br>CA8 - Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |

| | | | | |
|---|---|---|---|---|
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 - Documentation ethics, responsible practice<br>PO7 - Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks - All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 - SDG mapping; societal relevance<br>P2 - Problem scope and stakeholder requirements<br>P4 - Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 - Timeline, milestones, resource planning<br>P11 - Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 - Professional toolchain selection<br>P6 - Complete project build and integration<br>P7 - System commissioning and operational testing | 2: Fully operational \| 1-1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 - Measurable outcome vs stated goals<br>P9 - Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 - Communication plan and testing strategy<br>P10 - Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 - Skill growth mapping (pre/post project)<br>P13 - Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7- CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions - Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| **CA1** | **Problem Definition & Metrics** | State the problem clearly; identify inputs, expected outputs, and constraints | CO7 |

| | | | |
|---|---|---|---|
| CA2 | Experimental Design & Tool Setup | Plan solution approach; sketch algorithm/flowchart before coding | CO7 |
| CA3 | Code Implementation & Execution | Operate JDK, IDE, debugger, and Linux CLI with accuracy | CO7 |
| CA4 | Computational Efficiency & Optimization | Compile, run, and verify programs against all test cases | CO7 |
| CA5 | Output Analysis & Result Interpretation | Assess alternate approaches; justify chosen solution on efficiency grounds | CO8 |
| CA6 | Documented Outcome with Verification | Annotate outputs; trace variable values; provide inferences | CO7, CO8 |
| CA7 | Algorithmic Design & Solution Planning | Develop modular, reusable solutions addressing societal/real-world contexts | CO7, CO8 |
| CA8 | Lab Record Maintenance & Viva-Voce | Submit complete, formatted record; respond correctly to viva questions | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions - Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | SDG Alignment & Social Relevance | Identify and document how the project addresses at least one SDG (e.g., SDG 4, SDG 8, SDG 9) | CO8 \| PO6 |
| P2 | Problem Scoping & Requirements | Define problem statement, scope, objectives, and constraints in a structured document | CO8 \| PO2 |
| P3 | Communication & Testing Strategy | Produce class diagrams and architecture diagrams; justify design decisions | CO10 \| PO9 |
| P4 | Innovative Solution Proposal | Develop the project in clearly separated, reusable Java modules | CO8 \| PO3 |
| P5 | Professional Toolchain | Use IDE, version control (Git), and build tools professionally | CO7 \| PO5 |
| P6 | End-to-End Implementation | Execute structured test cases; document results and inferences | CO7, CO8 \| PO3 |
| P7 | System Commissioning & Testing | Implement robust error/exception handling in all critical modules | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Maintain naming conventions, comments, and clean code standards throughout | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Acknowledge sources; avoid plagiarism; adhere to coding standards | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Complete peer and self-evaluation rubrics; identify personal skill gaps | CO10 \| PO9, PO11 |
| P11 | Financial Feasibility & Planning | Demonstrate equitable task distribution and documented team coordination | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Deliver a structured 10-min demonstration; respond to evaluator questions | CO9 \| PO10 |

| | | | |
|---|---|---|---|
| **P13** | **Professional Attitude, Ethics & Responsibility** | Maintain a project plan; meet milestones; submit deliverables on schedule | CO9 \| PO11 |

## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

*Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping - confirming strict assessment separation.*

*Theory COs (CO1–CO6) have NO CA alignment - confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

*Theory COs (CO1–CO6) have NO project alignment - confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | | | | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | M | | | | H | H | H | H | H | H | M | H | | | | | M | | M | | | | | | |
| CO8 | | | | | M | H | H | H | M | H | H | H | H | M | H | H | H | H | H | H | H | H | | | | | |
| CO9 | | M | | | | | | | | | | M | | | | | M | | | | | | | | | H | H |
| CO10 | | | | | | | | | | | | | | | | M | H | | M | | | | | H | H | | |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

# PART IV
# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO-PO and CO-PSO Mapping Matrix (All 10 COs)

*Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | 1 | - | - | - | - | - | 2 | 3 | 2 | — |
| CO2 | 2 | 2 | - | - | 1 | - | - | - | - | - | 2 | 2 | 2 | 1 |
| CO3 | 2 | 2 | 1 | - | 1 | - | - | - | - | - | 2 | 2 | 2 | 1 |
| CO4 | 2 | 2 | 2 | 1 | 1 | - | - | 1 | - | - | 1 | 2 | 3 | 1 |
| CO5 | 2 | 1 | 1 | - | 2 | - | - | - | - | - | 1 | 1 | 2 | 2 |
| CO6 | 2 | 2 | 2 | 1 | 2 | 1 | - | 1 | 1 | - | 1 | 2 | 3 | 2 |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 2 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| **Avg** | **2.17** | **1.57** | **1.66** | **1.00** | **1.62** | **1.5** | **2.00** | **1.66** | **2.00** | **1.00** | **1.75** | **2.00** | **2.30** | **1.54** |

*PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators - All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | | | | | | | | | | M |
| CO2 | M | M | | | | | | | | | M |
| CO3 | M | M | | | | | | | | | M |
| CO4 | M | M | M | | | | | | | | |
| CO5 | M | | | | M | | | | | | |
| CO6 | M | M | M | | M | | | | | | |
| CO7 | M | | | | H | | | | | | M |
| CO8 | M | M | M | | M | M | | M | | | M |
| CO9 | | | | | | M | H | | M | | H |
| CO10 | | | | | | | | H | H | M | M |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Directly develops computational thinking, Python programming literacy, and measurable problem-solving skills through application-based programming (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Builds industry-relevant skills (NumPy, Pandas, data analysis, OOP) aligned with software development and data science career paths, (CO7) directly applicable to employment in technology sectors. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables construction of data analysis pipelines, digital tools, and Python applications supporting modern IT infrastructure (CO10). |
| SDG 17 | Partnerships for the Goals | 2 (Moderate) | Supports collaborative learning through team mini-projects, peer code reviews, and open-source library usage (CO9, CO7). |

## 18. Bloom's Taxonomy - Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain - Simpson (7 Levels) |
|---|---|---|
| L1 - Remember: Recall facts, definitions, basic concepts<br>L2 - Understand: Explain ideas, concepts, principles<br>L3 - Apply: Use knowledge to solve new problems<br>L4 - Analyze: Break down information, examine patterns<br>L5 - Evaluate: Judge, justify, assess, make decisions<br>L6 - Create: Design, develop, produce new solutions | A1 - Receiving: Awareness, willingness to attend<br>A2 - Responding: Active participation and reaction<br>A3 - Valuing: Showing commitment, assigning value<br>A4 - Organizing: Integrating values into personal system<br>A5 - Characterizing: Internalized value system | P1 - Perception: Sensory cues guide motor activity<br>P2 - Set: Mental, physical readiness to act<br>P3 - Guided Response: Basic practice through imitation<br>P4 - Mechanism: Habitual correct performance<br>P5 - Complex Overt Response: Skilled performance<br>P6 - Adaptation: Modify skills for special situations<br>P7 - Origination: Create new solution patterns |

*OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains - Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) - reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

*Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**Application based Programming in Python (CSCR1302) INTEGRATED COURSE PLAN - MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Design and Creativity Lab (CSCR1504)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester II | Batch 2026–2030*
*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

## PART I

**COURSE SYLLABUS**

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

# 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | II |
| **Course Code:** | CSCR1514 | **Course Type:** | Core — Lab Only |

# 2. Course Details

**LAB-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), Course Examination (CE), and End Semester Examination (ESE). No theory lecture component.**

| | | |
|---|---|---|
| 1 | **Course Code** | CSCR1514 |
| 2 | **Course Title** | **Design and Creativity Lab** |
| 3 | **Credits** | 2 |
| 4 | **Contact Hours (L-T-P-SL)** | 0-1-2-1 (Tutorial: 15 hrs \| Lab: 30 hrs \| Self Learning: 15 hrs \| Total: 60 hrs) |
| 5 | **Course Status** | Core — Lab Only (No Theory Lecture Component) |
| 6 | **Course Objectives** | Students will be able:<br>1. To equip students with the knowledge and skills to solve complex problems through a human-centered, iterative approach.<br>2. To focus on fostering creativity, empathy, and collaboration while guiding students through the stages of design thinking to develop impactful solutions.<br>3. To ideate, prototype, and implement innovative ideas in real-world contexts. |
| 7 | **Course Outcomes (COs)** | After successful completion of this course, the students will be able to:<br>**CO1 (Remember– L1):** Understand the design thinking process.<br>**CO2 (Understand – L2):** Conduct user-centered research<br>**CO3 (Apply– L3):** Develop and evaluate creative ideas.<br>**CO4 (Analyze – L4):** Build and test prototype.<br>**CO5 (Evaluate – L5):** Communicate and pitch innovative solutions.<br>**CO6 (Create – L6):** Transform innovation into actionable plans. |
| 8 | **Course Description** | This course will equip students with the knowledge and skills to solve complex problems through a human-centered, iterative approach. It focuses on fostering creativity, empathy, and collaboration while guiding students through the stages of design thinking to develop |

| | | |
|---|---|---|
| | | impactful solutions. By the end of the course, students will be able to ideate, prototype, and implement innovative ideas in real-world contexts. |
| **9** | **Teaching & Learning Scheme** | Lab Instructions (LI): 30 hrs \| Tutorial (T): 15 hrs \| Self Learning (SL): 15 hrs \| Total: 60 hrs \| Credits: 2 |
| **10** | **Mode of Examination** | Lab Only. CA: 30% \| CE: 30% \| ESE: 40% \| Total: 100 marks |
| **11** | **Self Learning (SL: 15 hrs)** | Case Study Analysis of Innovative Products/Services (e.g., analyzing design thinking application in real-world solutions), User Research Activity (Conduct interviews/observations and prepare empathy map for a chosen problem), Ideation Exercise (Brainstorming and generating multiple solutions for a selected problem statement), Prototype Design (Create low-fidelity prototype such as sketches, storyboards, or paper models) |
| **12** | **Textbook** | 1. Falk Uebernickel, Li Jiang & Walter Brenner, *Design Thinking: The Handbook.*<br>2. Christian Müller-Roterberg, *Design Thinking For Dummies* |
| **13** | **References** | 1. Larry J. Leifer, Michael Lewrick & Patrick Link, The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods<br>2. Alyssa Gallagher & Kami Thordarson, Design Thinking in Play: An Action Guide for Educators |

## 3. Outline Syllabus — Lab Units with CO Mapping

*i All CO mappings refer to Lab COs (CO1–CO6). This is a lab-only course; all assessment is via CA, CE, and ESE.*

| | Topic / Activity | CO Mapping |
|---|---|---|
| | **Unit-1: Introduction to design thinking (0-4-8-4 = 16hrs)** | |
| A | Basic Introduction, Design Thinking vs Traditional Problem Solving | CO1 |
| B | Key Principles of Design Thinking, stages of design thinking | CO1 |
| C | Introduction to innovation, types of innovations | CO1 |
| | **Unit-2: Empathizing and problem definition (0-3-6-3 = 12hrs)** | |
| **A** | Research types, primary research (observe, interview, immerse), secondary research (prior art), online research, past facts and figures. | CO2 |
| **B** | Empathy tools: beginner's mind, fly on the wall, AEIOU, Empathy map, 5W&H, 5Why | CO3 |
| **C** | Problem articulation, how might we (HMW), Problem Definition | CO3 |
| | **Unit 3: Ideation (0-4-8-4 = 16hrs)** | |
| **A** | Ideation, brainstorming techniques, Double diamond design process, what if | CO3 |
| **B** | Group ideation, encouraging diverse perspective | CO3 |
| **C** | Prioritizing and evaluating ideas | CO3 |
| | **Unit 4: Prototyping and testing (0-2-4-2 = 8 hrs)** | |
| **A** | Why to prototype, stages of prototype, benefits of a prototype | CO4 |
| **B** | Types of prototypes, Low fidelity prototype, high fidelity prototype, | CO4 |
| **C** | prototype testing, gathering feedback, iteration and refinement | CO4 |
| | **Unit 5: Business Modeling (0-2-4-2=8hrs)** | |
| **A** | Definition, types of business model, | CO5, CO6 |

| | | |
|---|---|---|
| B | Value proposition canvas, business model canvas | CO5, CO6 |
| C | Startup pitch template, case study | CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No. | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✔ | ✔ | | | | |
| 2 | 1.B | ✔ | ✔ | ✔ | ✔ | | |
| 3 | 1.C | ✔ | ✔ | ✔ | ✔ | | |
| 4 | 2.A | | ✔ | ✔ | ✔ | | |
| 5 | 2.B | | ✔ | ✔ | ✔ | ✔ | |
| 6 | 2.C | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 7 | 3.A | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 8 | 3.B | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 9 | 3.C | | | ✔ | ✔ | ✔ | ✔ |
| 10 | 4.A | ✔ | ✔ | ✔ | | | |
| 11 | 4.B | | ✔ | ✔ | ✔ | | |
| 12 | 4.C | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 13 | 5.A | ✔ | ✔ | ✔ | | | |
| 14 | 5.B | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 15 | 5.C | | ✔ | ✔ | ✔ | ✔ | ✔ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

*ℹ Only strong/dominant alignments are mapped. Lab COs span all three domains — Cognitive (L3–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of lab and project work.*

| | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | ✓ | | | | | | ✓ | | | | | |
| CO2 | | ✓ | | | | | ✓ | ✓ | | | | | ✓ | ✓ | | | | |
| CO3 | | | ✓ | | | | | ✓ | ✓ | | | | | ✓ | ✓ | | | |
| CO4 | | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | |
| CO5 | | | | | ✓ | | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO6** | | | | | | | | | | ✓ | | | | | | ✓ | ✓ | ✓ |
| | *Legend: ✓= Strong / Dominant mapping only.* | | | | | | | | | | | | | | | | | |

## 6. Lab Session Plan — List of Experiments

**W1–W12: Core experiments developing CO1–CO5 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO6 design, optimisation, and integration experiments — all assessed under CA and CE.**

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| **W1** | **S-1.1** | Introduction to Design Thinking | **CO1** | 3.0 |
| | **S-1.2** | Need for Design Thinking | **CO1** | |
| **W2** | **S-2.1** | Design Thinking vs Traditional Problem Solving | **CO1** | 3.0 |
| | **S-2.2** | Key Principles of Design Thinking | **CO1** | |
| **W3** | **S-3.1** | Human-Centered Design | **CO1** | 3.0 |
| | **S-3.2** | Stages of Design Thinking | **CO1** | |
| **W4** | **S-4.1** | Empathize Stage | **CO2** | 3.0 |
| | **S-4.2** | Define Stage | **CO2** | |
| **W5** | **S-5.1** | Ideate Stage | **CO3** | 3.0 |
| | **S-5.2** | Prototype Stage | **CO3** | |
| **W6** | **S-6.1** | Test Stage | **CO3** | 3.0 |
| | **S-6.2** | Introduction to Innovation | **CO3** | |
| **W7** | **S-7.1** | Importance of Innovation | **CO4** | 3.0 |
| | **S-7.2** | Types of Innovation | **CO4** | |
| **W8** | **S-8.1** | Incremental Innovation | **CO4** | 3.0 |
| | **S-8.2** | Disruptive Innovation | **CO4** | |
| **W9** | **S-9.1** | Research Methods Overview | **CO4** | 3.0 |
| | **S-9.2** | Primary Research Techniques | **CO4** | |
| **W10** | **S-10.1** | Observation Method | **CO5** | 3.0 |
| | **S-10.2** | Interview Method | **CO5** | |
| **W11** | **S-11.1** | Immersion Technique | **CO5** | 3.0 |

| | | | | |
|---|---|---|---|---|
| | **S-11.2** | Secondary Research | **CO5** | |
| **W12** | **S-12.1** | Prior Art Study | **CO6** | 3.0 |
| | **S-12.2** | Stages of Prototype Development | **CO6** | |
| **W13** | **S-13.1** | Low Fidelity Prototypes | **CO6** | 3.0 |
| | **S-13.2** | High Fidelity Prototypes | **CO6** | |
| **W14** | **S-14.1** | Prototype Testing and Feedback | **CO6** | 3.0 |
| | **S-14.2** | Iteration and Refinement | **CO6** | |
| **W15** | **S-15.1** | Business Model Canvas and Startup Pitch Template | **CO6** | 3.0 |
| | **S-15.2** | Stages of Prototype Development | **CO6** | |

*ℹ Instructions: Write programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

**PART II LAB ASSESSMENT FRAMEWORK** *CA Rubric, CE Structure, ESE Pattern, Lab Skill Dimensions*

## 7. Lab Skill Dimensions (LS1–LS8)

🔬 **LAB-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), Course Examination (CE), and End Semester Examination (ESE).**

*ℹ Eight Lab Skill Dimensions — mapping progressively from L3 to L6 — correspond to the six COs. They define exactly what competency is measured in each component of CA, CE, and ESE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **LS1** | Design Thinking Comprehension | Ability to understand the concepts, principles, stages, and importance of Design Thinking and innovation. | CO1 \| L3 | CA \| CE Sec A |
| **LS2** | User-Centered Research & Empathy Skills | Ability to perform primary and secondary research using observation, interviews, immersion, empathy maps, | CO1–CO3 \| L3 | CA \| CE Sec A |
| **LS3** | Problem Identification & Definition | Ability to analyze user needs, articulate problems, and frame | CO4 \| L4 | CA \| CE Sec B |

| | | | | |
|---|---|---|---|---|
| | | effective “How Might We (HMW)” statements. | | |
| **LS4** | Ideation & Creative Thinking | Ability to generate innovative ideas through brainstorming, double diamond process, what-if analysis, and group ideation activities. | CO5 \| L5 | CA \| CE Sec B\| ESE Sec B |
| **LS5** | Idea Evaluation & Decision Making | Ability to prioritize, compare, evaluate, and select feasible solutions based on design and innovation requirements. | CO3–CO5 \| L4 | CA \| ESE Sec B |
| **LS6** | Prototype Development Skills | Ability to create low-fidelity and high-fidelity prototypes demonstrating practical implementation of ideas. | CO1–CO5 \| L3 | CA (Lab Record) |
| **LS7** | Testing, Feedback & Iterative Refinement | Ability to test prototypes, gather user feedback, refine solutions, and improve outcomes iteratively. | CO4, CO6 \| L4–L6 | CA \| ESE Sec B/C |
| **LS8** | Business Modeling & Innovation Communication | Ability to develop business models using Value Proposition Canvas and Business Model Canvas, and effectively communicate solutions through startup pitches and case studies. | CO6 \| L6 | CE Sec C \| ESE Sec C |

## 8. CO × Lab Skill Dimension Mapping (6 COs × 8 Dimensions)

*i Each CO maps primarily to one or two LS dimensions (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this lab course.*

| CO | LS1 Research & Empathy | LS2 Problem Definition | LS3 Ideation & Creativity | LS4 Idea Evaluation | LS5 Prototyping | LS6 Testing & Refinement | LS7 Communication & Pitching | LS8 Business Modeling |
|---|---|---|---|---|---|---|---|---|
| **CO 1** | H | M | | | | | | |
| **CO 2** | H | H | | | | | | |
| **CO 3** | M | M | H | M | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **CO 4** | | M | M | H | H | M | | |
| **CO 5** | | | M | H | M | M | H | |
| **CO 6** | | | M | M | | | H | H |

*H = High / Primary  M = Medium / Secondary  Blank = No direct alignment*

# 9. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs & Skill Dimensions Assessed |
|---|---|---|---|
| **Continuous Assessment (CA)** | 30% | **30** | All Lab COs: CO1–CO6 \| LS1–LS7 \| Per-experiment rubric |
| **Course Examination (CE)** | 30% | **30** | CO1–CO6 \| LS1–LS8 \| Practical + Viva |
| **End Semester Examination (ESE)** | 40% | **40** | CO1–CO6 \| LS4–LS8 \| Program writing + Analysis + Design |
| **TOTAL** | **100%** | **100** | All COs assessed across all three instruments |

# 10. Continuous Assessment (CA) — 30 Marks

## 10.1 Per-Experiment CA Rubric (3.0 Marks each)

| Criterion | Marks | Lab Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| Research & Problem Understanding | 1 | LS1 — Research & Empathy<br>LS2 — Problem Definition | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO1–CO4 |
| Ideation & Solution Development | 1 | LS3 — Ideation & Creativity<br>LS4 — Idea Evaluation | 1.0: Correct & runs \| 0.5: Minor errors \| 0: Does not compile | CO1–CO5 |
| Prototype Development & Testing | 0.75 | LS5 — Prototyping LS6 — Testing & Refinement | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO3–CO5 |
| Communication & Professional Conduct | 0.25 | LS7 — Communication & Pitching LS8 — Business Modeling | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO6 |
| **Total** | **3.0** | All 8 LS dimensions covered | | CO1–CO6 |

## 10.2 Best-N-of-15 Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|

| | | | |
|---|---|---|---|
| >10 | Best 10 | **30 Marks** | Best 10 of all sessions (3 marks × 10 = 30) |
| < 10 | All attended | **≤ 30 Marks** | Each missed session = zero; cannot be compensated |

## 11. Continuous Evaluation (CE) — 30 Marks

*ℹ CE is a mid-point practical examination covering Units 1–3 (CO1–CO3). CO4, CO5, and CO6 are assessed in ESE only. CE maps to LS1–LS5.*

| Section | Marks | Lab Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| Sec A | 10 | LS1 — Design Thinking Comprehension LS2 — Research & Empathy Skills | CO1, CO2 | Conduct empathy analysis, identify user problems, apply research techniques, and explain findings using suitable empathy tools. |
| Sec B | 10 | LS3 — Problem Identification LS4 — Ideation & Creative Thinking LS5 — Idea Evaluation | CO2, CO3, CO4 | Generate innovative ideas using brainstorming/HMW methods, compare alternatives, prioritize solutions, and justify selected ideas. |
| Sec C (Viva) | 10 | LS6 — Prototype Development LS7 — Testing & Refinement | CO3–CO5 | Prototype demonstration, testing approach, feedback interpretation, iterative improvement, and viva questions based on practical activities. |
| **TOTAL** | **30** | **LS1–LS7** | **CO1–CO5** | **Units 1–4 covered. CO6 assessed primarily in ESE/project-based activities.** |

## 12. End Semester Examination (ESE) — 40 Marks

*ℹ ESE is comprehensive — all 5 units and all 6 COs. Full progression from LS2 (implementation) through LS8 (innovation). Minimum 16/40 required to pass.*

| Section | Marks | Lab Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| Sec A | 10 | LS1 — Design Thinking Comprehension LS2 — Research & Empathy Skills LS3 — Problem Identification | CO1, CO2, CO3 | Analyze user problems, apply empathy tools, define problem statements, and demonstrate understanding of Design Thinking stages and innovation concepts. |
| Sec B | 20 | LS4 — Ideation & Creative Thinking LS5 — Idea Evaluation LS6 — Prototype Development | CO3, CO4, CO5 | Generate and evaluate innovative ideas, perform brainstorming/HMW activities, design prototypes, and justify selected solutions using structured reasoning. |
| Sec C | 10 | LS7 — Testing & Refinement LS8 — Business Modeling & Innovation Communication | CO5, CO6 | Prototype testing, feedback analysis, iteration strategies, business model canvas preparation, startup pitch presentation, and innovation communication. |
| **TOTAL** | **40** | LS2–LS8 (all) | CO1–CO6 | Minimum 16/40 to pass. Scaled from 100-mark paper if needed. |

### 12.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (30) | CE (30) | ESE (40) | LS Dims | PO Primary |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO1** | Understand the design thinking process. | ✓ | ✓ | ✓ | LS1, LS2, LS6 | PO1, PO2, PO5 |
| **CO2** | Conduct user-centered research | ✓ | ✓ | ✓ | LS2, LS6 | PO1, PO3 |
| **CO3** | Develop and evaluate creative ideas. | ✓ | ✓ | ✓ | LS2, LS3, LS5, LS6 | PO1, PO2, PO3 |
| **CO4** | Build and test prototype. | ✓ | — | ✓ | LS3, LS4, LS5, LS7 | PO1, PO2, PO3 |
| **CO5** | Communicate and pitch innovative solutions. | ✓ | — | ✓ | LS4, LS5, LS7 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Transform innovation into actionable plans. | ✓ | — | ✓ | LS7, LS8 | PO1, PO2, PO10, PO11 |

⚠ *CO4 and CO5 are NOT assessed in CE (only Units 1–3 are covered at the course examination). They are assessed in CA (lab sessions) and ESE.*

**PART III COMBINED MAPPINGS & REFERENCE** *CO–PO Matrix, CO–PO Alignment, Bloom's Reference, Attendance & Pass/Fail*

## 13. CO–PO and CO–PSO Mapping Matrix

*Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | - | 1 | | 1 | - | - | - | 2 | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 3 | - | | - | 2 | 2 | 2 | 2 | - | - |
| **CO3** | 3 | 2 | 2 | 2 | 3 | 2 | | - | - | 2 | 3 | 2 | - | - |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | | 2 | 2 | 2 | 3 | 3 | - | - |
| **CO5** | 2 | 2 | 2 | 2 | 2 | 3 | | 2 | - | 3 | 2 | 2 | - | - |
| **CO6** | 3 | 2 | 3 | 2 | 3 | 3 | | 2 | 3 | 3 | 2 | 2 | - | - |
| **Avg** | **2.83** | **2.33** | **2.500** | **2.4** | **2.8** | **2.2** | **0** | **1.75** | **2.25** | **2.80** | **2.00** | **2.20** | **0** | **0** |

## 14. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | M | - | - | L | | L | - | - | - | M | - | - |
| **CO2** | H | H | H | H | H | - | | - | M | M | M | M | - | - |
| **CO3** | H | M | M | M | H | M | | - | - | M | H | M | - | - |
| **CO4** | H | H | H | H | H | M | | M | M | M | H | H | - | - |
| **CO5** | M | M | M | M | M | H | | M | - | H | M | M | - | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO6** | H | M | H | M | H | H | | M | H | H | M | M | - | - |

*H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment*

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts L2 — Understand: Explain ideas, concepts, principles L3 — Apply: Use knowledge to solve new problems L4 — Analyze: Break down information, examine patterns L5 — Evaluate: Judge, justify, assess, make decisions L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend A2 — Responding: Active participation and reaction A3 — Valuing: Showing commitment, assigning value A4 — Organizing: Integrating values into personal system A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity P2 — Set: Mental, physical readiness to act P3 — Guided Response: Basic practice through imitation P4 — Mechanism: Habitual correct performance P5 — Complex Overt Response: Skilled performance P6 — Adaptation: Modify skills for special situations P7 — Origination: Create new solution patterns |

*ℹ OBE Compliance Statement: This is a lab-only course. All 6 COs span all three domains — Cognitive (L3–L6) as the primary domain, Psychomotor (P3–P6) for implementation and design skills, and Affective (A2–A4) for professional and collaborative conduct — reflecting the skill-based, hands-on nature of laboratory assessment.*

## 16. Attendance Policy & Pass/Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Lab / Practical Sessions** | **75%** | All lab sessions | Debarred from ESE if below threshold |
| **Self-Learning Submissions** | All activities | SL activities (15 hrs — coding problems) | Incomplete SL affects CA score directly |

*⚠ Lab attendance must meet 75% minimum. Missing SL activities (coding platform submissions) directly impacts CA marks and is not compensable by examination performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ESE Score** | **≥ 16 / 40** | **MANDATORY** | 40% of ESE marks required; failing ESE means failing the course regardless of CA + CE performance |
| **Overall Total (CA + CE + ESE)** | **≥ 40 / 100** | **Must pass overall** | CA 30 + CE 30 + ESE 40 = 100; 40% overall minimum required |

**Design and Creativity Lab (CSCR1504)— LAB-ONLY COURSE PLAN — MEASUREMENT ARCHITECTURE**

11 Programme Outcomes → 6 Lab COs (CO1–CO6) → 3 Assessment Instruments → 8 Lab Skill Dimensions (LS1–LS8)

CO1–CO3: Apply/Analyse → LS1–LS3, LS6 → CA + CE + ESE

CO4–CO5: Analyse/Evaluate → LS3–LS5, LS7 → CA + ESE

CO6: Create → LS7–LS8 → CA + ESE Sec C

**Marks: CA 30 + CE 30 + ESE 40 = Total 100**

# COURSE PLAN

## Digital Prototyping (CSCR1507)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester II | Batch 2026–2030*

*Lab-Only Course Plan — All 6 Lab COs (CO1–CO6) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I COURSE SYLLABUS** *Course Identification, Details, Outcomes, BTL Mapping & Lab Session Plan*

# 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE | **Batch:** | 2025–2029 |
| **Program:** | B.Tech | **Current Academic Year:** | 2025–26 |
| **Branch:** | CSE-AIML | **Semester:** | II |
| **Course Code:** | CSCR1507 | **Course Type:** | Core — Lab Only |

# 2. Course Details

**LAB-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), Course Examination (CE), and End Semester Examination (ESE). No theory lecture component.**

| | | |
|---|---|---|
| **1** | **Course Code** | CSCR1507 |
| **2** | **Course Title** | Digital Prototyping |
| **3** | **Credits** | 2 |
| **4** | **Contact Hours (L-T-P-SL)** | 0-1-2-1 (Tutorial: 15 hrs \| Lab: 30 hrs \| Self Learning: 15 hrs \| Total: 60 hrs) |
| **5** | **Course Status** | Core — Lab Only (No Theory Lecture Component) |
| **6** | **Course Objectives** | The objective of this course is to introduce students to hands-on digital prototyping using basic electronic components, simulation tools, and microcontrollers. Students will learn to design, simulate, and implement real-world systems using Arduino and sensors, culminating in a working prototype-based project. |
| **7** | **Course Outcomes (COs)** | After completion of the course, students will be able to:<br><br>**CO1 (Remember – L1):** Identify and recall basic electronic components, Arduino hardware, and tools.<br>**CO2 (Understand – L2):** Explain working principles of circuits, sensors, and Arduino programs.<br>**CO3 (Apply – L3):** Build and simulate basic circuits using Tinkercad and Arduino.<br>**CO4 (Analyze – L4):** Debug and analyse circuit behavior and Arduino code.<br>**CO5 (Evaluate – L5):** Compare and select appropriate sensors and components for applications.<br>**CO6 (Create – L6):** Design and develop a complete Arduino-based prototype solving a real-world problem. |
| **8** | **Course Description** | This course introduces students to the fundamentals of digital prototyping through a highly hands-on and experiential learning approach. It covers basic electronic components, circuit design, and simulation using tools like Tinkercad, followed by practical implementation using Arduino boards. Students learn to interface various sensors and develop real-time applications through guided lab activities. The course emphasizes problem-solving, debugging, and iterative design thinking. It culminates in a mini |

| | | |
|---|---|---|
| | | project where students design and build a functional prototype addressing a real-world problem. Overall, it bridges the gap between theoretical concepts and practical engineering skills. |
| **9** | **Teaching & Learning Scheme** | Lab Instructions (LI): 30 hrs \| Tutorial (T): 15 hrs \| Self Learning (SL): 15 hrs \| Total: 60 hrs \| Credits: 2 |
| **10** | **Mode of Examination** | Lab Only. CA: 30% \| CE: 30% \| ESE: 40% \| Total: 100 marks |
| **11** | **Self Learning (SL: 15 hrs)** | Problem Solving / Coding Problems on coding platforms (Tinkercad).<br>15 small real-life problems of 1 hour each. Total = 15 hrs.<br>Evaluation: Based on problem solution submitted and test cases passed. |
| **12** | **Textbook** | Getting Started With Arduino by Massimo Banzi and Michael Shiloh |
| **13** | **References** | 1. Electronics is a hands-on instructional book by Charles Platt<br>2. Arduino Projects with Tinkercad is a practical guidebook by Johannes Wild<br>3. IoT & Arduino Lab Workbook by Dr. Zatin Gupta |

# 3. Outline Syllabus — Lab Units with CO Mapping

*All CO mappings refer to Lab COs (CO1–CO6). This is a lab-only course; all assessment is via CA, CE, and ESE.*

| | Topic / Activity | CO Mapping |
|---|---|---|
| | **Unit 1: Basics of Electronics & Prototyping** | |
| **A** | Introduction to Digital Prototyping, Breadboard, Power supply, Basic components: Resistor, Capacitor, LED, Switch | **CO1** |
| **B** | Ohm's Law, Series & Parallel Circuits (practical understanding), Circuit connections and safety | **CO1** |
| **C** | Hands-on: LED blinking, push-button control, Introduction & Usage of multimeter | **CO1** |
| | **Unit 2: Tinkercad Simulation** | |
| **A** | Introduction to Tinkercad Circuits environment, Virtual circuit design | **CO2** |
| **B** | Simulating basic circuits (LED, switch, buzzer), Debugging in simulation | **CO3** |
| **C** | Arduino simulation in Tinkercad, Basic code structure (setup, loop) | **CO3** |
| | **Unit 3: Arduino Fundamentals** | |
| **A** | Introduction to Arduino Uno, IDE installation, Digital I/O, pin configuration | **CO3** |

| | | |
|---|---|---|
| **B** | Programming basics: Variables, digitalRead, digitalWrite, delay, Serial monitor O/P | **CO3** |
| **C** | Hands-on: LED patterns, button input, buzzer control | **CO3** |
| | **Unit 4: Sensors & Interfacing** | |
| **A** | Introduction to sensors: LDR, Temperature, Ultrasonic, Analog vs Digital signals | **CO4, CO6** |
| **B** | Sensor interfacing with Arduino, Analog input handling | **CO4, CO6** |
| **C** | Design Real Life Applications like Automatic light system, Distance measurement, etc. | **CO4, CO6** |
| | **Unit 5: Prototype Development Project** | |
| **A** | Project idea and problem identification | **CO5, CO6** |
| **B** | Project Design, circuit building, implementation & coding | **CO5, CO6** |
| **C** | Testing, debugging, and final demonstration | **CO5, CO6** |

# 4. Topic-wise Bloom's Taxonomy Level Mapping

| Sr. No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A - Introduction to Digital Prototyping, Breadboard, Power supply, Basic components: Resistor, Capacitor, LED, Switch | | ✓ | | | | |
| 2 | 1.B - Ohm's Law, Series & Parallel Circuits (practical understanding), Circuit connections and safety | | ✓ | ✓ | | | |
| 3 | 1.C - Hands-on: LED blinking, push-button control, Introduction & Usage of multimeter | | ✓ | ✓ | | | |
| 4 | 2.A - Introduction to Tinkercad Circuits environment, Virtual circuit design | | ✓ | ✓ | | | |
| 5 | 2.B - Simulating basic circuits (LED, switch, buzzer), Debugging in simulation | | ✓ | ✓ | | | |
| 6 | 2.C - Arduino simulation in Tinkercad, Basic code structure (setup, loop) | | | ✓ | ✓ | | |
| 7 | 3.A - Introduction to Arduino Uno, IDE installation, Digital I/O, pin configuration | ✓ | ✓ | | | | |
| 8 | 3.B - Programming basics: Variables, digitalRead, digitalWrite, delay, Serial monitor O/P | | ✓ | ✓ | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | 3.C - Hands-on: LED patterns, button input, buzzer control | | | ✓ | ✓ | | |
| 10 | 4.A - Introduction to sensors: LDR, Temperature, Ultrasonic, Analog vs Digital signals | | | ✓ | ✓ | | |
| 11 | 4.B - Sensor interfacing with Arduino, Analog input handling | | | ✓ | ✓ | | |
| 12 | 4.C - Design Real Life Applications like Automatic light system, Distance measurement, etc. | | | | ✓ | ✓ | ✓ |
| 13 | 5.A - Project idea and problem identification | | | | ✓ | ✓ | ✓ |
| 14 | 5.B - Project Design, circuit building, implementation & coding | | | | ✓ | ✓ | ✓ |
| 15 | 5.C - Testing, debugging, and final demonstration | | | | ✓ | ✓ | ✓ |

# 5. CO vs Bloom's Taxonomy — All Three Domains

*i Only strong/dominant alignments are mapped. Lab COs span all three domains — Cognitive (L3–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of lab and project work.*

| | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **L1** | **L2** | **L3** | **L4** | **L5** | **L6** | **A1** | **A2** | **A3** | **A4** | **A5** | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** | **P7** |
| **CO 1** | | ✓ | | | | | | | | | | | ✓ | ✓ | | | | |
| **CO 2** | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | | |
| **CO 3** | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | | |
| **CO 4** | | ✓ | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | |
| **CO 5** | | | ✓ | ✓ | | | | ✓ | | | | | | | ✓ | ✓ | | |
| **CO 6** | | | ✓ | ✓ | ✓ | | | | ✓ | | | | | | ✓ | ✓ | ✓ | |

*Legend: ✓ = Strong / Dominant mapping only.*

# 6. Lab Session Plan — List of Experiments

**W1–W12: Core experiments developing CO1–CO5 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO6 design, optimization, and integration experiments — all assessed under CA and CE.**

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| **W1** | Session-1.1<br>DD/MM/YY | Experiment 1: Identification of Components<br>• Identify resistor, LED, capacitor, switch<br>• Read resistor colour codes<br>• Measure values using multimeter | **CO1** | 3.0 |
| | Session-1.2<br>DD/MM/YY | Experiment 2: Basic LED Circuit<br>• LED connection with resistor<br>• Polarity testing<br>• LED brightness variation | **CO1** | |
| **W2** | Session-2.1<br>DD/MM/YY | Experiment 3: Series & Parallel Circuits<br>• Series LED circuit<br>• Parallel LED circuit<br>• Compare brightness | **CO1** | 3.0 |
| | Session-2.2<br>DD/MM/YY | Experiment 4: Switch Controlled Circuit<br>• Push button LED control<br>• Toggle operation<br>• Debouncing concept (basic) | **CO1** | |
| **W3** | Session-3.1<br>DD/MM/YY | Experiment 5: Tinkercad Interface<br>• Create account & workspace<br>• Add components<br>• Simulate simple circuit | **CO1** | 3.0 |
| | Session-3.2<br>DD/MM/YY | Experiment 6: LED Simulation<br>• LED ON/OFF simulation<br>• Multiple LED connections<br>• Error debugging | **CO1** | |
| **W4** | Session-4.1<br>DD/MM/YY | Experiment 7: Buzzer Circuit Simulation<br>• Connect buzzer<br>• Create alarm circuit<br>• Debug faulty wiring | **CO2** | 3.0 |
| | Session-4.2<br>DD/MM/YY | Experiment 8: Switch + LED Simulation<br>• Switch-controlled LED<br>• Multi-switch logic<br>• Troubleshooting | **CO2** | |

| | | | | |
|---|---|---|---|---|
| **W5** | Session-5.1<br>DD/MM/YY | Experiment 9: Arduino IDE Setup<br>• Install Arduino IDE<br>• Board selection<br>• Upload first program | **CO3** | 3.0 |
| | Session-5.2<br>DD/MM/YY | Experiment 10: LED Blink Program<br>• Basic blink<br>• Modify delay<br>• Multiple LEDs | **CO3** | |
| **W6** | Session-6.1<br>DD/MM/YY | Experiment 11: LED Pattern Generation<br>• Sequential blinking<br>• Traffic light system<br>• Pattern design | **CO3** | 3.0 |
| | Session-6.2<br>DD/MM/YY | Experiment 12: Buzzer Interfacing<br>• Buzzer ON/OFF<br>• Alarm tone<br>• Conditional buzzer | **CO3** | |
| **W7** | Session-7.1<br>DD/MM/YY | Experiment 13: Push Button Input<br>• Button reading<br>• LED control<br>• Toggle logic | **CO4** | 3.0 |
| | Session-7.2<br>DD/MM/YY | Experiment 14: Multiple Inputs<br>• Two-button control<br>• AND/OR logic<br>• Debugging input issues | **CO4** | |
| **W8** | Session-8.1<br>DD/MM/YY | Experiment 15: Potentiometer Reading<br>• Analog input reading<br>• Display on serial monitor<br>• Mapping values | **CO4** | 3.0 |
| | Session-8.2<br>DD/MM/YY | Experiment 16: PWM Output<br>• Control LED brightness<br>• AnalogWrite usage<br>• Smooth fading | **CO4** | |
| **W9** | Session-9.1<br>DD/MM/YY | Experiment 17: LDR Interface<br>• Read light intensity<br>• Serial output<br>• Calibration | **CO4** | 3.0 |
| | Session-9.2<br>DD/MM/YY | Experiment 18: Automatic Street Light<br>• Threshold-based LED | **CO4** | |

| | | | | |
|---|---|---|---|---|
| | | • Day/Night detection<br>• Optimization | | |
| **W10** | Session-10.1<br>DD/MM/YY | Experiment 19: Temperature Sensor Interface<br>• Read temperature values<br>• Display on serial monitor<br>• Calibration | **CO5** | 3.0 |
| | Session-10.2<br>DD/MM/YY | Experiment 20: Temperature Alert System<br>• Threshold alert<br>• Buzzer activation<br>• Real-time monitoring | **CO5** | |
| **W11** | Session-11.1<br>DD/MM/YY | Experiment 21: Distance Measurement<br>• Sensor interfacing<br>• Measure distance<br>• Display output | **CO5** | 3.0 |
| | Session-11.2<br>DD/MM/YY | Experiment 22: Obstacle Detection<br>• LED/buzzer alert<br>• Range control<br>• Debugging | **CO5** | |
| **W12** | Session-12.1<br>DD/MM/YY | Experiment 23: Multi-Sensor Integration<br>• Combine LDR + LED<br>• Combine temperature + buzzer<br>• Logic building | **CO6** | 3.0 |
| | Session-12.2<br>DD/MM/YY | Experiment 24: Smart System Prototype<br>• Mini automation system<br>• Multi-output control<br>• Optimization | **CO6** | |
| **W13** | Session-13.1<br>DD/MM/YY | Experiment 25: Smart Lighting System<br>• LDR + PWM control<br>• Energy-efficient lighting<br>• Performance tuning | **CO6** | 3.0 |
| | Session-13.2<br>DD/MM/YY | Experiment 26: Smart Alarm System<br>• Ultrasonic + buzzer<br>• Multi-condition alert<br>• Testing scenarios | **CO6** | |
| **W14** | Session-14.1<br>DD/MM/YY | Experiment 27: Project Design & Planning<br>• Problem identification | **CO6** | 3.0 |

| | | | | |
|---|---|---|---|---|
| | | • Block diagram<br>• Component selection | | |
| | Session-14.2<br>DD/MM/YY | Experiment 28: Circuit Implementation<br>• Hardware setup<br>• Code development<br>• Integration | CO6 | |
| W15 | Session-15.1<br>DD/MM/YY | Experiment 29: Testing & Debugging<br>• Error handling<br>• Performance testing<br>• Optimization | CO6 | 3.0 |
| | Session-15.2<br>DD/MM/YY | Experiment 30: Final Demonstration<br>• Working prototype<br>• Presentation<br>• Viva | CO6 | |

*Instructions: Write programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

# 7. Lab Skill Dimensions (LS1–LS8)

**LAB-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), Course Examination (CE), and End Semester Examination (ESE).**

*Eight Lab Skill Dimensions — mapping progressively from L3 to L6 — correspond to the six COs. They define exactly what competency is measured in each component of CA, CE, and ESE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| LS1 | **Problem Definition & Tool Setup** | Define experiment goal; configure tool | CO1 \| L3 | CA \| CE Sec A |
| LS2 | **Implementation & Execution** | Write syntactically and logically correct code; compile and execute to produce expected output | CO1–CO3 \| L3 | CA \| CE Sec A |
| LS3 | **Data Structure Design & ADT Implementation** | Design and implement the hardware | CO4 \| L4 | CA \| CE Sec B |
| LS4 | **Algorithm Analysis & Complexity Evaluation** | Analyse & Caliber, the delay | CO5 \| L5 | CA \| CE Sec B\| ESE Sec B |
| LS5 | **Output Analysis & Result Interpretation** | Analyse output critically; explain deviations from expected results | CO3–CO5 \| L4 | CA \| ESE Sec B |
| LS6 | **Documented Outcome & Verification** | Record final outcome formally with aim, algorithm, code, output, and result; verify against problem statement | CO1–CO5 \| L3 | CA (Lab Record) |
| LS7 | **Algorithmic Design & Solution Planning** | Produce algorithm/pseudocode/flowchart before coding; justify design choices with respect to complexity and structure | CO4, CO6 \| L4–L6 | CA \| ESE Sec B/C |
| LS8 | **Innovation & Code Optimisation** | Formulate improved solutions; re-engineer existing code; benchmark improvements | CO6 \| L6 | CE Sec C \| ESE Sec C |

# 8. CO × Lab Skill Dimension Mapping (6

# COs × 8 Dimensions)

*i Each CO maps primarily to one or two LS dimensions (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this lab course.*

| CO | LS1 Prob.Def. | LS2 Implement. | LS3 DS Design | LS4 Algo.Anal. | LS5 Output Anal. | LS6 Doc.Outcome | LS7 Algo.Design | LS8 Innovation |
|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | | | | H | | |
| CO2 | | H | | | | H | | |
| CO3 | | H | | | H | H | | |
| CO4 | | | H | M | M | M | H | |
| CO5 | | | M | H | H | M | M | |
| CO6 | | | | M | | | H | H |

*H = High / Primary  M = Medium / Secondary  Blank = No direct alignment*

# 9. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs & Skill Dimensions Assessed |
|---|---|---|---|
| **Continuous Assessment (CA)** | 30% | **30** | All Lab COs: CO1–CO6 \| LS1–LS7 \| Per-experiment rubric |
| **Course Examination (CE)** | 30% | **30** | CO1–CO6 \| LS1–LS8 \| Practical + Viva |
| **End Semester Examination (ESE)** | 40% | **40** | CO1–CO6 \| LS4–LS8 \| Program writing + Analysis + Design |
| **TOTAL** | **100%** | **100** | All COs assessed across all three instruments |

# 10. Continuous Assessment (CA) — 30 Marks

## 10.1 Per-Experiment CA Rubric (3.0 Marks each)

| Criterion | Marks | Lab Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | 1.0 | LS1 — Problem definition, tool configuration LS7 — Algorithm/pseudocode/flow chart before coding | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO1–CO4 |
| **Code Implementation & Execution** | 1.0 | LS2 — Code correctness and compilation LS3 — Data structure implementation quality | 1.0: Correct & runs \| 0.5: Minor errors \| 0: Does not compile | CO1–CO5 |
| **Output Analysis & Lab Documentation** | 0.75 | LS5 — Output analysis LS6 — Lab record: aim, algo, code, output, result | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO3–CO5 |
| **Professional & Ethical Conduct** | 0.25 | LS8 — Responsible coding practice, record integrity | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO6 |
| **Total** | **3.0** | All 8 LS dimensions covered | | CO1–CO6 |

## 10.2 Best-N-of-15 Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|

| | | | |
|---|---|---|---|
| >10 | Best 10 | **30 Marks** | Best 10 of all sessions (3 marks × 10 = 30) |
| < 10 | All attended | ≤ **30 Marks** | Each missed session = zero; cannot be compensated |

# 11. Continuous Evaluation (CE) — 30 Marks

*ℹ CE is a mid-point practical examination covering Units 1–3 (CO1–CO3). CO4, CO5, and CO6 are assessed in ESE only. CE maps to LS1–LS5.*

| Section | Marks | Lab Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Sec A** | 10 | LS1 — Tool Setup LS2 — Code Implementation | CO1, CO2 | Write and execute a program on pointers or structures; demonstrate tool setup; expected output must match |
| **Sec B** | 10 | LS3 — DS Design LS5 — Output Analysis | CO2, CO3 | File handling or ADT implementation; trace and explain output; justify file type selection |
| **Sec C (Viva)** | 10 | LS6 — Lab Record LS7 — Algo Design | CO1–CO3 | Lab record verification; oral questions on algorithm design, complexity, and output interpretation; lab record must be complete |
| **TOTAL** | **30** | LS1–LS7 | CO1–CO3 | Units 1–3. CO4, CO5, CO6 assessed in ESE only. |

# 12. End Semester Examination (ESE) — 40 Marks

*ℹ ESE is comprehensive — all 5 units and all 6 COs. Full progression from LS2 (implementation) through LS8 (innovation). Minimum 16/40 required to pass.*

| Section | Marks | Lab Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Sec A** | 10 | LS2 — Implementation LS3 — DS Design | CO1, CO2, CO4 | Program writing: implement a given linked list operation, pointer-based program, or data structure; output must match expected |

| | | | | |
|---|---|---|---|---|
| **Sec B** | 20 | LS4 — Algo Analysis LS5 — Output Interpretation LS7 — Algo Design | CO3, CO4, CO5 | Algorithm tracing & complexity analysis; sort/search program with performance comparison; file operations with analysis; pseudocode design before coding |
| **Sec C** | 10 | LS7 — Algo Design LS8 — Innovation | CO5, CO6 | Design and optimise: re-engineer given inefficient code; propose improved algorithm with Big-O justification; or design a novel data structure solution |
| **TOTAL** | **40** | LS2–LS8 (all) | CO1–CO6 | Minimum 16/40 to pass. Scaled from 100-mark paper if needed. |

# 12.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (30) | CE (30) | ESE (40) | LS Dims | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Identify and recall basic electronic components, Arduino hardware, and tools. | ✓ | ✓ | ✓ | LS1, LS2, LS6 | PO1, PO2, PO5 |
| **CO2** | Explain working principles of circuits, sensors, and Arduino programs. | ✓ | ✓ | ✓ | LS2, LS6 | PO1, PO3 |
| **CO3** | Build and simulate basic circuits using Tinkercad and Arduino. | ✓ | ✓ | ✓ | LS2, LS3, LS5, LS6 | PO1, PO2, PO3 |
| **CO4** | Debug and analyse circuit behavior and Arduino code. | ✓ | — | ✓ | LS3, LS4, LS5, LS7 | PO1, PO2, PO3 |
| **CO5** | Compare and select appropriate sensors and components for applications. | ✓ | — | ✓ | LS4, LS5, LS7 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Design and develop a complete Arduino-based prototype solving a real-world problem. | ✓ | — | ✓ | LS7, LS8 | PO1, PO2, PO10, PO11 |

*⚠ CO4 and CO5 are NOT assessed in CE (only Units 1–3 are covered at the course examination). They are assessed in CA (lab sessions) and ESE.*

**PART III COMBINED MAPPINGS & REFERENCE** *CO–PO Matrix, CO–PO Alignment, Bloom's Reference, Attendance & Pass/Fail*

# 13. CO–PO and CO–PSO Mapping Matrix

*Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | - | 2 | 1 | 1 |
| CO2 | 1 | 2 | 3 | - | - | - | - | - | - | - | - | 1 | 3 | 1 |
| CO3 | 2 | 3 | 3 | - | - | - | - | - | - | - | - | 2 | 2 | 3 |
| CO4 | 2 | 3 | 1 | - | - | - | - | 2 | 2 | 1 | - | 2 | 2 | 2 |
| CO5 | 3 | 2 | - | - | - | - | - | 3 | 2 | 1 | 2 | 3 | 2 | 2 |
| CO6 | 2 | 3 | 3 | - | - | - | - | 2 | 1 | 2 | 3 | 2 | 3 | 3 |
| Avg | 2.00 | 2.50 | 2.40 | – | 2.00 | – | – | 2.33 | 1.67 | 1.33 | 2.50 | 2.00 | 2.17 | 2.00 |

# 14. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | M | | M | | | | | | | M | | |
| CO2 | | M | H | | | | | | | | | | H | |
| CO3 | M | H | H | | | | | | | | | M | M | H |
| CO4 | M | H | M | | | | | M | M | M | | M | M | M |
| CO5 | H | M | | | | | | H | M | M | M | H | M | M |
| CO6 | M | H | H | | | | | M | M | M | H | M | H | H |

*H = High / Primary alignment M = Medium / Secondary alignment Blank = No direct alignment*

# 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts L2 — Understand: Explain ideas, concepts, principles L3 — Apply: Use knowledge to solve new problems L4 — Analyze: Break down information, examine patterns L5 — Evaluate: Judge, justify, assess, make decisions L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend A2 — Responding: Active participation and reaction A3 — Valuing: Showing commitment, assigning value A4 — Organizing: Integrating values into personal system A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity P2 — Set: Mental, physical readiness to act P3 — Guided Response: Basic practice through imitation P4 — Mechanism: Habitual correct performance P5 — Complex Overt Response: Skilled performance P6 — Adaptation: Modify skills for special situations P7 — Origination: Create new solution patterns |

*ℹ OBE Compliance Statement: This is a lab-only course. All 6 COs span all three domains — Cognitive (L3–L6) as the primary domain, Psychomotor (P3–P6) for implementation and design skills, and Affective (A2–A4) for professional and collaborative conduct — reflecting the skill-based, hands-on nature of laboratory assessment.*

# 16. Attendance Policy & Pass/Fail Criteria

## 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Lab / Practical Sessions** | **75%** | All lab sessions | Debarred from ESE if below threshold |
| **Self-Learning Submissions** | All activities | SL activities (15 hrs — coding problems) | Incomplete SL affects CA score directly |

*⚠ Lab attendance must meet 75% minimum. Missing SL activities (coding platform submissions) directly impacts CA marks and is not compensable by examination performance.*

## 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ESE Score** | ≥ 16 / 40 | **MANDATORY** | 40% of ESE marks required; failing ESE means failing the course regardless of CA + CE performance |
| **Overall Total (CA + CE + ESE)** | ≥ 40 / 100 | **Must pass overall** | CA 30 + CE 30 + ESE 40 = 100; 40% overall minimum required |

**CSCR1507 — LAB-ONLY COURSE PLAN — MEASUREMENT ARCHITECTURE**

11 Programme Outcomes → 6 Lab COs (CO1–CO6) → 3 Assessment Instruments → 8 Lab Skill Dimensions (LS1–LS8)

CO1–CO3: Apply/Analyse → LS1–LS3, LS6 → CA + CE + ESE

CO4–CO5: Analyse/Evaluate → LS3–LS5, LS7 → CA + ESE

CO6: Create → LS7–LS8 → CA + ESE Sec C

**Marks: CA 30 + CE 30 + ESE 40 = Total 100**

**COURSE PLAN**

**Professional Communication (SKT 1100)**

PART I

# COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | I |
| **Course Code:** | SKT 1100 | **Course Type:** | Core — Theory Only |

## 2. Course Details

📘 **THEORY - ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | SKT 1100 |
| 2 | **Course Title** | **Professional Communication** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs Classroom + 45 hrs Self Learning = 90 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | The objective of this course is to develop learners into confident, effective, and articulate communicators by strengthening their presentation skills, public speaking abilities, group discussion competence, and overall LSRW proficiency. The course aims to enhance pronunciation and clarity of voice, reduce language inaccuracies, and build strong verbal reasoning skills through structured speaking, reading, and writing activities. By the end of the course, learners will demonstrate improved clarity of expression, critical thinking, accuracy in language use, and the ability to communicate with confidence in academic, professional, and real-world settings. |

| | | |
|---|---|---|
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>**CO1 (Remember – L1):** Communication Mastery & Presentation Excellence<br>Recall and identify fundamental concepts of professional communication, presentation structure, and essential elements of effective message delivery.<br><br>**CO2 (Understand – L2):** Public Speaking & Impromptu Communication Confidence<br>Explain the principles of public speaking, including speech organization, audience analysis, and techniques for confident impromptu communication.<br><br>**CO3 (Apply – L3):** Group Interaction, Debate & Discussion Skills<br>Demonstrate effective communication by actively participating in group discussions, debates, and collaborative interactions using appropriate verbal and non-verbal strategies.<br><br>**CO4 (Analyze – L4):** LSRW Skill Enhancement & Critical Reading Ability<br>Analyze written and spoken content by applying listening, speaking, reading, and writing (LSRW) skills to interpret, evaluate, and respond critically.<br><br>**CO5 (Evaluate – L5):** Pronunciation, Voice & Accent Improvement<br>Evaluate speech delivery based on pronunciation, intonation, voice modulation, and accent to enhance clarity and effectiveness in communication.<br><br>**CO6 (Create – L6):** Verbal Ability & Language Accuracy<br>Create well-structured verbal and written responses using appropriate grammar, vocabulary, and language accuracy in professional contexts. |
| 8 | **Course Description** | This course builds strong communication skills through focused practice in presentations, public speaking, group discussions, and debates. Learners enhance LSRW abilities, strengthen pronunciation and accent clarity, and improve verbal accuracy through structured activities and language exercises. The course equips students to communicate confidently, think critically, and express ideas effectively in academic and professional settings. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 30% \| MTE: 30% \| ETE: 40% \| Total: 100 marks** |
| 11 | **Textbook** | Business Communication Today – Bovee, Courtland L. & Thill, John V.<br>A comprehensive guide covering professional communication, presentations, writing, and workplace skills. |
| 12 | **References** | 1. Communication Skills – Sanjay Kumar & Pushp Lata<br>*Widely used in Indian universities; covers LSRW, interpersonal communication, and soft skills.*<br><br>2. Soft Skills – Alex K.<br>*Focuses on personality development, communication, and employability skills.*<br><br>3. English Grammar in Use – Raymond Murphy<br>*Excellent for grammar, error correction, and verbal ability practice.*<br><br>4. Word Power Made Easy – Norman Lewis<br>*Highly effective for vocabulary building and verbal ability.* |

| | | |
|---|---|---|
| | | 5. Online Resources:<br>• British Council Learning English (grammar, listening, speaking practice)<br>• Toastmasters International (public speaking frameworks)<br>• Newspaper editorials (The Hindu / Indian Express) for reading practice |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: The Art of Presentation Skills** | |
| **A** | The 3 kings of Presentation - Content, Cosmetics, Presenter. Structuring Your Message for Maximum Clarity. How to organise ideas, build a logical flow, create engaging openings, and craft a memorable conclusion | **CO1** |
| **B** | Delivering with Confidence and Impact. Mastering voice modulation, body language, eye contact, pacing, and audience engagement techniques. | **CO1** |
| **C** | Student Group Presentations | **CO1** |
| | **Unit 2: Introduction to Communication Readiness - Toastmasters Style** | |
| **A** | Introduction to Toastmaster-Style Speaking \| Speech Crafting Essentials (The Icebreaker Style), Voice Modulation & Vocal Variety | **CO2** |
| **B** | Body Language & Stage Presence - 7 C's of Communication | **CO2** |
| **C** | Impromptu speaking mastery (table topics), speech development & delivery | **CO2** |
| | **Unit 3: Class Debates & Group Discussion Essentials** | |
| **A** | Structuring Arguments & Presenting Your Point Clearly | **CO3** |
| **B** | Active Listening, Team Interaction & Turn-Taking Skills | **CO3** |
| **C** | Critical Thinking, Rebuttals & Handling Counterarguments | **CO3** |
| | **Unit 4: LSRW (Listening, Speaking, Reading, Writing)** | |

| | | |
|---|---|---|
| A | Listening Activities, Self-introduction/Greeting/Meeting people – Self branding (Activities & Simulation Exercises) Extempore & Free Speech Activities, 1-minute (JAM) Just a Minute | CO4 |
| B | Newspaper Reading, Speed Reading Exercises. Comprehension: Skimming and Scanning: Vocabulary Building: Critical thinking: Reading Fluency: Retention and Recall: Interpretation and Inference | CO4 |
| C | Written Exercises: Clarity of Expression, Grammar and Language Use, Vocabulary Enrichment, Organisation and Structure, Creative and Critical Thinking, Purposeful Writing, Editing and Revising, Tone and Style Appropriateness | CO4 |
| | **Unit 5: Introduction to Voice & Accent Essentials** | |
| A | Reduce MTI (Mother Tongue Interference) | CO5 |
| B | Learn Neutral (Globally Accepted English) | CO5 |
| C | Develop Clear, Professional-Sounding Pronunciation | CO5 |
| | **Unit 6: Verbal Ability** | |
| A | Cloze Tests & Sentence Completion | CO5 |
| B | Vocabulary Building & Reading Comprehension | CO5 |
| C | Error Spotting & Correction | CO5 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | | ✓ | ✓ | | ✓ |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | ✓ |
| 7 | 3.A | | | ✓ | ✓ | ✓ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 3.B | | ✓ | ✓ | ✓ | ✓ | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | ✓ |
| 10 | 4.A | | ✓ | ✓ | ✓ | | |
| 11 | 4.B | | ✓ | ✓ | ✓ | ✓ | |
| 12 | 4.C | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 13 | 5.A | | ✓ | ✓ | ✓ | ✓ | |
| 14 | 5.B | | ✓ | ✓ | ✓ | | |
| 15 | 5.C | | | ✓ | ✓ | ✓ | ✓ |
| 16 | 6.A | ✓ | ✓ | ✓ | | | |
| 17 | 6.B | | ✓ | ✓ | ✓ | | |
| 18 | 6.C | | ✓ | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | |
| CO2 | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | |
| CO3 | | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| CO4 | | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | |
| CO5 | | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| CO6 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | The 3 kings of Presentation - Content, Cosmetics, Presenter -- Structuring Your Message for Maximum Clarity. How to organise ideas, build a logical flow | UNIT-1 | 6 |
| DD/MM/YY | The 3 kings of Presentation - Content, Cosmetics, Presenter- Create engaging openings, and craft a memorable conclusion | | |
| DD/MM/YY | Delivering with Confidence and Impact -Mastering voice modulation, body language techniques | | |
| DD/MM/YY | Delivering with Confidence and Impact - Eye contact, pacing, and audience engagement techniques | | |
| DD/MM/YY | Student Group Presentations | | |
| DD/MM/YY | Student Group Presentations | | |
| DD/MM/YY | 7 C's of Communication | UNIT-2 | 4 |
| DD/MM/YY | Introduction to Toastmaster-Style Speaking/Voice Modulation & Vocal Variety, Body Language & Stage Presence | | |
| DD/MM/YY | Impromptu speaking mastery (Table topics) | | |
| DD/MM/YY | Impromptu speaking mastery (Table topics) | | |
| DD/MM/YY | Structuring Arguments & Presenting Your Point Clearly | UNIT-3 | 7 |
| DD/MM/YY | Active Listening, Team Interaction & Turn-Taking Skills | | |
| DD/MM/YY | Movie Review Activity | | |
| DD/MM/YY | Movie Review Discussion | | |
| DD/MM/YY | Constructive Criticism | | |
| DD/MM/YY | Critical Thinking, Rebuttals & Handling Counterarguments | | |
| DD/MM/YY | Self-introduction/Greeting/Meeting people | UNIT-4 | 10 |
| DD/MM/YY | Self branding (Activities & Simulation Exercises) | | |
| DD/MM/YY | Listening Activities | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Skimming / Scanning / Reading Fluency: Retention and Recall, Interpretation and Inference | | |
| DD/MM/YY | News Paper Reading | | |
| DD/MM/YY | Writing Essentials - Article Writing | | |
| DD/MM/YY | Writing Essentials - Article Reviewing | | |
| DD/MM/YY | Writing Essentials - Email Writing | | |
| DD/MM/YY | Writing Essentials - Email Reviewing | | |
| DD/MM/YY | Reduce MTI (Mother Tongue Interference) | UNIT-5 | 4 |
| DD/MM/YY | Pronunciation - Activity | | |
| DD/MM/YY | Critical & Creative Thinking Activity | | |
| DD/MM/YY | Voice modulation & clarity practice | | |
| DD/MM/YY | Grammar Rules 1 – Subject Verb Agreement (6 Rules), Active & Passive Voice, Direct & Indirect Speech | UNIT-6 | 13 |
| DD/MM/YY | Grammar Rules 2 – Articles, Prepositions & Verbs | | |
| DD/MM/YY | Tenses Rules with Examples | | |
| DD/MM/YY | Spotting Error Questions | | |
| DD/MM/YY | Sentence Correction Questions | | |
| DD/MM/YY | Spotting Error & Sentence Correction (Mixed Questions) | | |
| DD/MM/YY | Contextual Vocabulary Questions – I | | |
| DD/MM/YY | Contextual Vocabulary Questions – II | | |
| DD/MM/YY | Cloze Test – Overview | | |
| DD/MM/YY | Cloze Test – Practice Questions | | |
| DD/MM/YY | Sentence Completion Questions | | |
| DD/MM/YY | Para Jumbles Techniques | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Communication Fundamentals & Presentation Recall** | Recall and identify fundamental concepts of professional communication, presentation structure, audience engagement principles, and essential elements of effective message delivery | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| **TS2** | **Public Speaking & Impromptu Communication Understanding** | Explain principles of public speaking including speech organization, Toastmaster-style communication, audience analysis, confidence-building techniques, and impromptu speaking strategies | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| **TS3** | **Group Discussion, Debate & Interaction Application** | Apply communication strategies during group discussions, debates, collaborative interaction, rebuttal handling, and structured argument presentation using appropriate verbal and non-verbal communication | CO3 \| L3–L4 | CA \| MTE Sec B \| ETE Sec B |
| **TS4** | **LSRW Analysis & Critical Communication Interpretation** | Analyze written and spoken communication using listening, speaking, reading, and writing (LSRW) skills; interpret meaning, evaluate arguments, infer context, and respond critically in communication scenarios | CO4 \| L4–L5 | CA \| MTE Sec B \| ETE Sec B |
| **TS5** | **Pronunciation, Voice & Accent Evaluation** | Evaluate speech clarity, pronunciation accuracy, MTI reduction, voice modulation, tone, stress, intonation, and accent neutralization for professional communication effectiveness | CO5 \| L4–L5 | CA \| ETE Sec B/C |

| | | | | |
|---|---|---|---|---|
| **TS6** | **Verbal Ability & Professional Language Creation** | Create grammatically accurate, well-structured verbal and written responses using vocabulary, contextual understanding, error correction, comprehension, and professional communication conventions | CO6 \| L2–L6 | CA \| ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Process Interpretation | TS3 Algorithmic Application | TS4 Performance Evaluation | TS5 Memory System Analysis | TS6 File & Disk Evaluation |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | M | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Presentation & Public Speaking Activities (Presentation Delivery, Icebreaker Speech, JAM, Extempore, Table Topics)** | 5 Activities | **10** | CO1, CO2, CO5 | TS1, TS2, TS5 |
| **Group Discussion, Debate & Interaction Assessment** | 3 Activities | 10 | CO2, CO3, CO4 | TS2, TS3, TS4 |
| **LSRW & Communication Practice Assignments** | 4 Assignments | **5** | CO4, CO6 | TS4, TS6 |

| | | | | |
|---|---|---|---|---|
| **(Reading, Listening, Writing, Self-branding, Email/Article Writing)** | | | | |
| **Verbal Ability & Language Accuracy Tests (Vocabulary, Cloze Test, Error Spotting, Sentence Correction, Comprehension)** | 2 Tests | **5** | CO5, CO6 | TS5, TS6 |
| **TOTAL** | — | 30 | CO1–CO6 | TS1–TS6 |

## 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Presentation Skills Fundamentals — Presentation structure, audience engagement, content organization, introduction-body-conclusion framework | CO1 | TS1 | 6h SL | Presentation structure, clarity of ideas, organization, confidence, and delivery effectiveness |
| **Assignment 2** | Toastmaster-Style Speaking & Impromptu Communication — Icebreaker speech, voice modulation, stage presence, table topics | CO2 | TS2 | 6h SL | Speech organization, spontaneity, confidence, vocal delivery, body language, and audience engagement |
| **Assignment 3** | Group Discussion & Debate Practice — Argument construction, rebuttals, active listening, collaborative interaction | CO2, CO3 | TS2, TS3 | 6h SL | Quality of arguments, participation, listening skills, logical thinking, rebuttal handling, and communication effectiveness |
| **Assignment 4** | LSRW Activities — Listening comprehension, newspaper reading, JAM sessions, self-introduction, writing exercises | CO3, CO4 | TS3, TS4 | 6h SL | Interpretation ability, speaking fluency, reading comprehension, writing clarity, grammar, and critical response |
| **Assignment 5** | Pronunciation & Verbal Ability — MTI reduction, pronunciation drills, vocabulary, error spotting, sentence correction, cloze tests | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Pronunciation clarity, grammatical accuracy, vocabulary usage, verbal reasoning, fluency, and correctness |
| **Video Resume / Speech Presentation** | Professional video resume or recorded speech presentation demonstrating communication, self-branding, and professional interaction | CO1, CO2, CO5 | TS1, TS2, TS5 | 9h SL | Communication clarity, confidence, pronunciation, body language, structure, and professional presentation quality |
| **Case Study / Communication Analysis Report** | Analysis of real-world communication scenarios, debates, speeches, workplace communication, or media | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Critical analysis, interpretation, language accuracy, communication effectiveness, |

| | | | | | |
|---|---|---|---|---|---|
| | interaction with structured written report | | | | comparative evaluation, and report quality |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1 — Communication Fundamentals & Presentation Recall TS2 — Public Speaking & Impromptu Communication Understanding | **CO1, CO2** | Short-answer and descriptive questions: define principles of professional communication, explain presentation structure, discuss 7 C's of Communication, describe Toastmaster-style speaking, explain voice modulation, stage presence, audience engagement, and impromptu speaking techniques |
| **Section B** | **15** | TS3 — GD, Debate & Interaction Application TS4 — LSRW & Critical Communication Analysis | **CO2, CO3, CO4** | Application and analytical questions: analyze communication scenarios, construct arguments for debate topics, interpret communication caselets, evaluate responses in group discussions, analyze listening/reading passages, writing-based interpretation, and communication effectiveness assessment |
| **TOTAL** | 30 | TS1–TS4 | **CO1–CO4** | Units 1–3 only. CO5 and CO6 are assessed predominantly in ETE through pronunciation, verbal ability, writing, and language accuracy components. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — covering all 6 units and all 6 COs. The assessment evaluates the complete progression from TS1 (communication fundamentals) through TS6 (verbal ability and professional language creation). The examination measures conceptual understanding, communication application, analytical interpretation, pronunciation awareness, and professional language proficiency. Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Section A** | 20 | TS1 — Communication Fundamentals & Presentation Recall TS2 — Public Speaking & Impromptu Communication Understanding | **CO1, CO2** | Short-answer and conceptual questions from all units: communication principles, presentation structure, 7 C's of Communication, Toastmaster-style speaking, body language, voice modulation, audience engagement, impromptu communication, and professional interaction concepts |
| **Section B** | 40 | TS3 — GD, Debate & Interaction Application TS4 — LSRW & Critical Communication Analysis TS5 — Pronunciation, Voice & Accent Evaluation | **CO3, CO4, CO5** | Medium and application-oriented questions: communication scenario analysis, debate/GD response construction, listening and reading comprehension analysis, writing-based interpretation, pronunciation and MTI analysis, voice modulation evaluation, communication effectiveness assessment, and case-based communication exercises |
| **Section C** | 20 | TS5 — Pronunciation, Voice & Accent Evaluation TS6 — Verbal Ability & Language Creation | **CO5, CO6** | Long-answer and evaluative questions: pronunciation and accent improvement strategies, verbal ability exercises, vocabulary usage, error spotting, sentence correction, cloze tests, comprehension-based writing, professional email/article writing, and language accuracy evaluation |
| **TOTAL** | **80** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Understand fundamentals of professional communication, presentation structure, and message delivery | ✓ | ✓ | ✓ | TS1 | PO9, PO10, PO11, PSO1 |
| **CO2** | Explore public speaking, impromptu communication, voice modulation, and audience interaction | ✓ | ✓ | ✓ | TS2 | PO8, PO9, PO10, PO11 |
| **CO3** | Apply effective communication strategies in group discussions, debates, and collaborative interactions | ✓ | ✓ | ✓ | TS3 | PO2, PO8, PO9, PO10 |
| **CO4** | Analyze spoken and written communication using LSRW skills and critical interpretation | ✓ | ✓ | ✓ | TS4 | PO2, PO4, PO9, PO10, PSO2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO5** | Evaluate pronunciation, voice modulation, MTI reduction, and accent clarity for professional communication | ✓ | — | ✓ | TS5 | PO9, PO10, PO11, PSO2 |
| **CO6** | Create accurate and structured verbal/written responses using grammar, vocabulary, and verbal ability skills | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11, PSO3 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | | – | – | – | – | 1 | 2 | 3 | 1 | 2 | 1 | – |
| CO2 | 1 | 2 | | – | – | – | – | 2 | 2 | 3 | 2 | 2 | 2 | – |
| CO3 | 1 | 2 | 1 | – | – | – | – | 3 | 3 | 3 | 2 | 2 | 2 | 1 |
| CO4 | 1 | 2 | 2 | 1 | – | – | – | 2 | 2 | 3 | 2 | 2 | 3 | 1 |
| CO5 | 1 | 2 | 2 | – | – | – | – | 2 | 2 | 3 | 2 | 2 | 3 | 1 |
| CO6 | 1 | 2 | 2 | 1 | 1 | – | – | 2 | 2 | 3 | 3 | 3 | 3 | 2 |
| **Avg** | **1.00** | **1.83** | **1.25** | **1.00** | **1.00** | **–** | **–** | **2.00** | **2.17** | **3.00** | **2.00** | **2.17** | **2.33** | **1.20** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | M | | | | | | M | H | H | M | H | M | |
| CO2 | M | M | | | | | | M | H | H | M | M | H | |
| CO3 | M | M | M | | | | | H | H | H | M | H | M | M |
| CO4 | M | M | M | M | | | | M | H | H | H | M | H | M |
| CO5 | M | M | M | | | | | M | H | H | M | M | H | M |
| CO6 | M | M | H | M | M | | | M | H | H | H | H | H | M |

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Presentation Preparation & Practice – Create and record 2 structured presentations (content, delivery, visuals)** | 5 presentations × 1.5h each = 7.5h | CO1, CO2, CO3, CO4 TS1, TS2, TS3, TS4 | Based on structure, clarity, delivery, and improvement shown |
| 2 | **Video Resume Preparation – Students will design and record a professional video resume highlighting their introduction, skills, achievements, and career goals.** | 4 versions × 1.5h each = 6h | CO2, CO3, CO5 TS2, TS3, TS5 | Based on content structure, clarity of communication, confidence, body language, pronunciation, and overall presentation quality |
| 3 | **Listening Practice/LSRW (Audio/Video Based) – Attempt assessments, watch speeches/podcasts and summarize key points for practice.** | 4 assessments × 1.5h each = 6h | CO4, CO5, CO6 TS4, TS5, TS6 | Based on comprehension, summary quality, and interpretation |
| 4 | **Reading & Vocabulary Building – Newspaper Editorial reading, vocabulary exercises, and word usage.** | 6 reading sessions × 1.5h each = 9h | CO4, CO6 TS4, TS6 | Based on vocabulary usage, understanding, and consistency |
| 5 | **Writing Practice - WriteX (Email, Article, Paragraph Writing)** | 5 exercises × 1.5h each = 7.5h | CO4, CO6 TS4, TS6 | Based on clarity, grammar, structure, and coherence |
| 6 | **Verbal Ability Practice – Cloze tests, sentence correction, error spotting, reading comprehension** | 6 Practice Tests × 1.5h each = 9h | CO5, CO6 TS5, TS6 | Based on accuracy, speed, and correctness |

| | | | | |
|---|---|---|---|---|
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 / TS1–TS6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall communication concepts, terminology, presentation elements, and language fundamentals<br>L2 — Understand: Explain communication principles, speaking techniques, public speaking methods, and verbal concepts<br>L3 — Apply: Apply communication strategies, verbal skills, presentation techniques, and group interaction methods in practical situations<br>L4 — Analyze: Analyze written and spoken communication, arguments, reading passages, communication scenarios, and audience responses<br>L5 — Evaluate: Evaluate pronunciation, accent, speech clarity, verbal responses, communication effectiveness, and language accuracy<br>L6 — Create: Create structured verbal and written responses, presentations, professional communication artefacts, and original speech content | A1 — Receiving: Awareness and willingness to listen, participate, and engage in communication activities<br>A2 — Responding: Active participation in presentations, discussions, debates, and speaking activities<br>A3 — Valuing: Demonstrate confidence, professionalism, communication ethics, and appreciation for effective communication<br>A4 — Organizing: Integrate communication values, teamwork, professionalism, and collaborative interaction into personal communication style<br>A5 — Characterizing: Internalize professional communication behavior, confidence, and effective interpersonal interaction as consistent traits | P1 — Perception: Observing verbal and non-verbal communication cues during presentations and interactions<br>P2 — Set: Mental and physical readiness for speech delivery, public speaking, and communication performance<br>P3 — Guided Response: Practice pronunciation, voice modulation, presentation delivery, and speaking techniques through guided activities<br>P4 — Mechanism: Perform communication tasks, presentations, GDs, and speaking activities with improved fluency and habitual correctness<br>P5 — Complex Overt Response: Demonstrate skilled presentation delivery, debate participation, and fluent communication performance<br>P6 — Adaptation: Modify speaking style, tone, and communication approach according to audience and professional context<br>P7 — Origination: Develop original communication strategies, presentation approaches, and professional expression styles |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**Professional Communication (SKT 1100) — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 30 marks + MTE 30 marks + ETE 40 marks = Total 100 marks

# COURSE PLAN

## Engineering Physics (PHT1136)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | II |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | PHT1136 |
| 2 | **Course Title** | **Engineering Physics (EP)** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-2-3 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | To make students proverbial with the fundamental concepts of Semiconductors materials and electromagnetism and their real-life applications for configuring various electronics devices. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Remember – L1): Students will learn the fundamental concepts of mobility, conductivity, electrons and holes in an intrinsic semiconductor, Donor and Acceptor impurities (n-type and p-type semiconductor), Fermi levels etc. Students will gain knowledge about the formation of depletion region, barrier potential, Zener diode, Characteristics of Zener diode etc.<br>CO2 (Understand – L2): Students will have a clear understanding of Coherent sources, interaction of radiation with matter (spontaneous and stimulated emission), Einstein's relation, population inversion and pumping, Ruby LASER, He-Ne Laser and semiconductor Laser.<br>CO3 (Apply – L3): Students will show that they have learned the basics of fiber optics, Holography and its applications.<br>CO4 (Analyze – L4): Students will be able to understand the significance and applications of Maxwell's equations.<br>CO5 (Evaluate – L5): Students will be able to know about the short comings of classical physics and will learn various quantum mechanical principles.<br>CO6 (Create – L6): Student will be familiar with the essential concepts of Semiconductors materials technology and their applications in industries.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Student will be able to determine the Energy Band Gap of Semiconductor materials.<br>CO8 (Create – L5/L6): Student will be able to find Planck constant by light emitting diode method and determine the numerical aperture and acceptance angle of an optical fibre.<br>CO9 (Apply – L2/L3): Student will be able to determine the Hall coefficient, carrier density and the mobility of a semiconductor material, find the variation of magnetic field along the axis of current carrying circular coil and also to find out the IV characteristics of a solar cell.<br>CO10 (Apply – L3): Student will be able to understand laboratory experiments for Interpreting results, error analysis, writing reports and analyzing data. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 20 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | 1. To study advanced topics like: Transistors and MOSFETs; Semiconductor lasers; LED and OLED physics; Nanomaterials; Carbon nanotubes; Graphene; Quantum dots<br>2. Value Added Experiment: To determine the focal length of the combination of two lenses separated by a distance with the help of a nodal slide and to verify the formula. |
| 11 | **References** | Textbook: Semiconductor physics and devices: basic principles- Donald A. Neamen.<br>References:<br>1. Integrated Electronics- Millman - Halkias, Tata Mc Graw Hill |

| | | |
|---|---|---|
| | | 2. Laser and non-linear optics by B.B. laud, New Age Int.<br>3. Semiconductor Devices- Kanaan Kano, Pearson Education.<br>4. Electronics devices and circuit theory by R.L. Boylestad, Pearson.<br>5. Introduction to Electrodynamics, David J. Griffiths, Pearson Cambridge University Press<br>6. Fundamentals of Electricity and Magnetism, D. N. Vasudeva, S. Chand & Co. New Delhi<br>7. Fundamentals of Physics, Halliday, Resnick and Walker, John Wiley.<br>8. Concepts of Modern Physics, Beiser Arthur, McGraw-Hill Education |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Semiconductor Physics (4-0-4-6 = 14 hrs)** | |
| **A** | Classification of Solids on the basis of energy band, electrons and holes concentration in intrinsic semiconductors, Fermi levels, Mobility, conductivity | CO1, CO6 |
| **B** | Donor and Acceptor impurities (n-type and p-type semiconductor), Drift and diffusion current, Hall effect | |
| **C** | p-n junction, formation of depletion region, barrier potential, Avalanche and Zener breakdown. | |
| **Tools Used** | Proper experimental setup present in the lab will be used | |
| **Activities** | **Objective: To perform the experiments related to Semiconductor Physics** | |
| **Unit 2** | **Laser Physics and optoelectronic Sources (6-0-4-6 = 16 hrs)** | |
| **A** | Coherent sources, interaction of radiation with matter (spontaneous and stimulated emission), Einstein's relation | CO2, CO6 |
| **B** | Population inversion and pumping, active components of laser, optical amplification or gain | |
| **C** | Optoelectronic sources: Light emitting diode (construction, basic working principle), semiconductor laser (construction, basic working principle) | |
| **Tools Used** | Proper experimental setup present in the lab will be used | |
| **Activities** | Objective: To perform the experiments related to Laser Physics and optoelectronic Sources | |
| **Unit 3** | **Fiber Optics (8-0-4-6 = 18 hrs)** | |

| | | |
|---|---|---|
| A | Introduction, structure of optical fiber, Light guidance through optical fiber | CO3, CO6 |
| B | Acceptance angle and Acceptance cone, Numerical aperture, Types of optical fibers | |
| C | Attenuation and Dispersion in optical fiber, Applications of optical fibers | |
| Tools Used | Proper experimental setup present in the lab will be used | |
| Activities | Objective: To perform the experiments related to Fiber Optics | |
| Unit 4 | **Electromagnetism (6-0-4-6 = 16 hrs)** | |
| A | Gauss's theorem, Biot-Savart law and its application to current carrying circular loop | CO4 |
| B | Ampere's law and its applications to infinitely long straight wire, and solenoids. Electromagnetic induction; Faraday's law | |
| C | Maxwell's equations and speed of EM waves in free space | |
| Tools Used | Proper experimental setup present in the lab will be used | |
| Activities | Objective: To perform the experiments related to Electromagnetism | |
| Unit 5 | **Quantum Mechanics (6-0-4-6 = 16 hrs)** | |
| A | Inadequacy of classical Physics, Wave particle duality, de-Broglie wavelength | CO5, CO6 |
| B | Davisson-Germer experiment, Schrodinger wave equation | |
| C | Particle in a 1-dimensional box | |
| Tools Used | Proper experimental setup present in the lab will be used | |
| Activities | Objective: To perform the experiments related to Stefan's law and IV characteristics of a solar cell | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | ✓ | ✓ | | | | |
| 4 | 2.A | ✓ | ✓ | | | | |
| 5 | 2.B | ✓ | ✓ | | | | |
| 6 | 2.C | ✓ | ✓ | | | | |
| 7 | 3.A | | | ✓ | | | |
| 8 | 3.B | | | ✓ | | | |
| 9 | 3.C | | | ✓ | | | |
| 10 | 4.A | | | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | | |
| 13 | 5.A | | | | ✓ | ✓ | ✓ |
| 14 | 5.B | | | | ✓ | ✓ | ✓ |
| 15 | 5.C | | | | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | | | | |
| CO5 | | | | | ✓ | | | | | | | | | | | | | |
| CO6 | | | | | | ✓ | | | | | | | | | | | | |
| CO7 | | | ✓ | | | | | | | | | | | | | | | |
| CO8 | | | ✓ | | ✓ | | | | | | | | | | | | | |
| CO9 | | | ✓ | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | | |
| CO10 | | | ✓ | | | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Classification of Solids on the basis of energy band, electrons and holes concentration in intrinsic semiconductors, Fermi levels, Mobility, conductivity | Unit 1 | 4 |
| DD/MM/YY | Donor and Acceptor impurities (n-type and p-type semiconductor), Drift and diffusion current, | | |
| DD/MM/YY | Hall effect | | |
| DD/MM/YY | p-n junction, formation of depletion region, barrier potential, Avalanche and Zener breakdown | | |
| DD/MM/YY | Coherent sources, interaction of radiation with matter (spontaneous and stimulated emission), | Unit 2 | 6 |
| DD/MM/YY | Einstein's relation | | |
| DD/MM/YY | population inversion and pumping | | |
| DD/MM/YY | active components of laser, optical amplification or gain | | |
| DD/MM/YY | semiconductor laser (construction, basic working principle) | | |
| DD/MM/YY | semiconductor laser (construction, basic working principle) | | |
| DD/MM/YY | Introduction, structure of optical fiber | Unit 3 | 8 |
| DD/MM/YY | Light guidance through optical fiber | | |
| DD/MM/YY | Acceptance angle and Acceptance cone | | |
| DD/MM/YY | Numerical aperture, Numerical | | |
| DD/MM/YY | Types of optical fibers | | |
| DD/MM/YY | Attenuation and Dispersion in optical fiber, Numerical | | |
| DD/MM/YY | Applications of optical fibers | | |
| DD/MM/YY | Practice numericals drom Units-1, 2 and 3 | | |
| DD/MM/YY | Gauss's theorem, Biot-Savart law and its application to current carrying circular loop | Unit 4 | 6 |
| DD/MM/YY | Ampere's law and its applications to infinitely long straight wire, and solenoids | | |
| DD/MM/YY | Electromagnetic induction, Faraday's law | | |
| DD/MM/YY | Maxwell's equations and speed of EM waves in free space | | |
| DD/MM/YY | Maxwell's equations and speed of EM waves in free space | | |
| DD/MM/YY | Strings: Manipulation of text data, Command Line Arguments | | |
| DD/MM/YY | Inadequacy of classical Physics | Unit 5 | 6 |
| DD/MM/YY | Wave particle duality, de-Broglie wavelength | | |
| DD/MM/YY | Davisson-Germer experiment | | |

| | | | |
|---|---|---|---|
| **DD/MM/YY** | Schrodinger wave equation | | |
| **DD/MM/YY** | Schrodinger wave equation | | |
| **DD/MM/YY** | Particle in a 1-dimensional box | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W5: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W6–W8 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| **W1** | S-1.1 | To determine the Energy band gap of a semiconductor using Four Probe method. | **CO7** | 3.0 |
| | S-1.2 | To determine the energy band gap by PN junction diode. | **CO7** | |
| **W2** | S-2.1 | To determine the Planck's constant by light emitting diode. | **CO7** | 3.0 |
| | S-2.2 | To determine the wavelength of prominent lines of mercury source by plane diffracting grating | **CO7** | |
| **W3** | S-3.1 | To determine the numerical aperture and acceptance angle of multimode plastic optical fibre. | **CO7** | 3.0 |
| | S-3.2 | To determine width of single slit and double slit by using Laser diffraction. | **CO7** | |
| **W4** | S-4.1 | To study Hall effect and determine the Hall coefficient, carrier density and the mobility of a semiconductor material. | **CO7** | 3.0 |
| | S-4.2 | To determine the specific resistance of the material of a given wire using Carey Foster's bridge | **CO7** | |
| **W5** | S-5.1 | To study the magnetoresistance of the given semiconductor material. | **CO7** | 3.0 |
| | S-5.2 | To determine the variation of magnetic field along the axis of current carrying circular coil. | **CO7** | |
| **W6** | S-6.1 | To determine the focal length of the combination of two lenses separated by a distance with the help of a nodal slide and to verify the formula. | **CO8** | 3.0 |
| | S-6.2 | To determine the Planck constant by light emitting diode method. | **CO8** | |
| **W7** | S-7.1 | Verification of Stefan's law and determination of Stefan's constant of radiation. | **CO8/CO9** | 3.0 |
| | S-7.2 | To find out the IV characteristics of a solar cell. | **CO8/CO10** | |
| **W8** | S-8.1 | Self-assessment form submitted | **CO8/CO9** | 3.0 |
| | S-8.2 | Final presentation, group reflection, Viva-voce | **CO9/CO10** | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

**THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Factual Recall & Conceptual Recognition** | Semiconductor Physics | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| **TS2** | **Conceptual Explanation & Logical Interpretation** | Laser Physics and optoelectronic Sources | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| **TS3** | **Procedural Application & Problem Solving** | Fiber Optics | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| **TS4** | **Analytical Reasoning & Program Tracing** | Electromagnetism | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| **TS5** | **Comparative Evaluation & Algorithmic Justification** | Quantum Mechanics | CO5 \| L5 | ETE Sec B/C |
| **TS6** | **Synthesis & Holistic Design** | Electromagnetism and Quantum Mechanics | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short-answer: definitions, output prediction, syntax identification |
| **Sec B** | **6** | TS3 — Procedural Application TS4 — Analytical Reasoning | **CO3, CO4** | Program writing; program tracing — detect errors and trace execution |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions: definitions, syntax, output tracing, concept MCQs (all units) |

| | | | | |
|---|---|---|---|---|
| **Sec B** | **50** | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Medium questions: program writing, debugging, algorithm comparison, complexity analysis |
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long/design questions: design modular solutions, justify choices, complete application |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |

| | | | | |
|---|---|---|---|---|
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define experiment problem; identify measurable attributes, parameters, success criteria | CO7, CO8 |
| CA2 | **Experimental Design & Tool Setup** | Plan experiment; configure development environment (gcc, IDE, Linux CLI, debugger) | CO7 |
| CA3 | **Code Implementation & Execution** | Write correct code; compile and execute to produce expected output | CO7 |
| CA4 | **Computational Efficiency & Optimization** | Evaluate time/space complexity; identify bottlenecks; propose optimizations | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Analyse output critically; explain deviations; draw evidence-based inferences | CO8 |
| CA6 | **Documented Outcome with Verification** | Record final outcome formally; verify against the problem statement | CO7, CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Produce algorithm/flowchart/pseudocode before coding; justify design choices | CO7, CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records; demonstrate conceptual understanding orally | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | **SDG Alignment & Social Relevance** | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | **Problem Scoping & Requirements** | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | **Communication & Testing Strategy** | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | **Innovative Solution Proposal** | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | **Professional Toolchain** | Select and justify development tools; configure professional project environment | CO7 \| PO5 |

| | | | |
|---|---|---|---|
| P6 | End-to-End Implementation | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

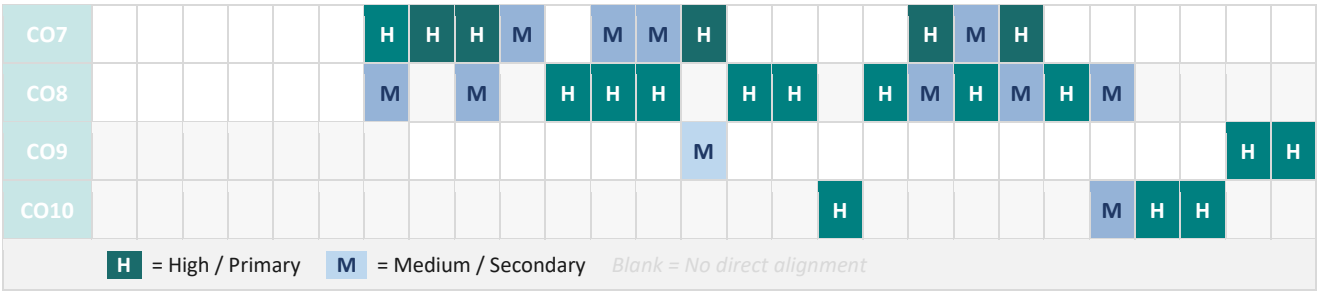
## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 -Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | M | | M | H | | | | | | | | | | | | | | | | | | | | | |




PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | | | |
| CO2 | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | | | |
| CO3 | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | | | |
| CO4 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | | | |
| CO5 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | | | |
| CO6 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | | | |
| CO7 | 1 | 3 | 1 | 2 | 1 | 1 | | | | | | | | |
| CO8 | 1 | 3 | 1 | 2 | 1 | 1 | | | | | | | | |
| CO9 | 1 | 3 | 1 | 2 | 1 | 1 | | | | | | | | |
| CO10 | 1 | 3 | 1 | 1 | 1 | 1 | | | | | | | | |
| Avg | 2.50 | 2.14 | 2.33 | 1.75 | 2.33 | 1.80 | 3.00 | 2.50 | 1.50 | 2.00 | 2.13 | 2.22 | 2.30 | 2.38 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |
| CO2 | H | M | | | | | | | M | | |
| CO3 | M | H | M | | M | M | | | M | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | | M | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in computational thinking and structured programming; aligned with lifelong learning (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant programming and professional tool skills (CO7) directly applicable to employment in technology sectors. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables development of efficient software solutions; fosters innovation through real-world application design (CO6, CO8) and team-based projects (CO10). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**EP (PHT1136) INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Probability and Statistics (MTT1214)

*Sharda School of Engineering & Science (SSES) | B.Tech CSE-AIML | Semester II | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MSE + ETE Assessment*

**PART I**

# COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE —Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | II |
| **Course Code:** | MTT1214 | **Course Type:** | Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MSE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **MTT1214** |
| 2 | **Course Title** | **Probability and Statistics** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-1-0 (Theory: 40hrs Classroom + 30 hrs Self Learning = 70hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | 1. Develop the ability to collect, organize, and analyze data effectively.<br>2. Understand the concepts of probability and uncertainty in real-world situations.<br>3. Interpret statistical results and draw meaningful conclusions from data.<br>4. Enhance problem-solving skills through the application of statistical reasoning. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Define measure of central tendency, dispersion, and moments to interpret data distributions, including skewness and kurtosis. |

| | | |
|---|---|---|
| | | CO2 (Explore – L2/L3): Explain the fundamental concepts of probability, including conditional probability, Bayes' theorem, and expectation for discrete and continuous random variables.<br>CO3 (Apply – L3): Apply the discrete and continuous probability distributions such as Binomial, Poisson, Normal, and Exponential distributions in real-world problems.<br>CO4 (Analyze – L4/L5): Analyze relationships between variables using correlation, rank correlation, and regression analysis techniques.<br>CO5 (Analyze – L4/L5): Evaluate curve fitting with the help of least squares and hypothesis testing (small and large sample tests) to analyze data and draw inferences.<br>CO6 (Analyze – L6): Interpret chi-square tests to assess goodness of fit and independence of attributes in statistical data. |
| 8 | **Course Description** | This course provides a comprehensive introduction to the fundamental concepts of probability and statistics. Topics include probability theory, random variables, probability distributions (discrete and continuous), mathematical expectation, sampling distributions, hypothesis testing, correlation, and regression analysis. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 40hrs \| Self Learning (SL): 30 hrs \| Total: 70 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MSE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | (i) Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.<br>(ii) S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002. |
| 12 | **References** | 1. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968.<br>2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.<br>3. Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010. |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MSE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Descriptive Statistics** | |
| A | Measure of central tendency and its measures, | CO1 |
| B | Dispersion and its measures, | CO1 |
| C | Moments, Skewness and Kurtosis. | CO1 |
| | **Unit 2: Probability theory** | |
| A | Definition of Probability and Conditional probability, Baye's rule, | CO2 |
| B | Discrete and Continuous random variables, p.m.f and p.d.f. | CO2 |
| C | Expectation and Variance of Discrete and Continuous Random Variables, Chebyshev's Inequality. | CO2 |
| | **Unit 3: Probability distribution** | |
| A | Discrete Probability distributions: Binomial, Poisson, | CO3 |
| B | Geometric distribution, Continuous distribution: Uniform distribution, | CO3 |
| C | Normal and exponential distribution, Gamma distribution. | CO3 |
| | **Unit 4: Correlation, Regression and Curve Fitting** | |
| A | Correlation and Rank Correlation, | CO4 |
| B | Regression, | CO4 |
| C | Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves.<br>Rule. | CO4 |
| | **Unit 5: Testing of Hypothesis** | |
| A | Test of significance: small sample test, large sample test for mean, proportion and Variance, | CO5 |

| | | |
|---|---|---|
| B | Chi-square test for goodness of fit, | CO6 |
| C | Chi-square test for independence of attributes. | CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | | ✓ | ✓ | | | |
| 8 | 3.B | | ✓ | ✓ | | | |
| 9 | 3.C | | ✓ | ✓ | | | |
| 10 | 4.A | | | ✓ | ✓ | ✓ | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | ✓ | | |
| 13 | 5.A | | | ✓ | ✓ | | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | | ✓ | ✓ | | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | | | | | | | | | | |
| CO4 | | | ✓ | ✓ | ✓ | | ✓ | | | | | ✓ | | | | | | |
| CO5 | | | ✓ | ✓ | | | | | | | | | | | | | | |
| CO6 | | | ✓ | ✓ | | | | | | | | | | | | | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

*Total classroom contact: 40 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | OBE, Measure of central tendency | UNIT-1 | 6 |
| DD/MM/YY | Mean, Mode, Median | | |
| DD/MM/YY | Dispersion and its measure | | |
| DD/MM/YY | Moments, Relation between moments | | |
| DD/MM/YY | Skewness | | |
| DD/MM/YY | Kurtosis | | |
| DD/MM/YY | Probability definition, conditional probability | UNIT-2 | 11 |
| DD/MM/YY | Bayes' rule | | |
| DD/MM/YY | Discrete random variables | | |
| DD/MM/YY | Independent random variables | | |
| DD/MM/YY | Expectation of Discrete Random Variables | | |
| DD/MM/YY | Chebyshev's Inequality | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Continuous random variables and their properties | | |
| DD/MM/YY | Probability mass function(p.m.f.) | | |
| DD/MM/YY | Expectation of Continuous Random Variables | | |
| DD/MM/YY | Probability Density Function(p.d.f.) | | |
| DD/MM/YY | Chebyshev's Inequality | | |
| DD/MM/YY | Discrete Probability distributions: Binomial | UNIT-3 | 7 |
| DD/MM/YY | Discrete Probability distributions: Poisson | | |
| DD/MM/YY | Geometric Distribution | | |
| DD/MM/YY | Continuous distribution: Uniform distribution, | | |
| DD/MM/YY | Normal distribution | | |
| DD/MM/YY | exponential distribution, | | |
| DD/MM/YY | Gamma distribution | | |
| DD/MM/YY | Correlation | UNIT-4 | 8 |
| DD/MM/YY | Rank Correlation | | |
| DD/MM/YY | Tied Rank Correlation | | |
| DD/MM/YY | Regression | | |
| DD/MM/YY | Method of least squares | | |
| DD/MM/YY | Fitting of straight lines | | |
| DD/MM/YY | Fitting of second degree parabolas | | |
| DD/MM/YY | Fitting of more general curves | | |
| DD/MM/YY | Sampling, Test of significance | UNIT-5 | 8 |
| DD/MM/YY | test for proportion (large sample) | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | test for mean (large sample) | | |
| DD/MM/YY | test for variance (large sample) | | |
| DD/MM/YY | test for mean (small sample) | | |
| DD/MM/YY | test for variance (small sample) | | |
| DD/MM/YY | Chi-square test for goodness of fit | | |
| DD/MM/YY | Chi-square test for independence of attributes. | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MSE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MSE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Statistical Concepts & Descriptive Data Interpretation | Recall and interpret measures of central tendency, dispersion, moments, skewness and kurtosis for describing data distributions | CO1 \| L1–L2 | CA \| MSE Sec A \| ETE Sec A |
| TS2 | Probability Reasoning & Random Variable Interpretation | Explain probability concepts, conditional probability, Bayes' theorem, random variables, expectation and variance | CO2 \| L2–L3 | CA \| MSE Sec B \| ETE Sec A |
| TS3 | Probability Distribution Application | Apply Binomial, Poisson, Geometric, Uniform, Normal, Exponential and Gamma distributions to solve numerical problems | CO3 \| L3 | CA \| ETE Sec B |

| | | | | |
|---|---|---|---|---|
| **TS4** | **Correlation & Regression Analysis** | **Analyze relationships among variables using correlation, rank correlation and regression techniques** | CO4 \| L4–L5 | CA \| ETE Sec B |
| **TS5** | **Statistical Inference & Hypothesis Evaluation** | **Evaluate curve fitting models and perform hypothesis testing for decision-making using statistical evidence** | CO5 \| L4–L5 | CA \| ETE Sec B/C |
| **TS6** | **Chi-Square Interpretation & Statistical Decision Making** | **Discuss goodness-of-fit and independence tests and draw valid conclusions from statistical data** | CO6 \| L6 | CA \| ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Process Interpretation | TS3 Algorithmic Application | TS4 Performance Evaluation | TS5 Memory System Analysis | TS6 File & Disk Evaluation |
|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | | | | |
| **CO2** | **M** | **H** | **M** | | | |
| **CO3** | | **M** | **H** | **M** | | |
| **CO4** | | | **M** | **H** | **M** | |
| **CO5** | | | | **M** | **H** | **M** |
| **CO6** | | **M** | | **M** | **M** | **H** |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **10** | CO1, CO2, CO3, CO4,CO5,CO6 | TS1, TS2, TS3, TS4 |

| | | | | |
|---|---|---|---|---|
| **Assessment 1-2** | 2 assessment | **15** | CO1,CO2, CO3,CO4,CO6 | TS1,TS2,TS3, TS4, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment -wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Measures of Central Tendency, Dispersion, Moments | CO1 | TS1 | 6h SL | Numerical calculations and interpretation |
| **Assignment 2** | Probability, Conditional Probability, Bayes' Theorem | CO2 | TS2 | 6h SL | Problem solving and reasoning |
| **Assignment 3** | Probability Distributions | CO2, CO3 | TS2, TS3 | 6h SL | Distribution-based numerical applications |
| **Assignment 4** | Correlation and Regression Analysis | CO3, CO4 | TS3, TS4 | 6h SL | Computation and analytical interpretation |
| **Assignment 5** | Curve Fitting and Hypothesis Testing | CO3, CO4, CO5 | TS3, TS4, TS5 | 6h SL | Statistical inference and evaluation |

## 10. Mid Serm Examination (MSE) — 15 Marks (Units 1–2)

ℹ *MSE covers Units 1–2 (CO1, CO2), CO3, CO4, CO5 and CO6 are assessed in ETE only. MSE maps to TS1–TS2.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **5** | TS1 — Conceptual Recall & Probability and Statistics Identification TS2 — Conceptual Explanation & Process Interpretation | **CO1, CO2** | Short-answer questions, conceptual explanations, probability reasoning |
| **Section B** | **10** | TS3 — Probability Distribution Application TS4 — Correlation & Regression Analysis | **CO1, CO2** | Numerical problems involving distributions and applications |
| **TOTAL** | **15** | TS1–TS2 | **CO1–CO2** | Units 1–2 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

> ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 24/60 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **24.0** | TS1,TS2,TS3,TS4,TS5,TS6 — Conceptual Recall & Conceptual Explanation | **CO1, CO2, CO3, CO4, CO5, CO6** | Short questions (all units): definitions, Conceptual and short-answer questions |
| **Section B** | **10.8** | TS3 — Probability Distribution Application TS4 — Performance Evaluation TS5 — Statistical Inference & Hypothesis Evaluation | **CO3, CO4, CO5** | Medium questions: Numerical and analytical questions |
| **Section C** | **18.0** | TS3,TS4,TS5 —&Hypothesis Evaluation Interpretation | **CO3, CO4, CO5** | Long/evaluation questions: virtual memory analysis, thrashing, disk scheduling comparisons |
| **Section D** | **7.2** | T6 — Chi-Square & Statistical Inference | **CO6** | Long/evaluation questions: virtual memory analysis, |
| **TOTAL** | **60** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 24/60 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MSE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Define measure of central tendency, dispersion, and moments to interpret data distributions, including skewness and kurtosis | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| **CO2** | Explain the fundamental concepts of probability, including conditional probability, Bayes' theorem, and expectation for discrete and continuous random variables. | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| **CO3** | Apply the discrete and continuous probability distributions such as Binomial, Poisson, Normal, and Exponential distributions in real-world problems. | ✓ | — | ✓ | TS3 | PO1, PO2, PO3, PO4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO4** | Analyze relationships between variables using correlation, rank correlation, and regression analysis techniques. | ✓ | — | ✓ | TS4 | PO9, PO10, PO11 |
| **CO5** | Evaluate curve fitting with the help of least squares and hypothesis testing (small and large sample tests) to analyze data and draw inferences. | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Interpret chi-square tests to assess goodness of fit and independence of attributes in statistical data | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO3, CO4, CO5 and CO6 are NOT assessed in MSE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 |
| CO2 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 3 |
| CO3 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO6 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 2 |
| Avg | 3.00 | 2.50 | 1.60 | 2.16 | 2.16 | 1.33 | 1.00 | 1.00 | 1.00 | 1.33 | 1.00 | 1.50 | 3.00 | 2.50 | 2.16 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | M | M | M | M | M | M | M | M | M | M | M | M | M |
| CO2 | H | M | H | M | M | M | M | M | M | M | M | M | M | M | M |
| CO3 | H | M | M | M | H | M | M | M | M | M | M | M | M | M | M |
| CO4 | H | H | M | M | M | M | M | M | M | M | M | M | M | M | M |
| CO5 | H | M | M | M | M | M | M | M | M | M | M | M | M | M | M |
| CO6 | H | H | M | H | M | M | M | M | M | M | M | M | M | M | M |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 30 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | Numerical Assignment Writing (5 assignments based on probability, distributions, correlation, regression and hypothesis testing) | 5 assignments × 6 hrs each<br>Total = 30 hrs | CO1–CO6 TS1–TS6 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance |
| | **TOTAL Self-Learning Hours** | **30 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (Normal, and Exponential distributions in real-world problems). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of hypothesis testing, correlation, and regression analysis.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MSE |
| **Overall Total (CA + MSE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MSE 15 + ETE 60 = 100; 40% overall minimum required |

**MTT1214 — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Define / Understand → TS1, TS2 → CA + MSE Sec A, Sec B + ETE Sec A**

**CO3–CO5: Apply / Evaluate → TS3, TS4 → CA + ETE Sec B/C**

**CO6: Estimate, Discuss → TS5, TS6 → CA + ETE Sec D**

CA 25 marks + MSE 15 marks + ETE 60 marks = Total 100 marks

# COURSE PLAN

## Object Oriented Programming Using Java (CSCR1301)

*School of Computing Science & Engineering (SSCSE) | B.Tech. CSE-AIML | Semester II | Batch 2026 - 2030*

*Integrated Course Plan - Theory COs (CO1-CO6) + Lab COs (CO7-CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I**

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech. | **Current Academic Year:** | 2026–27 |
| **Branch:** | CSE-AIML | **Semester:** | II |

## 2. Course Details

*Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR1515 |
| 2 | **Course Title** | **Object Oriented Programming Using Java** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-2-2 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | To introduce object-oriented programming concepts in Java and develop problem-solving skills through structured lab practice, design exercises, ethical coding, and collaborative project work. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs - Assessed via MTE + ETE:**<br>CO1 (Remember - L1): List and identify core Java programming constructs like keywords, primitive data types, operators, and JVM architecture components with higher quartile accuracy in recall assessments.<br>CO2 (Understand - L2): Classify and differentiate the four OOP principles (encapsulation, abstraction, inheritance, polymorphism) and explain their role in Java program structure through annotated code examples.<br>CO3 (Apply - L3): Construct executable Java programs using classes, objects, constructors, method overloading, and control structures to solve at least five distinct computational problems per unit. |

| | | |
|---|---|---|
| | | CO4 (Analyze - L4): Decompose and trace Java programs involving arrays, strings, wrapper classes, and inheritance hierarchies to locate design flaws and reusability gaps, producing documented debug reports.<br>CO5 (Evaluate - L5): Assess and justify design choices for Java programs employing polymorphism, interfaces, exception handling, and file I/O against correctness, robustness, and maintainability criteria.<br>CO6 (Create - L6): Architect and implement a concurrent Java application integrating multithreading, synchronization, and inter-thread communication that satisfies a defined problem specification within stated time and resource constraints.<br>**LAB COs - Assessed via Laboratory Assessment only:**<br>CO7 (Apply - L3): Execute Java programs using professional tools (JDK, Eclipse/NetBeans, Linux CLI, debuggers); configure experimental setups; demonstrate system operation; maintain structured lab records.<br>CO8 (Create - L5/L6): Design and develop modular Java applications addressing real-world problems with societal awareness; propose solutions with planning justifications; evaluate outcomes against stated objectives in a written format.<br>CO9 (Apply - L2/L3): Demonstrate professional, ethical, and responsible coding practices; perform self-assessed skill audits; document reflective learning entries across at least three lab milestones.<br>CO10 (Apply - L3): Collaborate and communicate effectively in team-oriented lab activities; plan, implement, and present programming solutions; apply project management principles across at least one mini-project cycle. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 30 hrs + Self Learning (SL) 30 hrs = 90 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | 1. Coding Problems on HackerRank/LeetCode - 10 OOP-focused problems minimum.<br>2. Virtual Labs (NPTEL): Java programming experiments.<br>3. MOOC course on Java/OOP (SWAYAM/Coursera/NPTEL). |
| 11 | **References** | Textbook: Schildt, H. - Java: The Complete Reference (12th Ed.), McGraw-Hill.<br>Reference: Bloch, J. - Effective Java (3rd Ed.), Addison-Wesley.<br>Reference: Horstmann, C.S. - Core Java Vol. I: Fundamentals (12th Ed.), Prentice Hall. |

## 3. Outline Syllabus - Theory Units with CO Mapping (CO1–CO6)

*Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Fundamentals of Java Programming (6-0-6-4 = 16 hrs)** | |
| **A** | Introduction to Java: JVM architecture, bytecode, platform independence, basic program structure, keywords, identifiers, variables, constants, data types, type casting | CO1 |
| **B** | Operators and Expressions: Arithmetic, logical, relational, bitwise, assignment operators; precedence and associativity; ternary operator; type conversion | CO2 |
| **C** | Control Structures: if, if-else, nested if, switch-case; while, do-while, for, enhanced for; break, continue, return | CO3 |
| **Tools Used** | Linux Environment, JDK, Eclipse/NetBeans IDE, Online Compilers, Competitive Coding Platforms (HackerRank, LeetCode) | |
| **Activities** | **Objective:** To familiarize students with the Java programming environment and develop clear understanding of basic syntax, operators, and control flow structures.<br>Study of Linux Commands | |

| | | |
|---|---|---|
| | • Install JDK, configure IDE, write and execute "Hello World"; explore basic program structure<br>• Demonstration of different data types with type-conversion examples (implicit/explicit casting)<br>• Programs demonstrating operator precedence and associativity rules<br>• Decision-making programs using if-else, nested if, and switch-case<br>• Implementing iterative constructs using while, do-while, and for loops<br>• Writing nested-loop programs for pattern printing and mathematical computations | |
| **Unit 2** | **Classes and Objects (6-0-8-6 = 20 hrs)** | |
| **A** | Classes, Objects, Constructors: Class definition, object instantiation, default/parameterised/copy constructors, constructor overloading, this keyword, garbage collection | CO2 |
| **B** | Methods and Overloading: Method declaration, invocation, pass-by-value vs. reference, static members/blocks, command-line arguments, varargs, method overloading | CO3 |
| **C** | Arrays and String Handling: 1D/2D arrays, String and StringBuilder, string methods/immutability, wrapper classes, autoboxing/unboxing | CO4 |
| **Tools Used** | Linux Environment, Java IDE (Eclipse/NetBeans), Debugger tools, Git/GitHub, Virtual Labs | |
| **Activities** | **Objective:** To understand OOP concepts, develop real-world entities using classes, master object creation and method implementation, and apply arrays and strings for data manipulation.<br>• Creating classes and objects to represent real-world entities (Student, Product, Employee)<br>• Implementing various constructor types and demonstrating constructor overloading<br>• Applying method overloading for flexible function creation<br>• Demonstrating static variables, methods, and their use cases<br>• Implementing 1D and 2D arrays: declaration, initialization, traversal<br>• Array operations: linear/binary search, bubble/insertion/selection sort<br>• String manipulation: palindrome check, anagram detection, reversal, substring operations<br>• Using wrapper classes for type conversions and processing command-line arguments | |
| **Unit 3** | **Advanced OOP Concepts (8-0-8-8 = 24 hrs)** | |
| **A** | Inheritance and Hierarchies: Single/multi-level/hierarchical inheritance, super keyword, method overriding, final keyword, abstract classes, Object class methods (toString, equals, hashCode) | CO1, CO4 |
| **B** | Polymorphism and Interfaces: Compile-time and runtime polymorphism, dynamic dispatch, interface definition and implementation, default/static interface methods, lambda expressions, functional interfaces | CO5 |
| **C** | Packages, Encapsulation, and Access Control: Package creation, import statements, access modifiers (public/private/protected/package-private), getters/setters, inner and nested classes | CO6 |
| **Tools Used** | IDE with refactoring tools, UML tools (Lucidchart, PlantUML), Code-review platforms, GitHub | |
| **Activities** | **Objective:** To design modular, flexible, and reusable Java programs using inheritance, polymorphism, interfaces, and packages; to understand encapsulation principles.<br>• Creating class hierarchies demonstrating single and multi-level inheritance<br>• Implementing method overriding and demonstrating dynamic polymorphism<br>• Designing abstract classes for extensible application frameworks<br>• Creating interfaces and implementing multiple inheritance of type | |

| | | |
|---|---|---|
| | • Organising code using packages and demonstrating code-reusability benefits<br>• Implementing encapsulation using access modifiers and getter/setter methods<br>• Creating nested and inner classes for specialised use cases<br>• Comparing OOP designs and selecting the most appropriate approach | |
| **Unit 4** | **Exception Handling and File I/O (5-0-4-6 = 15 hrs)** | |
| **A** | Exception Handling: Exception hierarchy (Throwable, Exception, RuntimeException, Error), try-catch-finally, throw/throws, custom exceptions, multiple catch blocks, best practices | CO5 |
| **B** | File I/O Streams: InputStream, OutputStream, Reader, Writer; byte vs. character streams; FileInputStream/FileOutputStream; FileReader/FileWriter; BufferedReader/Writer; Scanner class | CO5 |
| **C** | Advanced File Operations: Sequential and random access, serialisation/deserialisation, directory operations, CSV file processing, data import/export | CO5 |
| **Tools Used** | IDE with debugging capabilities, LogBack/SLF4J for logging, File management tools, Text editors | |
| **Activities** | **Objective:** To develop robust Java programs that handle runtime errors effectively and perform efficient file I/O operations for real-world data management.<br>• Handling runtime errors using appropriate try-catch-finally blocks<br>• Creating custom exceptions for application-specific error handling<br>• Implementing multi-level exception handling in complex programs<br>• Reading data from text files and processing information<br>• Writing data to files in structured formats<br>• Implementing file operations: merging files, sorting file contents, generating file statistics<br>• Creating buffered I/O programs for efficient file processing | |
| **Unit 5** | **Multithreading (5-0-4-6 = 15 hrs)** | |
| **A** | Thread Fundamentals: Thread concept, benefits of multithreading, Thread class and Runnable interface, creating threads, thread naming/identification, thread priorities, JVM scheduling | CO6 |
| **B** | Thread Lifecycle and Synchronisation: Thread states, control methods (start, run, sleep, join, yield), synchronized keyword, locks, mutual exclusion, deadlock prevention, thread interruption | CO6 |
| **C** | Inter-thread Communication and Concurrency: wait/notify/notifyAll, producer-consumer pattern, Executor framework, volatile keyword, concurrent collections, thread-safe data structures | CO6 |
| **Tools Used** | IDE with thread debugging, JProfiler for thread analysis, Thread visualisation tools, Concurrency testing frameworks | |
| **Activities** | **Objective:** To develop concurrent Java applications demonstrating advanced thread management, synchronization, and inter-thread communication for real-world multi-threaded scenarios.<br>• Creating and managing multiple threads using Thread class and Runnable interface<br>• Implementing thread priorities and observing JVM scheduling behavior<br>• Demonstrating complete thread lifecycle using appropriate thread methods<br>• Implementing synchronized methods and blocks for race-condition prevention<br>• Solving classic concurrency problems: Producer-Consumer, Dining Philosophers<br>• Implementing inter-thread communication using wait() and notify()<br>• Building simple thread pools and Executor service implementations | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | | ✓ | | | |
| 2 | 1.B | | | ✓ | | | |
| 3 | 1.C | | | ✓ | | | |
| 4 | 2.A | | | ✓ | | | |
| 5 | 2.B | | | ✓ | | | |
| 6 | 2.C | | | | ✓ | | |
| 7 | 3.A | | ✓ | | ✓ | ✓ | |
| 8 | 3.B | | ✓ | | | ✓ | ✓ |
| 9 | 3.C | | | | | ✓ | |
| 10 | 4.A | | | | | ✓ | |
| 11 | 4.B | | | | | ✓ | |
| 12 | 4.C | | | | | ✓ | |
| 13 | 5.A | | | | | | ✓ |
| 14 | 5.B | | | | | | ✓ |
| 15 | 5.C | | | | | | ✓ |

## 5. CO vs Bloom's Taxonomy - All Three Domains (Updated for 10 COs)

*Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | ✓ | | | | | ✓ | | | | | | |
| CO2 | | ✓ | | | | | | ✓ | | | | | ✓ | | | | | |
| CO3 | | | ✓ | | | | | ✓ | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | | | | | ✓ | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | | | ✓ | | | | | | ✓ | | |
| CO6 | | | | | | ✓ | | | | ✓ | | | | | | | ✓ | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | | | | |
| CO8 | | | | | | ✓ | | | | ✓ | | | | | | | ✓ | |
| CO9 | | | ✓ | | | | | | | | ✓ | | | | ✓ | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO10 | | | ✓ | | | | | | ✓ | | | | | | ✓ | | | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory - 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Java, JVM architecture, bytecode, platform independence, and the basic structure of a Java program. | Unit 1 | 6 |
| DD/MM/YY | Keywords and identifiers, variables and constants, and primitive and non-primitive data types. | | |
| DD/MM/YY | Implicit and explicit type casting, type conversion, and expressions in Java. | | |
| DD/MM/YY | Arithmetic operators, relational and logical operators, assignment and bitwise operators, ternary operator, and operator precedence and associativity. | | |
| DD/MM/YY | If statement, if-else statement, nested if, and switch-case statement. | | |
| DD/MM/YY | While loop, do-while loop, for loop, enhanced for loop, and break, continue, and return statements. | | |
| DD/MM/YY | OOP basics: class, object, encapsulation, abstraction (conceptual view) | Unit 2 | 8 |
| DD/MM/YY | Defining classes and objects; object creation and memory model | | |
| DD/MM/YY | Constructors: default, parameterised, overloading; this keyword | | |
| DD/MM/YY | Methods: definition, calling, pass-by-value; static members and blocks | | |
| DD/MM/YY | 1D and 2D arrays: declaration, initialization, traversal | | |
| DD/MM/YY | Arrays in applications: searching, sorting, matrix operations | | |
| DD/MM/YY | Strings: String and StringBuilder, common operations and methods | | |
| DD/MM/YY | Wrapper classes, autoboxing/unboxing, command-line arguments | | |
| DD/MM/YY | Single, multi-level, and hierarchical inheritance, super keyword, method overriding. | Unit 3 | 6 |
| DD/MM/YY | Method overriding, 'final' keyword, abstract classes/methods for framework design, Object class, its methods e.g. toString, equals, and hashCode. | | |
| DD/MM/YY | Compile-time polymorphism through method overloading, runtime polymorphism through method overriding, and dynamic method dispatch. | | |
| DD/MM/YY | Interface definition and implementation, multiple interface implementation, default and static methods in interfaces, and functional interfaces with lambda expressions. | | |
| DD/MM/YY | Packages, package creation and naming conventions, import statements, and access modifiers including public, private, protected, and package-private access. | | |
| DD/MM/YY | Getters and setters for data encapsulation, package-level organization and code reusability strategies, and applications of inner classes and nested classes. | | |
| DD/MM/YY | Exception hierarchy, checked vs. unchecked, try-catch-finally | Unit 4 | 4 |
| DD/MM/YY | Throw and throws, multiple catch blocks, custom exceptions | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Basics of file I/O, byte vs. character streams, FileInputStream/FileOutputStream | | |
| DD/MM/YY | Readers/Writers, buffered streams, Scanner, simple file-based applications | | |
| DD/MM/YY | Multithreading: concept, Thread class and Runnable interface, thread lifecycle | Unit 5 | 6 |
| DD/MM/YY | Thread methods (sleep, join, yield); thread priorities and scheduling | | |
| DD/MM/YY | Synchronisation: synchronized methods/blocks, race conditions | | |
| DD/MM/YY | Inter-thread communication: wait, notify, notifyAll; producer-consumer | | |
| DD/MM/YY | Thread pools and Executor framework (intro); simple concurrent tasks | | |

## 7. Lab Session Plan - List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Java Environment Setup & Basic Programs<br>• Install JDK, configure Eclipse/NetBeans<br>• "Hello World" with comments and program structure<br>• Arithmetic operations (+, –, *, /, %)<br>• Scanner class for user input | CO7 | 3.0 |
| | S-1.2 | Operator Precedence & Type Conversion<br>• Programs demonstrating operator precedence<br>• Explicit/implicit type casting examples<br>• Programs with mixed data types | CO7 | |
| W2 | S-2.1 | Decision Making - if-else & switch<br>• Grade calculator (marks → A/B/C/D/F)<br>• ATM menu system (balance check, withdraw, deposit)<br>• Simple calculator using switch-case | CO7 | 3.0 |
| | S-2.2 | Nested Loops & Patterns<br>• Pyramid, diamond, right-triangle patterns<br>• Floyd's triangle, number patterns<br>• Sum of digits, factorial using loops | CO7 | |
| W3 | S-3.1 | Classes & Objects - Real-World Modelling<br>• Student class (name, rollno, marks, percentage)<br>• Rectangle class (length, breadth, area, perimeter)<br>• BankAccount class (balance, deposit, withdraw) | CO7, CO8 | 3.0 |
| | S-3.2 | Constructors & Method Overloading<br>• Constructor overloading in Student class<br>• Copy constructor for Rectangle<br>• Method overloading: add(int), add(double), add(int,int) | CO7, CO8 | |
| W4 | S-4.1 | Arrays - 1D Operations<br>• Declaration, initialisation, traversal<br>• Linear search, frequency count<br>• Largest/smallest element, sum/average | CO7 | 3.0 |
| | S-4.2 | Array Algorithms<br>• Bubble, selection, insertion sort | CO7 | |

| | | | | |
|---|---|---|---|---|
| | | • Binary search (sorted array)<br>• Reverse array, duplicate removal | | |
| **W5** | S-5.1 | 2D Arrays & Matrix Operations<br>• Matrix addition, subtraction, multiplication<br>• Transpose of matrix<br>• Diagonal elements sum | **CO7** | 3.0 |
| | S-5.2 | String Manipulation<br>• Palindrome check, anagram detection<br>• Vowel/consonant count, word count<br>• String reversal, substring operations | **CO7** | |
| **W6** | S-6.1 | Inheritance - Class Hierarchy<br>• Shape hierarchy: Circle, Rectangle extends Shape<br>• Vehicle hierarchy: Car, Bike extends Vehicle<br>• Employee hierarchy: Manager, Developer | **CO7, CO8** | 3.0 |
| | S-6.2 | Method Overriding & Polymorphism<br>• Override calculateArea(), display() methods<br>• Dynamic method dispatch demonstration<br>• final keyword usage | **CO7, CO8** | |
| **W7** | S-7.1 | Abstract Classes & Interfaces<br>• Abstract Shape class with abstract methods<br>• Drawable interface implementation<br>• Multiple interface implementation | **CO7, CO8** | 3.0 |
| | S-7.2 | Object Class Methods<br>• Override toString(), equals(), hashCode()<br>• Compare objects using overridden methods<br>• Lambda expressions and functional interfaces | **CO7, CO8** | |
| **W8** | S-8.1 | Exception Handling - Basic<br>• Divide by zero, array index out of bounds<br>• NumberFormatException handling<br>• try-catch-finally blocks | **CO7** | 3.0 |
| | S-8.2 | Advanced Exception Handling<br>• Custom exception: InvalidAgeException<br>• Multiple catch blocks<br>• throw/throws keywords | **CO7** | |
| **W9** | S-9.1 | File I/O - Byte Streams<br>• FileInputStream/FileOutputStream<br>• Copy file content<br>• Character count in file | **CO7** | 3.0 |
| | S-9.2 | File I/O - Character Streams<br>• FileReader/FileWriter<br>• Line-by-line reading/writing<br>• Word count from text file | **CO7** | |
| **W10** | S-10.1 | Advanced File Operations<br>• Student record management (add, search, delete)<br>• CSV file read/write<br>• File merging and sorting file contents | **CO7, CO8** | 3.0 |
| | S-10.2 | Multithreading - Thread Creation<br>• Thread using Thread class vs. Runnable<br>• Multiple threads execution<br>• Thread naming and priority | **CO7, CO8** | |
| | S-11.1 | Thread Lifecycle & Methods | **CO7, CO8** | |

| | | | | |
|---|---|---|---|---|
| **W11** | | • Demonstrate thread states (new, runnable, terminated)<br>• sleep(), join(), yield() methods<br>• Thread interruption | | 3.0 |
| | S-11.2 | Thread Synchronisation<br>• Synchronised methods/blocks<br>• Race condition demonstration<br>• Atomic counter example | **CO7, CO8** | |
| **W12** | S-12.1 | Inter-Thread Communication<br>• Producer-Consumer using wait()/notify()<br>• Bounded buffer problem<br>• Thread coordination | **CO7, CO8** | 3.0 |
| | S-12.2 | Thread Pools & Executors<br>• ExecutorService creation<br>• Fixed thread pool execution<br>• Callable and Future | **CO7, CO8** | |
| **W13** | S-13.1 | Mini Project - Phase 1: Proposal & Design<br>• Topic selection with SDG alignment<br>• UML class diagram and system design<br>• Project plan and task distribution | **CO8, CO9, CO10** | 3.0 |
| | S-13.2 | Mini Project - Phase 2: Implementation<br>• Core module coding and unit testing<br>• Code review and refactoring<br>• Version control (Git commits) | **CO8, CO9, CO10** | |
| **W14** | S-14.1 | Mini Project - Phase 3: Integration & Testing<br>• Full integration of modules<br>• Test cases: edge cases, exception handling<br>• Documentation and README | **CO8, CO9, CO10** | 3.0 |
| | S-14.2 | Mini Project - Phase 4: Presentation Preparation<br>• Slide deck (problem, design, demo, reflection)<br>• Rehearsal and peer review<br>• Lab record finalisation | **CO8, CO9, CO10** | |
| **W15** | S-15.1 | Mini Project - Final Presentation & Viva<br>• Team demonstration (10 min)<br>• Individual viva questions<br>• Rubric-based evaluation by faculty | **CO8, CO9, CO10** | 3.0 |
| | S-15.2 | Lab Examination<br>• One unseen problem (OOP concept)<br>• Code, compile, execute, and document<br>• Viva on submitted solution | **CO9/CO10** | |

*Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

## THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) - CO1 through CO6

**THEORY COs (CO1–CO6) - Assessed exclusively via MTE and ETE only**

*Six theory skill dimensions - one per Bloom's level L1–L6 - correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Factual Recall & Conceptual Recognition** | Recall and list Java keywords, data types, operators, JVM components, and basic syntax elements from memory. | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| TS2 | **Conceptual Explanation & Logical Interpretation** | Classify and differentiate OOP principles; explain class structure, encapsulation, and abstraction through annotated examples. | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| TS3 | **Procedural Application & Problem Solving** | Construct executable Java programs using classes, objects, constructors, method overloading, and control structures. | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| TS4 | **Analytical Reasoning & Program Tracing** | Decompose and trace Java programs involving arrays, strings, wrapper classes, and inheritance to identify flaws and produce debug reports. | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| TS5 | **Comparative Evaluation & Algorithmic Justification** | Assess and justify design choices for programs employing polymorphism, interfaces, exceptions, and file I/O against correctness and maintainability criteria. | CO5 \| L5 | ETE Sec B/C |
| TS6 | **Synthesis & Holistic Design** | Architect and implement a concurrent Java application integrating multithreading and synchronisation within defined constraints. | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure - MTE and ETE

### 9.1 Mid Term Examination (MTE) - 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1, TS2 | **CO1, CO2** | Short-answer: definitions, output prediction, syntax identification |
| **Sec B** | **6** | TS3, TS4 | **CO3, CO4** | Program writing; program tracing - detect errors and trace execution |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) - 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Sec A** | **25** | TS1, TS2 | **CO1, CO2** | Short questions: definitions, syntax, output tracing, concept MCQs (all units) |
| **Sec B** | **50** | TS3, TS4 | **CO3, CO4, CO5** | Medium questions: program writing, debugging, algorithm comparison, complexity analysis |
| **Sec C** | **25** | TS5, TS6 | **CO5, CO6** | Long/design questions: design modular solutions, justify choices, complete application |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme - Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation - no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) - Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each - assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection - all 4 Lab COs (CO7–CO10) |
| **TOTAL** | - | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each - Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 - Problem definition: attributes, metrics, success criteria<br>CA2 - Experimental design and tool configuration<br>CA7 - Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 - Execution correctness; output matches expected<br>CA4 - Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 - Output analysis and result interpretation<br>CA6 - Documented outcome with verification<br>CA8 - Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 - Documentation ethics, responsible practice<br>PO7 - Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks - All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 - SDG mapping; societal relevance<br>P2 - Problem scope and stakeholder requirements<br>P4 - Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 - Timeline, milestones, resource planning<br>P11 - Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 - Professional toolchain selection<br>P6 - Complete project build and integration<br>P7 - System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 - Measurable outcome vs stated goals<br>P9 - Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 - Communication plan and testing strategy<br>P10 - Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |

| | | | | |
|---|---|---|---|---|
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 - Skill growth mapping (pre/post project)<br>P13 - Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions - Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define experiment problem; identify measurable attributes, parameters, success criteria | CO7, CO8 |
| CA2 | **Experimental Design & Tool Setup** | Plan experiment; configure development environment (gcc, IDE, Linux CLI, debugger) | CO7 |
| CA3 | **Code Implementation & Execution** | Write correct code; compile and execute to produce expected output | CO7 |
| CA4 | **Computational Efficiency & Optimization** | Evaluate time/space complexity; identify bottlenecks; propose optimizations | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Analyse output critically; explain deviations; draw evidence-based inferences | CO8 |
| CA6 | **Documented Outcome with Verification** | Record final outcome formally; verify against the problem statement | CO7, CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Produce algorithm/flowchart/pseudocode before coding; justify design choices | CO7, CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records; demonstrate conceptual understanding orally | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions - Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | **SDG Alignment & Social Relevance** | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | **Problem Scoping & Requirements** | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | **Communication & Testing Strategy** | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | **Innovative Solution Proposal** | Produce class diagrams and architecture diagrams; justify design decisions | CO8 \| PO3, PO5 |
| P5 | **Professional Toolchain** | Develop the project in clearly separated, reusable Java modules | CO7, CO8 \| PO5 |
| P6 | **End-to-End Implementation** | Use IDE, version control (Git), and build tools professionally | CO8 \| PO1, PO3 |

| | | | |
|---|---|---|---|
| P7 | System Commissioning & Testing | Execute ≥5 structured test cases; document results and inferences | CO8 \| PO1 |
| P8 | Measurable Impact & Outcome | Implement robust error/exception handling in all critical modules | CO8, CO9 \| PO3 |
| P9 | Critical Analysis & Reporting | Maintain naming conventions, comments, and clean code standards throughout | CO9 \| PO8 |
| P10 | Professional Presentation & Teamwork | Acknowledge sources; avoid plagiarism; adhere to coding standards | CO9 \| PO9, PO11 |
| P11 | Financial Feasibility & Planning | Complete peer and self-evaluation rubrics; identify personal skill gaps | CO10 \| PO9 |
| P12 | Individual Skill Growth Mapping | Demonstrate equitable task distribution and documented team coordination | CO10 \| PO10 |
| P13 | Professional Attitude, Ethics & Responsibility | Deliver a structured 10-min demonstration; respond to evaluator questions | CO10 \| PO9 |

## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping - confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment - confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment - confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | | H | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | | H | | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | | H | | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | | H | | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | | | | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | M | | | | H | H | H | H | M | H | | H | M | | | | H | M | | M | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO8 | | | | | M | H | H | H | M | H | H | H | H | M | H | H | H | H | H | H | H | H | | | | | |
| CO9 | | M | | | | | | | | | | | | H | | H | | | | | M | H | H | H | | | |
| CO10 | | | | | | | | | | | | | M | | M | M | M | M | | | | | M | M | H | H | H |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | 3 | 2 | |
| CO2 | 3 | 2 | | | | | | | | | | 3 | 2 | |
| CO3 | 3 | 3 | 2 | | | | | | | | | 3 | 3 | |
| CO4 | 3 | 3 | 2 | 2 | | | | | | | | 3 | 2 | |
| CO5 | 2 | 3 | 3 | 2 | | | | | | | | 2 | 3 | |
| CO6 | 2 | 2 | 3 | 2 | 2 | | | | | | | 2 | 3 | 3 |
| CO7 | 2 | | 2 | | 3 | | | | | | | 2 | 3 | |
| CO8 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | | | | | 2 | 3 | 2 |
| CO9 | | | | | | | | 3 | | | | | | |
| CO10 | | | | | | | | | 3 | 3 | 2 | | | |
| **Avg** | **2.38** | **2.5** | **2.5** | **2.0** | **2.33** | **2.0** | **2.0** | **3.0** | **3.0** | **3.0** | **2.0** | **2.5** | **2.62** | **2.5** |

*PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators - All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | | | | | | | | | | |
| CO2 | H | M | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | H | H | M | | | | | | | | |
| CO4 | H | H | M | M | | | | | | | |
| CO5 | M | H | H | M | | | | | | | |
| CO6 | M | M | H | M | M | | | | | | |
| CO7 | M | | M | | H | | | | | | |
| CO8 | M | M | H | M | M | M | M | | | | |
| CO9 | | | | | | | | H | | | |
| CO10 | | | | | | | | | H | H | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Course develops programming competency and computational problem-solving skills; lab record, viva, and self-assessment promote lifelong learning habits. (CO1-CO10). |
| SDG 8 | Decent Work & Economic Growth | 2 (Moderate) | OOP skills and professional tool use (IDE, Git, debuggers) prepare students for industry-grade software development roles. (CO3, CO5, CO6, CO7, CO8) |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Designing concurrent and file-based Java applications addresses real-world infrastructure and software innovation challenges. (CO5, CO6, CO8) |
| SDG 17 | Partnerships for the Goals | 2 (Moderate) | Team-based mini-project promotes collaboration, shared responsibility, and communication skills aligned with partnership values. (CO10) |

## 18. Bloom's Taxonomy - Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain - Simpson (7 Levels) |
|---|---|---|
| L1 - Remember: Recall facts, definitions, basic concepts<br>L2 - Understand: Explain ideas, concepts, principles<br>L3 - Apply: Use knowledge to solve new problems<br>L4 - Analyze: Break down information, examine patterns<br>L5 - Evaluate: Judge, justify, assess, make decisions<br>L6 - Create: Design, develop, produce new solutions | A1 - Receiving: Awareness, willingness to attend<br>A2 - Responding: Active participation and reaction<br>A3 - Valuing: Showing commitment, assigning value<br>A4 - Organizing: Integrating values into personal system<br>A5 - Characterizing: Internalized value system | P1 - Perception: Sensory cues guide motor activity<br>P2 - Set: Mental, physical readiness to act<br>P3 - Guided Response: Basic practice through imitation<br>P4 - Mechanism: Habitual correct performance<br>P5 - Complex Overt Response: Skilled performance<br>P6 - Adaptation: Modify skills for special situations<br>P7 - Origination: Create new solution patterns |

*OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains - Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) - reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

*Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**OOP (CSCR1301) using Java INTEGRATED COURSE PLAN - MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

| School: SSCSE | | Batch: 2026-30 |
|---|---|---|
| Programme: B.Tech. | | Current Academic Year: 2026-27 |
| Branch: CSE, IT | | Semester: II |
| 1 | Course Code | **IKT1001** |
| 2 | Course Title | **Fundamentals of Indian Knowledge System** |
| 3 | Credits | **Audit/Non-Credit** |
| 4 | Contact Hours (L-T-P) | **2-0-0** |
| | Course Type | **Value Added Course** |
| 5 | Course Objective | 1. To introduce students to the fundamental principles and introductory aspects of Indian Knowledge Systems (IKS).<br>2. To recognize the vast corpus of knowledge traditions of India and discuss its evolution through multidisciplinary framework.<br>3. To encourage students to develop their perspectives in domains such as Vedic Mathematics, Astronomy, Metallurgy, Ayurveda etc. **(SDG 3: Good Health and Well Being & SDG4: Quality Education)**<br>4. To highlight the importance of indigenous traditions in resolving contemporary issues in various fields. |
| 6 | Course Outcomes | Students will be able to:<br><br>CO1: Explain the geographical, literary and philosophical foundations of India and its knowledge traditions.<br><br>CO2: Explain the key contributions of Indian Mathematics and Astronomy and trace their influence on modern science and computing.<br><br>CO3: Interpret the contrications of Metallurgy and Ayurveda, and develop informed perspectives on their contemporary relevance. **SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education)**<br><br>CO4: Relate the importance of Indian tradition of spirituality and ethics to modern times.<br><br>CO5: Examine the significance of indigenous knowledge traditions in addressing contemporary challenges in areas such as health, education, environment, society, and sustainable development.<br><br>CO6: Apply insights derived from Indian Knowledge Systems to critically reflect on contemporary issues and develop contextually relevant solutions**.** |
| 7 | Course Description | This course is an exploration of the Indian Knowledge System (IKS), encompassing its meaning, nature, and scope. Students will engage with the Vedic corpus and other classical texts, interpreting them through their perspectives while developing critical thinking skills. The course |

| | | | |
|---|---|---|---|
| | | emphasizes the application of traditional knowledge to contemporary times | |
| 8 | **Syllabus** | | **CO Mapping** |
| | **Unit 1** | **Introduction to Indian Knowledge System** | |
| | **A** | • India, that is Bharat: Understanding *Bharatavarsha* — Historical Geography of Bharat, Bharat: a land of rare natural endowments | CO1 |
| | **B** | • Understanding Indian Knowledge Systems: Nature, Philosophy and Character | CO1 |
| | **C** | • Understanding the Vedic Corpus: the Vedas; components of the Vedas; Vedangas | CO1 |
| | **Unit 2** | **Indian Mathematics** | |
| | **A** | • Introduction to Vedic Mathematics: Numbers, fractions and geometry in the Vedas. Decimal nomenclature of numbers in the Vedas | CO2 |
| | **B** | • Zero and Infinity. Constructions from Sulba Sutras. Decimal Place Value System: Simplification of arithmetic operation; Linguistic representation of Numbers | CO2 |
| | **C** | • Ancient Indian Mathematicians: Baudhayana; Pingala; Aryabhatta, Varahmihira; Bhaskara I & II | CO2 |
| | **Unit 3** | **Indian Astronomy** | |
| | **A** | • Early Astronomical Observations: Celestial observations in the Vedic corpus; Study of *Surya, Candra, Naksatra* and *Graha.* | CO3 |
| | **B** | • Major Texts of Indian Astronomy: *Vedanga Jyotisa*; *Surya Siddhanta*; *Aryabhatiya Pañcasiddhantika*; *Brahmasphutasiddhanta*, *Tantrasangraha* | CO3 |
| | **C** | • Astronomical Evidence and Instruments: Inscriptions recording solar and lunar eclipses; Astronomical instruments. | CO3 |
| | **Unit 4** | *Rasashastra*: Ancient Indian Metallurgy | |
| | **A** | • Introduction to *Rasashastra*: Objectives of *Rasashastra*, Important Substances: Metals and Minerals | CO4 |
| | **B** | • Important Processes: *Shodhana, Bhavana, Marana, Bhasma* | CO4 |

| | | | |
|---|---|---|---|
| | **C** | • Important Texts: *Rasaratna Samuccaya; Rasendra Mangala*; *Rasa Hridaya Tantra; Rasarnava Ayurveda Prakasha* | CO4 |
| | **Unit 5** | **Health Sciences of Ancient India** | |
| | **A** | • Vedic Foundations of Ayurveda: maintenance of health and treatment of disease. Fundamental concepts: Triguna, Panchamahabhuta and Saptadhatu. | CO5; CO6 |
| | **B** | • Health, Disease and Preventive Practices: Ayurvedic understanding of the causes of disease and imbalance of *Dosas*. *Dinacarya*; Ritucarya. Food, lifestyle and preventive healthcare in Ayurveda. | CO5; CO6 |
| | **C** | • Major Texts and Pharmacological Knowledge: Major Ayurvedic texts: *Caraka Samhita*, *Susruta Samhita* and *Ashtangahrdaya*; Indigenous knowledge of medicinal plants and substances. | CO5; CO6 |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA: 25 | ETE: 75 (MCQ Type) |
| | Readings Text book/s* | • Kapoor, K. & Singh, A.K. (2005) *Indian Knowledge Systems* (Vols. 1–2). New Delhi: D.K. Printworld Pvt. Ltd.<br>• Kapoor, K. (2014/2020) *Comparative Literary Theory: An Overview*. New Delhi: D.K. Printworld (P) Limited.<br>• Kapoor, K., Sheshagiri Rao, K.L. (eds.) (2010/2025) *Encyclopedia of Hinduism* (11 vols.). New Delhi: Indian Heritage Research Foundation & Rupa & Co.<br>• Kapoor, K. (2005) *Text and Interpretation: The Indian Tradition*. New Delhi: D.K. Printworld Pvt. Ltd.<br>• Rajani, M.B. and Kumar, V. (2019) '*Title of article*', *Journal of the Society of Architectural Historians*, 78(4), pp. 392–408. | |

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|---|---|---|
| | | • Muhlberger, S. (1998) *Democracy in Ancient India*. World History of Democracy. Available at: https://uts.nipissingu.ca/muhlberger/histdem/indiadem.htm<br>• Kanungo, A.K. and Dussubieux, L. (2022) 'Indigenous glass manufacture in India: an ethnographic approach', *Journal of Glass Studies*, 64, pp. 225–248.<br>• Sjoman, N.E. (1986) 'The memory eye: an examination of memory in traditional knowledge systems', *Journal of Indian Philosophy*, 14(2), pp. 195–213. doi:10.1007/BF00194196.<br>• Bag, A.K. (1997) *History of Technology in India*, Vol. I. New Delhi: Indian National Science Academy.<br>• Dasgupta, S. (1975) *A History of Indian Philosophy*, Vol. I. Delhi: Motilal Banarsidass.<br>• Dutt, M.N. (2018) *The Mahabharata*. 10 vols. Delhi: Parimal Publications.<br>• Jha, A. (2009) *Traditional Knowledge System in India*. New Delhi: [Publisher not specified].<br>• Joseph, G.G. (2016) *Indian Mathematics: Engaging with the World from Ancient to Modern Times*. London: World Scientific.<br>• Lal, B.B. (1997) *The Earliest Civilization of South Asia*. New Delhi: Aryan Books International.<br>• Mahadevan, B., Bhat, R.V. and Nagendra Pavana, R.N. (2022) *Introduction to Indian Knowledge System*. Delhi: PHI Learning Private Limited.<br>• Pandey, P.C. (n.d.) *Madhya Himalayi Sanskriti mein Gyan, Vigyan evam Paravigyan*. [Publication details not specified].<br>• Subbarayappa, B.V. and Sarma, K.V. (1985) *Indian Astronomy: A Source Book*. Mumbai: Nehru Centre. |

**COURSE ARTICULATION MATRIX:**

| | POs<br>COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO1 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 |
| | CO2 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 2 |
| | CO3 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 1 | 1 |
| | CO4 | 2 | 1 | 1 | 1 | 2 | 3 | 3 | 1 | 2 | 1 | 3 |
| | CO5 | 1 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 |
| | CO6 | 1 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 2 | 1 |

# COURSE PLAN

## Fundamentals of Indian Knowledge System (IKT1001)

**VAC — Value Added Course | Audit (Zero Credit) | L-T-P-S : 2-0-0-2**

SSCSE | B. Tech. CSE, B. Tech. CSE-AIML & B. Tech. CS-ME| Semester III | Batch 2026–2030

Audit Course | AICTE 11-PO Framework | All 6 COs (CO1–CO6) | SDG 3 & SDG 4

**PART-I COURSE SYLLABUS** Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2026–27 |
| **Branch:** | **CSE-AIML** | **Semester:** | II |
| **Course Code:** | IKT1001 | **Course Type:** | VAC — Value Added Course \| Audit (Zero Credit) |

ॐ This is a ZERO CREDIT audit course offered as a Value Added Course (VAC) to B.Tech CSE and B.Tech CSE-AIML students. It is mandatory for all students in Semester III. Assessment is graded as Satisfactory (S) or Unsatisfactory (U) — no numeric marks, no grade points, no impact on SGPA/CGPA.

## 2. Course Details

📘 **AUDIT COURSE — Zero credit. No numeric assessment. Graded S / U based on attendance, participation, and Viva/Practical demonstration only.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | To be assigned |
| 2 | **Course Title** | Fundamentals of Indian Knowledge System (IKS) |
| 3 | **Credits** | 0 (Zero) — Audit Course |
| 4 | **Contact Hours (L-T-P-S)** | 2-0-0-2 (Theory/Lecture: 30 hrs, No Laboratory) |
| 5 | **Course Type** | VAC — Value Added Course \| Audit \| Mandatory for B.Tech CSE & B.Tech CSE-AIML (Semester III) |
| 6 | **SDG Alignment** | SDG 3: Good Health and Well-Being \| SDG 4: Quality Education |
| 7 | **Pre-requisites** | None. Open to all B.Tech CSE, B.Tech CSE-AIML and B.Tech CS-ME students. |
| 8 | **Course Objectives** | 1. To introduce students to the fundamental principles and introductory aspects of Indian Knowledge Systems (IKS).<br>2. To enable students to interpret select ancient texts and encourage them to develop their own perspectives.<br>3. To highlight the importance of Indian spiritual tradition in resolving contemporary issues across various fields.<br>4. To understand the importance of traditional Indian knowledge in science, technology, mathematics, metallurgy, and lifestyle in maintaining good health and well-being. (SDG 3)<br>5. To guide students in evaluating the philosophical, cultural, and spiritual dimensions of ancient Indian texts, developing a deeper appreciation of values and ideas that have shaped Indian thought.<br>6. To recognize the vast corpus of India's knowledge traditions and discuss their evolution through a multidisciplinary lens, fostering quality education. (SDG 4) |
| 9 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Identify meaning, nature, and scope of IKS..<br>CO2 (Explore – L2/L3): Explain key components of ancient Indian literature.<br>CO3 (Apply – L3): Apply Indian spirituality and ethics to modern contexts.<br>CO4 (Analyze – L4/L5): Analyze diversity in traditional Indian food and lifestyle.<br>CO5 (Analyze – L4/L5): Examine contributions of IKS in mathematics, astronomy, science & technology.<br>CO6 (Analyze – L2/L4): Develop an appreciation for IKS for modern times. (SDG 3: Good Health and Well Being & SDG 4: Quality Education) |
| 10 | **Course Description** | This course provides an in-depth exploration of the Indian Knowledge System (IKS), encompassing its meaning, nature, and scope. Students will engage with the Vedic corpus and other classical texts, interpreting them through their perspectives while developing critical thinking skills. The course emphasizes the application of traditional knowledge to contemporary times. |
| 11 | **Teaching & Learning Scheme** | Classroom / Lecture: 30 hrs \| Self Learning (SL): 30 hrs \| Total: 60 hrs |
| 12 | **Mode of Examination** | Audit — Practical / Viva-Voce \| **CA: 100%**<br>Graded: S (Satisfactory) / U (Unsatisfactory) \|<br>No numeric marks awarded |
| 13 | **Textbook** | |

| | | |
|---|---|---|
| 14 | **References** | 1. Kapoor, K. & Singh, A.K. (2005) Indian Knowledge Systems (Vols. 1–2). New Delhi: D.K. Printworld Pvt. Ltd.<br>2. Kapoor, K. (2014/2020) Comparative Literary Theory: An Overview. New Delhi: D.K. Printworld (P) Limited.<br>3. Kapoor, K., Sheshagiri Rao, K.L. (eds.) (2010/2025) Encyclopedia of Hinduism (11 vols.). New Delhi: Indian Heritage Research Foundation & Rupa & Co.<br>4. Kapoor, K. (2005) Text and Interpretation: The Indian Tradition. New Delhi: D.K. Printworld Pvt. Ltd.<br>5. Rajani, M.B. and Kumar, V. (2019) 'Title of article', Journal of the Society of Architectural Historians, 78(4), pp. 392–408.<br>6. Muhlberger, S. (1998) Democracy in Ancient India. World History of Democracy. Available at: https://uts.nipissingu.ca/muhlberger/histdem/indiadem.htm<br>7. Kanungo, A.K. and Dussubieux, L. (2022) 'Indigenous glass manufacture in India: an ethnographic approach', Journal of Glass Studies, 64, pp. 225–248.<br>8. Sjoman, N.E. (1986) 'The memory eye: an examination of memory in traditional knowledge systems', Journal of Indian Philosophy, 14(2), pp. 195–213. doi:10.1007/BF00194196.<br>9. Bag, A.K. (1997) History of Technology in India, Vol. I. New Delhi: Indian National Science Academy.<br>10. Dasgupta, S. (1975) A History of Indian Philosophy, Vol. I. Delhi: Motilal Banarsidass.<br>11. Dutt, M.N. (2018) The Mahabharata. 10 vols. Delhi: Parimal Publications.<br>12. Jha, A. (2009) Traditional Knowledge System in India. New Delhi: [Publisher not specified].<br>13. Joseph, G.G. (2016) Indian Mathematics: Engaging with the World from Ancient to Modern Times. London: World Scientific.<br>14. Lal, B.B. (1997) The Earliest Civilization of South Asia. New Delhi: Aryan Books International.<br>15. Mahadevan, B., Bhat, R.V. and Nagendra Pavana, R.N. (2022) Introduction to Indian Knowledge System. Delhi: PHI Learning Private Limited.<br>16. Pandey, P.C. (n.d.) Madhya Himalayi Sanskriti mein Gyan, Vigyan evam Paravigyan. [Publication details not specified].<br>17. Subbarayappa, B.V. and Sarma, K.V. (1985) Indian Astronomy: A Source Book. Mumbai: Nehru Centre. |

## 3. Outline Syllabus with CO Mapping

ℹ CO mappings in this section refer to COs (CO1–CO6). Audit course: no numeric marks; all content contributes to Satisfactory (S) assessment through participation, reflective journals, and viva-voce.

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Introduction to Indian Knowledge System** | |
| **A** | Understanding Indian Knowledge Systems: Nature, Philosophy and Character | **CO1** |
| **B** | Distinctive categories of traditional knowledge: Indigenous; Local; Autochthonous; Community Knowledge. Historicity of IKS | **CO1** |
| **C** | Understanding Indic Terminologies: darśana; jñāna, vijñāna, vidyā | **CO1** |
| | **Unit 2: Introduction to Ancient Indian Literature(6 Lectures)** | |
| **A** | Understanding the Vedic Corpus: Meaning and features of the Vedas; Rigveda, Samaveda, Yajurveda and Atharvaveda. | **CO2** |

| | | |
|---|---|---|
| B | Buddhism: Origin and founder — Gautama Buddha; Life of Buddha; Four Noble Truths; Eightfold Path Three Jewels; Buddhist teachings and principles; Major Buddhist schools; Spread of Buddhism in India and Asia | CO2 |
| C | Jainism: Founder and Tirthankaras; Five Great Vows | CO2 |
| | **Unit 3: Ancient Mathematics(6 Lectures)** | |
| A | Introduction to Vedic Mathematics | CO3 |
| B | Important Sutras: Ekadhikena Purvena, Nikhilam Navatashcaramam Dashatah, Urdhva-Tiryagbhyam Paravartya Yojayet, Anurupyena | CO3 |
| C | Using Urdhva-Tiryagbhyam | CO3 |
| | **Unit 4: Rasashastra: Ancient Indian Metallurgy (6 Lectures)** | |
| A | Introduction to Rasashastra: Objectives of Rasashastra, Important Substances: Metals and Minerals | CO4 |
| B | Important Processes: Shodhana, Bhavana, Marana, Bhasma | CO4 |
| C | Important Texts: Rasaratna Samuccaya; Rasendra Mangala; Rasa Hridaya Tantra; Rasarnava Ayurveda Prakasha | CO4 |
| | **Unit 5: Recontextualising Indian Knowledge System: Relevance in Contemporary Times (6 Lectures)** | |
| A | Loss, Recovery and Renewal of Indic Knowledge | CO5 |
| B | Recontextualising Indian Knowledge for contemporary requirements | CO5, CO6 |
| C | Solving global crises with Indian Knowledge. | CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

ℹ BTL mapping is for pedagogical planning purposes. As an audit course, no numeric assessment is applied per topic; however, Bloom's levels guide the depth of engagement expected in reflective journals and viva-voce.

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | **1.A** | ✓ | ✓ | | | | |
| 2 | **1.B** | ✓ | ✓ | | | | |
| 3 | **1.C** | | ✓ | ✓ | | | |
| 4 | **2.A** | ✓ | ✓ | | | | |
| 5 | **2.B** | | ✓ | | | | |
| 6 | **2.C** | | ✓ | ✓ | | | |
| 7 | **3.A** | ✓ | ✓ | | | | |
| 8 | **3.B** | | ✓ | ✓ | | | |
| 9 | **3.C** | | | ✓ | ✓ | | |
| 10 | **4.A** | ✓ | ✓ | | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11 | **4.B** | | | ✓ | ✓ | | |
| 12 | **4.C** | | ✓ | | ✓ | | |
| 13 | **5.A** | | | | ✓ | ✓ | |
| 14 | **5.B** | | | | ✓ | ✓ | |
| 15 | **5.C** | | | | | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ Affective domain features strongly for an IKS audit course — CO6 (Valuing, A3) and CO2 (Responding, A2) reflect the importance of personal engagement with cultural and philosophical content. Psychomotor (P3) appears for CO3 (mental application of Vedic sutras).

| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | | | | | | ✓ | | | | | | | | | | |
| **CO2** | ✓ | ✓ | | | | | | ✓ | | | | | | | | | | |
| **CO3** | | ✓ | ✓ | | | | | | | | | | | ✓ | | | | |
| **CO4** | | ✓ | | ✓ | | | | | ✓ | | | | | | | | | |
| **CO5** | | | | ✓ | ✓ | | | | ✓ | | | | | | | ✓ | | |
| **CO6** | | | | | ✓ | ✓ | | | ✓ | ✓ | | | | | | ✓ | ✓ | |

Legend: ✓ = Strong/Dominant mapping. Affective domain (A2–A4) is prominent for an IKS audit course — engagement, appreciation, and valuing are central. Psychomotor (P3) for CO3 (mental sutra application). L6 for CO6 (creative synthesis of IKS relevance).

## 6. Lecture Plan Outline (30 Lectures / 30 Hours)

ℹ Total classroom contact: 30 hours across 5 units (6 lectures each). Self-Learning activities (30 hrs) are structured in Section 14.

| Date | Topics to be Covered / Title | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Indian Knowledge System Meaning, scope, objectives and significance of IKS | **UNIT-1** | **6** |
| DD/MM/YY | Nature, Philosophy and Character of IKS Holistic nature, knowledge traditions, values and worldview | | |
| DD/MM/YY | Categories of Traditional Knowledge Indigenous, Local, Autochthonous and Community Knowledge | | |
| DD/MM/YY | Historicity of IKS Evolution, preservation and transmission of Indian knowledge traditions | | |
| DD/MM/YY | Indic Terminologies Meaning and significance of darśana, jñāna, vijñāna and vidyā | | |
| DD/MM/YY | Schools and Dimensions of Indian Knowledge Overview of philosophical, scientific, artistic and social dimensions of IKS; Unit-1 recap | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Introduction to Ancient Indian Literature Overview, characteristics and importance of ancient Indian literature | **UNIT-2** | **6** |
| DD/MM/YY | Vedic Corpus Meaning, features and structure of the Vedas | | |
| DD/MM/YY | Four Vedas Rigveda, Samaveda, Yajurveda and Atharvaveda | | |
| DD/MM/YY | Buddhism: Origin and Life of Buddha Gautama Buddha, origin, life and major events | | |
| DD/MM/YY | Core Teachings of Buddhism Four Noble Truths, Eightfold Path and Three Jewels | | |
| DD/MM/YY | Buddhism and Jainism Buddhist schools, spread in India/Asia; Jainism, Tirthankaras and Five Great Vows | | |
| DD/MM/YY | Introduction to Ancient Indian Mathematics Historical development, mathematical traditions and contribution of India | **UNIT-3** | **6** |
| DD/MM/YY | Introduction to Vedic Mathematics Concept, principles and applications of Vedic Mathematics | | |
| DD/MM/YY | Sutra 1: Ekadhikena Purvena Meaning, principle and applications | | |
| DD/MM/YY | Sutra 2: Nikhilam Navatashcaramam Dashatah Concept and multiplication techniques | | |
| DD/MM/YY | Sutra 3: Urdhva-Tiryagbhyam Vertical and crosswise multiplication method | | |
| DD/MM/YY | Sutras: Paravartya Yojayet and Anurupyena Principles, applications and revision of major sutras | | |
| DD/MM/YY | Introduction to Rasashastra-Meaning, origin, objectives and significance of Rasashastra | **UNIT-4** | **6** |
| DD/MM/YY | Metals and Minerals-Important metals, minerals and their traditional applications | | |
| DD/MM/YY | Shodhana and Bhavana-Meaning, objectives and traditional processes | | |
| DD/MM/YY | Marana and Bhasma-Concepts, preparation principles and traditional significance | | |
| DD/MM/YY | Important Rasashastra Texts-Rasaratna Samuccaya, Rasendra Mangala and Rasa Hridaya Tantra | | |
| DD/MM/YY | Other Texts and Metallurgical Heritage-Rasarnava, Ayurveda Prakasha; overview of ancient Indian metallurgy | | |
| DD/MM/YY | Loss of Indic Knowledge-Causes of decline, disruption and loss of traditional knowledge | **UNIT-5** | **6** |
| DD/MM/YY | Recovery of Indic Knowledge-Documentation, preservation, digitisation and revival of knowledge | | |
| DD/MM/YY | Renewal of Indian Knowledge-Reinterpretation, innovation and integration with contemporary education | | |
| DD/MM/YY | Recontextualising IKS-Applying Indian knowledge to contemporary scientific, social and technological requirements | | |
| DD/MM/YY | IKS and Global Challenges-Potential applications in sustainability, environment, health, education and societal wellbeing | | |
| DD/MM/YY | Integration and Contemporary Relevance of IKS-Solving global crises using IKS; course-wide revision and student presentations | | |

**PART II AUDIT ASSESSMENT FRAMEWORK** Zero-Credit Assessment: S / U Grading | Viva-Voce, Attendance & Participation | No Numeric Marks

## 7. Audit Assessment — Overview and Principles

⚠ ZERO CREDIT COURSE — No numeric marks are awarded. No grade points. No SGPA/CGPA impact. The course is graded ONLY as S (Satisfactory) or U (Unsatisfactory) based on attendance, participation, self-learning activities, and Viva/Practical demonstration.

ॐ The purpose of this audit course is not examination but genuine engagement with Indian Knowledge Systems. Assessment criteria therefore emphasise attendance, reflective learning, and ability to articulate IKS concepts — not rote recall or examination performance.

| Grade | Meaning | SGPA / CGPA Impact | Criteria |
|---|---|---|---|
| S | **Satisfactory** | None — Zero Credit Course | Meets ALL mandatory criteria: attendance ≥ 75%, all SL activities submitted, Viva-Voce participated |
| U | **Unsatisfactory** | None — Zero Credit Course | Fails any mandatory criterion: attendance < 75%, or SL activities not submitted, or Viva-Voce absent |

## 8. Audit Assessment Criteria (S / U Determination)

### 8.1 All Three Criteria Must Be Met for S Grade

| Criterion | Requirement | Evidence | COs Engaged | Weight in S/U |
|---|---|---|---|---|
| **A. Attendance** | **≥ 75% of 30 scheduled lecture hours (minimum 23 sessions attended)** | Attendance register; biometric / roll-call records | CO1–CO6 | **MANDATORY (failure = U)** |
| **B. Self-Learning Activities (Reflective Journal + Assignments)** | All 5 unit-wise reflective entries + 1 literature exploration report submitted | Portfolio of submitted written reflections; teacher spot-check; digital submission | CO1–CO6 (unit-wise) | **MANDATORY (failure = U)** |
| **C. Viva-Voce / Practical Demonstration** | Participate in end-of-semester Viva-Voce OR submit and present a group/individual IKS exploration project | Viva-Voce held at end of semester; examiner checklist; OR project presentation with peer assessment | CO3, CO4 CO5, CO6 | **MANDATORY (failure = U)** |

### 8.2 Viva-Voce / Practical Demonstration — Areas of Assessment (CO-wise)

ℹ The Viva-Voce is not a formal examination — it is a conversational assessment. The examiner engages students in a dialogue about IKS concepts covered in the course. There are no minimum marks — the criterion is participation and basic coherent engagement with the content.

| Area | Viva Topics / Demonstration | CO Assessed | Criterion |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Unit 1 — IKS Foundation** | Explain the meaning of IKS; distinguish jñāna, vijñāna, vidyā; give examples of traditional knowledge categories | CO1 | S/U |
| **Unit 2 — Ancient Literature** | Name and describe the four Vedas; explain one of the Four Noble Truths; describe one Jain principle (e.g., Ahimsa or Anekantavada) | CO2 | S/U |
| **Unit 3 — Vedic Mathematics** | Demonstrate application of one Vedic sutra (e.g., multiply 97×98 using Nikhilam; or compute 23×34 using Urdhva-Tiryagbhyam); explain the computational principle behind it | CO3 | S/U |
| **Unit 4 — Rasashastra** | Define Bhasma and explain the Shodhana process; name two classical Rasashastra texts; connect one Rasashastra process to a modern material science concept | CO4 | S/U |
| **Unit 5 — Contemporary Relevance** | Give two examples of IKS contributions to mathematics or astronomy; explain how one IKS domain addresses SDG 3 or SDG 4; articulate your personal reflection on the value of IKS | CO5, CO6 | S/U |

## 9. CO-wise Assessment Summary (Audit Course)

ॐ In an audit course, all COs are assessed holistically through the three mandatory criteria. The table below shows the primary CO coverage per activity for pedagogical clarity — not for marks allocation.

| CO | CO Statement (Short) | Attendance (A) | SL Activities (B) | Viva-Voce (C) | S/U Grade | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Identify and explain the meaning, nature, and scope of IKS including Indic terminologies | ✓ | ✓ | — | S/U | PO3, PO6, PO11 |
| CO2 | Explain key components of ancient Indian literature — Vedas, Buddhism, Jainism | ✓ | ✓ | ✓ | S/U | PO3, PO4, PO6 |
| CO3 | Apply Vedic Mathematics sutras and connect IKS to modern analytical contexts | ✓ | ✓ | ✓ | S/U | PO1, PO2, PO3 |
| CO4 | Analyze Rasashastra — processes, substances, and classical texts with modern parallels | ✓ | ✓ | ✓ | S/U | PO4, PO5, PO6 |
| CO5 | Evaluate IKS contributions to science, technology, and astronomy; assess loss and renewal | ✓ | ✓ | ✓ | S/U | PO4, PO5, PO8 |
| CO6 | Develop appreciation for IKS and recontextualize it for contemporary global challenges | ✓ | ✓ | ✓ | S/U | PO6, PO7, PO11 |

**PART III COMBINED MAPPINGS & REFERENCE** CO–PO Matrix (11 POs), CO–PO Alignment, SDG Mapping, Self-Learning, Bloom's Reference & Attendance

## 10. CO–PO and CO–PSO Mapping Matrix (AICTE 11-PO Framework)

ℹ Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. 11-PO AICTE framework. Averages computed over non-zero entries. PSO1–PSO3 are programme-specific outcomes for B.Tech CSE / CSE-AIML.

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | **3** | 1 | 2 | 1 | 2 | 2 | 1 | 2 | **3** | 1 | **3** | 2 |
| CO2 | 1 | **3** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | **3** | **3** | 1 | 1 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | **3** | **3** | 1 | 1 |
| CO4 | 2 | 1 | 1 | 1 | 2 | **3** | **3** | 1 | 1 | 2 | 2 | 2 | 1 | **3** |
| CO5 | 1 | **3** | **3** | 2 | 2 | 1 | **3** | 2 | 2 | **3** | **3** | 2 | 1 | 2 |
| CO6 | 1 | 2 | 2 | 1 | 1 | 2 | **3** | 2 | **3** | **3** | **3** | 2 | 2 | 1 |
| **Avg** | **1.50** | **2.17** | **2.17** | **1.33** | **1.83** | **1.67** | **2.17** | **1.83** | **1.83** | **2.50** | **2.83** | **1.83** | **1.50** | **1.83** |

★ PO7 (Environment & Sustainability) and PO11 (Lifelong Learning) receive the highest average mapping — reflecting IKS themes of ecological ethics and perpetual knowledge pursuit. PO6 (Engineer & Society) is strongly addressed through Units 4 and 5.

## 11. CO × PO Alignment Map (H/M Indicators — All 6 COs × 11 POs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | M | **H** | M | M | M | M | M | M | M | **H** | M | **H** | M |
| CO2 | M | **H** | M | M | M | M | M | M | M | **H** | **H** | M | M | M |
| CO3 | M | M | M | M | M | M | M | M | M | M | **H** | **H** | M | M |
| CO4 | M | M | M | M | M | **H** | **H** | M | M | M | M | M | M | **H** |
| CO5 | M | **H** | **H** | M | M | M | **H** | M | M | **H** | **H** | M | M | M |
| CO6 | M | M | M | M | M | M | **H** | M | **H** | **H** | **H** | M | M | M |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 12. Course-to-SDG Mapping (Sustainable Development Goals)

SDG 3 (Good Health & Well-Being) and SDG 4 (Quality Education) are the primary SDG alignments explicitly identified in the source syllabus. Additional SDGs are addressed through course content.

| SDG Goal | Description | Alignment | How This Course Addresses It |
|---|---|---|---|
| **SDG 3** | **Good Health & Well-Being** | **Primary (High)** | Units 4 and 5 directly address traditional Indian approaches to health: Rasashastra (ancient pharmacy), Ayurveda principles, yoga, and preventive lifestyle wisdom. Students learn how IKS knowledge systems contribute to holistic well-being — connecting CO4 (Rasashastra analysis) and CO6 (recontextualising for modern times). (CO4, CO5, CO6) |

| | | | |
|---|---|---|---|
| **SDG 4** | **Quality Education** | **Primary (High)** | The entire course is a quality education initiative per AICTE mandate, introducing Indian epistemological traditions to engineering students. Units 1 and 2 explore ancient Indian educational systems (Gurukul, oral tradition, Guru-Shishya parampara). Unit 5 connects IKS pedagogy to modern education reform. (CO1, CO2, CO5, CO6) |
| **SDG 10** | **Reduced Inequalities** | Secondary (Moderate) | Unit 1 covers community and indigenous knowledge — recognising the knowledge contributions of historically marginalised communities. Unit 2 addresses Jain and Buddhist philosophical traditions of equality (Ahimsa, universal compassion). (CO1, CO2) |
| **SDG 13** | **Climate Action** | Secondary (Moderate) | Unit 5 explores Indian philosophical frameworks for ecological responsibility — Dharma-based environmental ethics, traditional water management, and sustainable agriculture rooted in IKS. (CO5, CO6) |
| **SDG 16** | **Peace, Justice & Strong Institutions** | Slight (Low) | Buddhist and Jain ethical frameworks (Unit 2) and IKS values of harmony, debate (Vaad-Vivad tradition), and non-violence provide philosophical grounding for peaceful coexistence and just institutions. (CO2, CO6) |

## 13. Self-Learning Activities (SL: 30 Hours — Mandatory for S Grade)

⚠ All SL activities are MANDATORY. Non-submission of any activity results in U (Unsatisfactory) grade regardless of attendance. These are not graded numerically — they are assessed as Complete (C) or Incomplete (I) for S/U determination.

| S.No | Activity | Hours | COs | Submission |
|---|---|---|---|---|
| **A. Unit-wise Reflective Journal Entries (5 entries — one per unit, 4 hrs each = 20 hrs total)** | | | | |
| **A1** | Unit 1 Reflection — IKS Foundation: In 400–500 words, reflect on what 'knowledge' meant in ancient India versus what it means to you as an engineering student today. Identify one Indic terminology (jñāna, vijñāna, vidyā, or darśana) and explain how it applies to your own learning experience at Sharda University | 4 hrs | CO1 | Written journal entry (handwritten or typed) — submitted to course instructor |
| **A2** | Unit 2 Reflection — Ancient Literature: Choose one tradition studied (Vedas, Buddhism, or Jainism) and write a 400–500 word comparative note exploring one principle from that tradition and its relevance to your daily life or professional ethics as a future engineer | 4 hrs | CO2 | Written journal entry — submitted to course instructor with personal perspective clearly expressed |
| **A3** | Unit 3 Application — Vedic Mathematics: Solve 10 numerical problems using at least 2 different Vedic sutras (minimum: 5 problems with Urdhva-Tiryagbhyam and 5 with Nikhilam or Ekadhikena Purvena); write a 200-word note comparing your experience with Vedic methods vs. conventional arithmetic | 4 hrs | CO3 | Problem-solving worksheet + written comparison note — submitted to course instructor |
| **A4** | Unit 4 Exploration — Rasashastra: Read about one Bhasma preparation (e.g., Swarna Bhasma or Tamra Bhasma) from a traditional or modern Ayurvedic source. Write a 400-word note connecting the classical Shodhana-Marana-Bhasma process to modern pharmaceutical or materials science concepts (nano-particles, bioavailability, purity standards) | 4 hrs | CO4 | Written exploration note with source citation — submitted to course instructor |
| **A5** | Unit 5 Synthesis — IKS in My Domain: Identify one area of your branch (CSE or CSE-AIML) where IKS concepts, methods, or values can contribute. Write a 500-word personal reflection or poster on the intersection of your technical domain and an IKS tradition (e.g., Sanskrit grammar and formal language theory, Vedic algorithms and computer science, Ayurveda and health data analytics) | 4 hrs | CO5, CO6 | Written personal reflection or poster (A3 size) — submitted and briefly presented in class (3–4 min) |

| B. IKS Literature / Resource Exploration Report (1 report = 10 hrs total) | | | | |
|---|---|---|---|---|
| **B1** | Explore one resource — either a chapter from a recommended textbook, a peer-reviewed article on IKS, an NPTEL IKS lecture series module, or a documentary/film on Indian classical knowledge (e.g., on Aryabhata, Nagarjuna, or the Iron Pillar). Write a 600-word structured report: what you explored, key ideas learned, critical perspective, and personal reflection on what this adds to your engineering education | Resource study: 5 hrs Report writing: 5 hrs Total = 10 hrs | CO2–CO5 | Structured report (typed, 600 words min.) with resource citation — submitted to course instructor by Week 13 |
| | **TOTAL Self-Learning Hours** | **A: 20 hrs + B: 10 hrs = 30 hours** | CO1–CO6 | All 6 activities (A1–A5, B1) are mandatory for S grade. Late submissions accepted up to 1 week before viva-voce date. |

## 14. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts L2 — Understand: Explain ideas, concepts, and principles L3 — Apply: Use knowledge to solve problems in new situations L4 — Analyze: Break down information, examine relationships L5 — Evaluate: Judge, justify, assess, and make decisions L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend A2 — Responding: Active participation and reaction A3 — Valuing: Commitment and assigning value to content A4 — Organizing: Integrating values into a personal system A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity P2 — Set: Mental, physical readiness to act P3 — Guided Response: Practice through imitation/trial P4 — Mechanism: Habitual correct performance P5 — Complex Overt Response: Skilled performance P6 — Adaptation: Modify skills for special situations P7 — Origination: Create new solution patterns |

★ OBE Compliance Statement: All 6 COs span Cognitive domain (L1–L6). Affective domain (A2–A4) is prominent — engagement, appreciation, and valuing are central outcomes for a Value Added Course in IKS. Psychomotor domain (P3) appears for CO3 (mental application of Vedic sutras) and CO6 (creative synthesis). This reflects the unique pedagogical character of an IKS audit course, which prioritises cultural engagement, reflective learning, and lifelong appreciation alongside cognitive understanding.

## 15. Attendance Policy & S / U Determination Criteria

### 15.1 Attendance Policy

| Component | Minimum Required | Applicable To | Consequence |
|---|---|---|---|
| **Theory / Lecture Sessions** | **≥ 75% (min. 23 of 30 sessions)** | All B.Tech CSE & CSE-AIML students enrolled in Semester III | Attendance < 75% → U (Unsatisfactory) grade regardless of SL and Viva completion |
| **Self-Learning Submissions** | **All 6 activities (A1–A5, B1)** | All enrolled students | Missing any 2 or more activities → U grade; 1 late submission accepted with penalty (noted on record) |

⚠ Both conditions — attendance AND all SL submissions — must be satisfied for S grade. A student who attends all 30 lectures but submits no reflective journals will receive U grade. This course is mandatory; U grade results in required re-enrolment in a subsequent offering.

### 15.2 S / U Determination Summary

| Condition | Grade | Remarks |
|---|---|---|
| **Attendance ≥ 75% AND All SL Activities submitted AND Viva-Voce participated** | **S** | Satisfactory — course requirement fulfilled. No credit awarded. No SGPA/CGPA impact. |
| **Attendance < 75% OR Any mandatory SL activity missing OR Viva-Voce absent** | **U** | Unsatisfactory — student must re-enrol. No numeric marks exist to compensate. No supplementary exam available. |
| **Medical/Emergency exemption for attendance < 75%** | **I → S** | Incomplete → Satisfactory granted only on approved medical certificate, Dean's recommendation, and completion of all SL activities by next semester. Decision at institutional discretion. |

## 16. PO Description Reference (AICTE 11-PO Framework)

| PO | Programme Outcome | PO | Programme Outcome |
|---|---|---|---|
| **PO1** | Engineering Knowledge: apply mathematical, scientific, and engineering fundamentals | **PO7** | Environment & Sustainability: understand and address societal and environmental impact |
| **PO2** | Problem Analysis: identify and analyze complex engineering problems | **PO8** | Ethics: apply ethical principles in professional engineering practice |
| **PO3** | Design/Development: design systems or processes meeting specified needs | **PO9** | Individual & Team Work: function effectively as individual and in diverse teams |
| **PO4** | Investigation: conduct research including data analysis and interpretation | **PO10** | Communication: communicate effectively on complex engineering activities |
| **PO5** | Modern Tool Usage: use modern engineering tools and IT for complex activities | **PO11** | Project Management & Finance / Lifelong Learning: apply knowledge for lifelong personal development |
| **PO6** | Engineer & Society: apply contextual knowledge to assess societal, health, safety, legal & cultural issues | **PSO1–3** | Programme-Specific Outcomes — defined by the institution for B.Tech CSE & CSE-AIML |

**Fundamentals of Indian Knowledge System (IKT1001) VAC — AUDIT COURSE SUMMARY (Zero Credit | B.Tech CSE, CSE-AIML & CS-ME | Semester I / II)**

Course: Fundamentals of Indian Knowledge System | L-T-P: 2-0-0 | Contact Hours: 30 | SL: 30 hrs | Total: 60 hrs
6 COs (CO1–CO6) | AICTE 11-PO Framework | SDG 3 (Good Health) & SDG 4 (Quality Education)

**Assessment: S (Satisfactory) / U (Unsatisfactory) — NO NUMERIC MARKS — NO SGPA/CGPA IMPACT**

**S Grade = Attendance ≥ 75% + All SL Activities (A1–A5, B1) Submitted + Viva-Voce Participated**

| Semester 3, Credits: 22 | |
|---|---|
| **COURSE CODE** | **COURSE NAME** |
| CSCR2510 | Computer Network |
| CSCR2111 | Discrete Structures |
| CSCR2512 | Principles of Operating System |
| CSCF2200 | Concepts of Machine Learning |
| SKP2301 | Skills & Informatics-1: Professional Skills, Data Structures & Web Technologies |
| CSCR2600 | Project Based Learning (PBL) -1 (Mini-Hackathon Based) |
| CSCR2511 | Data Structures |

# COURSE PLAN

## Computer Networks (CSCR2510)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE | Semester IV | Batch 2026 onwards*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I**

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | III |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSCR2510** |
| 2 | **Course Title** | **Computer Networks** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-4-2 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | To provide students with a strong foundation in computer networking concepts, reference models, transmission techniques, routing, and network protocols, along with practical exposure to network design, simulation, and troubleshooting for real-world networking applications. |

| | | |
|---|---|---|
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Understand – L2): Demonstrate networking fundamentals and differentiate the working of OSI and TCP/IP models.<br>CO2 (Analyze – L4): Investigate error control, flow control, and MAC protocols for reliable communication.<br>CO3 (Apply – L3): Apply IP addressing, subnetting, routing, and congestion control techniques.<br>CO4 (Analyze – L4): Examine transport layer services, TCP/UDP protocols, and congestion control mechanisms.<br>CO5 (Understand – L2): Describe connection management and application layer protocols.<br>CO6 (Understand – L2): Outline the basic concepts and applications of cryptography and network security.<br><br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Configure and troubleshoot network utilities and commands.<br>CO8 (Analyze – L4): Implement error detection, routing and congestion control algorithms.<br>CO9 (Apply – L3): Simulate and evaluate network topologies using Packet Tracer and networking tools.<br>CO10 (Evaluate/Create – L5/L6): Implement cryptographic algorithms or Develop secure networking applications. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 60 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | • Practice IP addressing, subnetting, routing, and protocol-based numerical problems.<br>• Perform Computer Networks Virtual Labs (NPTEL/Virtual Labs) on routing, CRC, flow control, and network simulation.<br>• Complete a MOOC/NPTEL/SWAYAM course on Computer Networks and network security fundamentals. |
| 11 | **References** | **Text Book**<br>Tanenbaum, A. S. — Computer Networks (4th Edition), PHI.<br>**Reference Books**<br>Forouzan, B. A. — Data Communications and Networking, TMH, Latest Edition.<br>Stallings, W. — Data and Computer Communication, Macmillan Press. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction** | |
| A | Introduction to Computer Networks, applications, network classification, network topologies, communication modes, and geographical distribution of networks. | CO1, CO2 |
| B | OSI and TCP/IP reference models, functions of each layer, and networking devices: Hub, Repeater, Switch, Bridge, Router, and Gateway. | CO1, CO2 |
| C | Transmission Media: Wired and Wireless media, bandwidth concepts, and multiplexing techniques — FDM and TDM. | CO1, CO2 |
| **Tools Used** | Cisco Packet Tracer, Whiteboards, Virtual Labs, Networking Utilities (PING, IPCONFIG, TRACERT, NETSTAT) | |
| **Activities** | Objective: To understand networking fundamentals, reference models, networking devices, and transmission techniques.<br>• Study of Computer Network Fundamentals.<br>• Comparison of OSI and TCP/IP models.<br>Demonstration of Networking Devices-<br>• Hub, Switch, Bridge, Router, Gateway and Repeater<br>• Working and applications of networking devices<br>Practical exposure using networking tools-<br>• Basic networking commands: PING, IPCONFIG, TRACERT, NETSTAT<br>• Network simulation using Cisco Packet Tracer and Virtual Labs | |
| **Unit 2** | **Data Link Layer** | |
| A | Functions of Data Link Layer, Framing, Error Detection and Error Correction techniques: Parity Bit, CRC, and Hamming Code. | CO1, CO2 |
| B | Flow Control Protocols: Stop-and-Wait, Sliding Window, Go-Back-N, and Selective Repeat ARQ. | CO1, CO2 |
| C | MAC- Sub-layer Protocols: ALOHA, CSMA, CSMA/CD protocols, and IEEE Standards 802.3, 802.4,802.5 | CO1, CO2 |
| **Tools Used** | Cisco Packet Tracer, GCC Compiler/C Programming Environment, Wireshark, Virtual Labs, Whiteboards, Networking Utilities. | |
| **Activities** | Objective: To understand framing, error control, flow control, and MAC protocols used in reliable data communication.<br>• Implementation of error detection and correction methods: Parity, CRC, and Hamming Code.<br>• Demonstration of Stop-and-Wait and Sliding Window protocols.<br>• Analysis of MAC protocols: ALOHA, CSMA, and CSMA/CD.<br>• Simulation of flow control and MAC protocols using Cisco Packet Tracer and Virtual Labs. | |
| **Unit 3** | **Network Layer** | |

| | | |
|---|---|---|
| **A** | Functions of Network Layer, Network Layer Protocols: IP, ICMP, ARP, RARP, and IGMP; Types of Routing Algorithms. | CO1, CO3 |
| **B** | IPv4 Addressing, IP Header Format, CIDR, Subnet Mask, Subnetting. | |
| **C** | Congestion Control Techniques: Leaky Bucket and Token Bucket Algorithms. | |
| **Tools Used** | Cisco Packet Tracer, GCC Compiler/C Programming Environment, Virtual Labs, Whiteboards, Networking Utilities. | |
| **Activities** | **Objective**: To understand network layer protocols, IP addressing, subnetting, routing algorithms, and congestion control techniques.<br>• Practice on IPv4 addressing, subnetting, CIDR, and subnet mask calculations.<br>• Analysis of routing algorithms and routing table concepts.<br>• Implementation of subnetting and routing-based numerical problems.<br>• Network layer simulation using Cisco Packet Tracer and Virtual Labs. | |
| **Unit 4** | **Transport Layer** | |
| A | Need of transport layer & its services, Quality of Service, connection oriented and connection less communication | CO1, CO4, CO5 |
| B | Transmission Control Protocol (TCP): Segment Structure, Header Format, Connection Management, and Flow Control. | |
| C | TCP congestion control, Internet Congestion Control Algorithm, Overview of User Datagram Protocol (UDP) | |
| **Tools Used** | Wireshark, Cisco Packet Tracer, Virtual Labs, GCC Compiler/C Programming Environment, Whiteboards, Networking Utilities. | |
| **Activities** | **Objective:** To understand transport layer services, TCP/UDP protocols, connection management, flow control, and congestion control mechanisms.<br>• Comparison of connection-oriented and connectionless communication.<br>• Analysis of TCP segment structure and header fields.<br>• Demonstration of TCP connection establishment and termination.<br>• Comparison of TCP and UDP protocols using Wireshark and Packet Tracer simulations. | |
| **Unit 5** | **Application Layer** | |
| A | Domain Name System (DNS), HTTP, FTP, SMTP | CO1,CO5,CO6 |
| B | Network Security services, cryptography, Symmetric versus Asymmetric cryptographic algorithms- DES, and RSA | |
| C | Application of Security in Networks: Digital signature | |

| | | |
|---|---|---|
| **Tools Used** | Wireshark, Cisco Packet Tracer, GCC Compiler/C Programming Environment, OpenSSL Tools, Virtual Labs, Web Browsers. | |
| **Activities** | **Objective**: To understand application layer protocols, cryptography concepts, and network security mechanisms.<br>• Analysis of client-server communication using networking tools.<br>• Demonstration of DNS lookup and HTTP request-response process.<br>• Implementation of basic cryptographic algorithms: DES and RSA. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | ✓ | ✓ | | | |
| 7 | 3.A | | ✓ | ✓ | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | ✓ | ✓ | | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | | |
| 13 | 5.A | | ✓ | ✓ | | | |
| 14 | 5.B | | | | ✓ | ✓ | ✓ |
| 15 | 5.C | | | | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

*Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | Affective (A1–A5) | Psychomotor (P1–P7) |
|---|---|---|---|

| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | ✓ | | | | | ✓ | | | | | | | | | | | |
| CO2 | | | | ✓ | | | ✓ | ✓ | | | | | | | | | | |
| CO3 | | | ✓ | | | | | ✓ | ✓ | | | | | ✓ | ✓ | | | |
| CO4 | | | | ✓ | | | | ✓ | ✓ | | | | | ✓ | ✓ | | | |
| CO5 | | ✓ | | | | | ✓ | ✓ | | | | | | | | | | |
| CO6 | | ✓ | | | | | ✓ | ✓ | ✓ | | | | | | | | | |
| CO7 | | | ✓ | | | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | |
| CO8 | | | | ✓ | | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | |
| CO9 | | | ✓ | | ✓ | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | |
| CO10 | | | | | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Computer Networks, applications, network classification, communication modes and geographical distribution of networks | Unit 1 | 6 |
| DD/MM/YY | Network topologies and types of computer networks | | |
| DD/MM/YY | OSI reference model and functions of each layer | | |
| DD/MM/YY | TCP/IP reference model and comparison with OSI model | | |
| DD/MM/YY | Networking devices: Hub, Repeater, Switch, Bridge | | |
| DD/MM/YY | Router, Gateway, transmission media, bandwidth, FDM and TDM | | |
| DD/MM/YY | Functions of Data Link Layer, framing concepts | Unit 2 | 6 |
| DD/MM/YY | Error Detection and Correction: Parity Bit, CRC | | |
| DD/MM/YY | Hamming Code and error correction techniques | | |
| DD/MM/YY | Flow Control Protocols: Stop-and-Wait and Sliding Window | | |
| DD/MM/YY | Go-Back-N and Selective Repeat ARQ | | |
| DD/MM/YY | MAC protocols: ALOHA, CSMA, CSMA/CD and IEEE standards 802.3, 802.4, 802.5 | | |
| DD/MM/YY | Functions of Network Layer and Network Layer Protocols: IP, ICMP | Unit 3 | 6 |
| DD/MM/YY | ARP, RARP, IGMP and routing algorithms | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | IPv4 Addressing and IP Header Format | | |
| DD/MM/YY | CIDR, subnet mask and subnetting techniques | | |
| DD/MM/YY | Numerical problems on subnetting and routing concepts | | |
| DD/MM/YY | Congestion Control Techniques: Leaky Bucket and Token Bucket Algorithms | | |
| DD/MM/YY | Need of Transport Layer and transport layer services | Unit 4 | 6 |
| DD/MM/YY | Quality of Service, connection oriented and connectionless communication | | |
| DD/MM/YY | TCP: Segment Structure and Header Format | | |
| DD/MM/YY | TCP Connection Management and Flow Control | | |
| DD/MM/YY | TCP Congestion Control and Internet Congestion Control Algorithms | | |
| DD/MM/YY | UDP overview and comparison between TCP and UDP | | |
| DD/MM/YY | Domain Name System (DNS) and HTTP Protocol | Unit 5 | 6 |
| DD/MM/YY | FTP and SMTP protocols | | |
| DD/MM/YY | Network Security services and cryptography concepts | | |
| DD/MM/YY | Symmetric and Asymmetric cryptographic algorithms: DES and RSA | | |
| DD/MM/YY | Digital Signature and applications of security in networks | | |
| DD/MM/YY | Revision, problem solving and case study discussion | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Study of Data Communication and Networking fundamentals; identification of five components of data communication system | CO7 | 3.0 |
| | S-1.2 | Study of OSI reference model and TCP/IP model using networking diagrams and simulations | CO7 | |
| W2 | S-2.1 | Practice of networking utilities: IPCONFIG, PING, TRACERT and NETSTAT commands | CO7 | 3.0 |
| | S-2.2 | Configure basic peer-to-peer network and troubleshoot connectivity issues | CO7 | |
| W3 | S-3.1 | Study and simulation of computer network topologies using Cisco Packet Tracer | CO7 | 3.0 |
| | S-3.2 | Demonstration and configuration of networking devices: Hub, Switch, Bridge, Router and Gateway | CO7 | |
| W4 | S-4.1 | Implement Character Stuffing and De-stuffing using C programming | CO7 | 3.0 |
| | S-4.2 | Implement Error Detection using Cyclic Redundancy Check (CRC) algorithm | CO7 | |
| W5 | S-5.1 | Implement Hamming Code generation and error correction technique | CO7 | 3.0 |
| | S-5.2 | Simulation of framing and error detection techniques using Virtual Labs | CO7 | |

| | | | | |
|---|---|---|---|---|
| W6 | S-6.1 | Demonstration of Stop-and-Wait protocol using networking simulation tools | CO7 | 3.0 |
| | S-6.2 | Simulation of Sliding Window protocol and flow control mechanisms | CO7 | |
| W7 | S-7.1 | Simulation and analysis of ALOHA and CSMA protocols | CO7 | 3.0 |
| | S-7.2 | Simulation of CSMA/CD and IEEE 802.3 LAN protocol using Packet Tracer | CO7 | |
| W8 | S-8.1 | Write a C program to identify IP address classes (Class A, B, C, D and E) | CO7 | 3.0 |
| | S-8.2 | Write a C program to convert dotted decimal IP address into 32-bit binary format | CO7 | |
| W9 | S-9.1 | Practice IPv4 addressing, subnetting and subnet mask calculations | CO7 | 3.0 |
| | S-9.2 | Configure routing tables and analyze routing algorithms using Packet Tracer | CO7 | |
| W10 | S-10.1 | Implement congestion control using Leaky Bucket algorithm | CO7 | 3.0 |
| | S-10.2 | Implement Token Bucket algorithm and compare congestion control techniques | CO7 | |
| W11 | S-11.1 | Analyze TCP and UDP packets using Wireshark | CO7 | 3.0 |
| | S-11.2 | Demonstration of TCP connection establishment, termination and flow control | CO7 | |
| W12 | S-12.1 | Create and simulate network topology using Cisco Packet Tracer | CO7 | 3.0 |
| | S-12.2 | Configure client-server communication and DNS lookup process using networking tools | CO7 | |
| W13 | S-13.1 | Implement Distance Vector Routing algorithm with real-world routing analysis | CO8 | 3.0 |
| | S-13.2 | Case study and performance analysis of routing and congestion control techniques in real networks | CO8 | |
| W14 | S-14.1 | Implement DES encryption algorithm; analyze security applications and submit reflection report | CO8/CO9 | 3.0 |
| | S-14.2 | Team-based implementation of RSA algorithm with peer review and collaborative presentation | CO8/CO10 | |
| W15 | S-15.1 | Develop secure client-server communication application with ethical networking practices and self-assessment | CO8/CO9 | 3.0 |
| | S-15.2 | Open-ended mini project using Packet Tracer/cryptographic tools; final demonstration, teamwork evaluation and presentation | CO9/CO10 | |

ℹ *Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

**THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Basic Networking Concepts & Terminology | Recall basic networking concepts, OSI/TCP-IP models, networking devices, transmission media, and protocol names | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| TS2 | Understanding of Data Communication & Protocols | Explain framing, error control, flow control, MAC protocols, and the working of networking layers and protocols | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| TS3 | IP Addressing & Routing Problem Solving | Apply IPv4 addressing, subnetting, CIDR, routing concepts, and congestion control techniques to solve numerical and networking problems | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| TS4 | Analysis of Transport Layer Mechanisms | Analyze TCP/UDP protocols, connection management, flow control, and congestion control mechanisms in computer networks | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| TS5 | Understanding of Application Layer & Security Concepts | Explain DNS, HTTP, FTP, SMTP, cryptography concepts, and compare different security mechanisms and protocols | CO5 \| L2–L5 | ETE Sec B/C |
| TS6 | Secure Networking & Protocol Design Understanding | Understand the use of cryptographic algorithms, digital signatures, and secure communication techniques in computer networks | CO6 \| L2–L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO3 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | **6** | TS1 — Basic Networking Concepts & Terminology<br>TS2 — Understanding of Data Communication & Protocols | CO1, CO2 | Short-answer questions: definitions, protocol functions, networking concepts, OSI/TCP-IP layers, device identification |
| Sec B | **4** | TS3 — IP Addressing & Routing Problem Solving | CO3 | Numerical problems, subnetting, IP addressing, routing concepts, CRC/congestion control based analytical questions |
| TOTAL | 10 | TS1–TS3 | CO1–CO3 | Units 1–3 covered; CO4, CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Sec A | 25 | TS1 — Basic Networking Concepts & Terminology<br>TS2 — Understanding of Data Communication & Protocols | CO1, CO2 | Short questions: networking fundamentals, OSI vs TCP/IP models, transmission media, networking devices, framing, error control, flow control, MAC protocols and protocol-based conceptual questions |
| Sec B | 50 | TS3 — IP Addressing & Routing Problem Solving<br>TS4 — Analysis of Transport Layer Mechanisms | CO3, CO4 | Medium questions: IP addressing, subnetting, routing algorithms, congestion control numericals, TCP/UDP analysis, transport layer services, flow control and protocol analysis questions |
| Sec C | 25 | TS5 — Understanding of Application Layer & Security Concepts<br>TS6 — Secure Networking & Protocol Design Understanding | CO5, CO6 | Long-answer/design questions: connection management, DNS, HTTP, FTP, SMTP, cryptography concepts, DES/RSA comparison, digital signatures and network security applications |
| TOTAL | 100 | TS1–TS6 (all) | CO1–CO6 | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| Lab Experiments (CA) | Best 10 of 12 | 30 | 3.0 marks each — assesses CO7, CO8 and CO9 through implementation, simulation, troubleshooting and documentation |

| | | | |
|---|---|---|---|
| Mini Project | 1 Project | 10 | Network design/simulation or secure networking application using Cisco Packet Tracer / cryptographic tools — assesses all Lab COs (CO7–CO10) through design, implementation, demonstration and presentation |
| **TOTAL** | — | **40** | Laboratory Assessment only |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Understanding & Network Configuration** | 1.0 | CA1 — Understanding of networking problem and objectives CA2 — Network/tool configuration and setup CA7 — Planning of solution, topology, algorithm or protocol implementation | 1.0: Proper understanding and correct setup \| 0.5: Partial understanding/setup \| 0: Incorrect or missing | CO7, CO8 |
| **Implementation, Simulation & Execution** | 1.0 | CA3 — Correct execution of program/simulation/network configuration CA4 — Efficient implementation and troubleshooting using networking tools | 1.0: Correct execution with proper results \| 0.5: Partially correct execution \| 0: Failed execution | CO7 |
| **Result Analysis & Lab Documentation** | 0.75 | CA5 — Analysis and interpretation of outputs/results CA6 — Proper documentation and verification of results CA8 — Lab record completion and viva understanding | 0.75: Complete analysis and documentation \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Conduct & Ethical Practices** | 0.25 | CO9 — Responsible use of networking tools and documentation ethics PO7 — Professional behaviour and ethical laboratory practices | 0.25: Consistent and professional \| 0.10: Occasional compliance \| 0: Absent | CO9 |
| **Total** | **3.0** | **All 8 CA skill dimensions covered** | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | 30 Marks | x lowest experiment scores are dropped |
| **10** | All 10 | 30 Marks | No score dropped |
| **< 10** | All Conducted | ≤ 30 Marks | Missing experiments treated as zero (deficit = zero) |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | 1.5 | P1 — SDG mapping and societal relevance of networking/security application P2 — Network requirements, objectives and problem scope P4 — Suitable networking/security solution with possible alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO10 / PO3, PO6 |

| | | | | |
|---|---|---|---|---|
| **Project Planning & Resource Utilization** | 1.5 | P2 — Timeline, milestones and implementation planning P11 — Effective use of networking tools, simulation software and lab resources | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Testing** | 2.0 | P5 — Appropriate networking/security tool selection P6 — Complete implementation and integration of routing, congestion control or security mechanisms P7 — Testing, troubleshooting and verification of outputs | 2: Fully functional \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Result Analysis & Technical Documentation** | 2.0 | P8 — Analysis of outputs/results against objectives P9 — Comparative analysis, screenshots/logs and technical report preparation | 2: Thorough \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO4, PO6 |
| **Communication, Presentation & Teamwork** | 2.0 | P3 — Demonstration planning and communication strategy P10 — Professional presentation, viva performance and teamwork | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Conduct** | 1.0 | P12 — Reflection on learning and skill development P13 — Ethical practices, responsible tool usage and professional conduct | 1.0: Reflective & professional \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | **All 13 Project Skill Dimensions; all 4 Lab COs (CO7–CO10)** | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| **CA1** | Network Problem Understanding & Configuration Planning | Understand the networking/security problem; identify required utilities, protocols, topology requirements and expected outcomes | CO7, CO8 |
| **CA2** | Experimental Design & Tool Configuration | Plan experiments and configure networking/simulation tools such as Cisco Packet Tracer, Wireshark, GCC, OpenSSL and Virtual Labs | CO7, CO9 |
| **CA3** | Implementation, Configuration & Execution | Correctly configure network utilities, implement algorithms/programs and execute simulations to obtain expected outputs | CO7, CO8 |
| **CA4** | Troubleshooting, Testing & Performance Analysis | Troubleshoot configuration/execution errors; analyze routing, congestion and protocol performance | CO7, CO8 |
| **CA5** | Output Analysis & Result Interpretation | Analyze outputs, packet flow, routing behaviour, congestion results and security implementation outcomes logically | CO8, CO10 |
| **CA6** | Documentation & Result Verification | Maintain proper lab records, screenshots/logs and verify outputs against experiment objectives | CO7, CO8, CO9 |
| **CA7** | Algorithm, Security & Topology Design | Develop routing logic, congestion control flow, cryptographic implementation or network topology design before execution; justify approach | CO8, CO9, CO10 |
| **CA8** | Lab Record Maintenance, Viva & Professional Practice | Maintain complete lab records and demonstrate conceptual understanding, simulation knowledge and professional conduct during viva | CO7, CO9, CO10 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| **P1** | SDG Alignment & Social Relevance | Relate the networking/security project to societal needs, secure communication, smart systems or digital connectivity applications | CO10 \| PO6 |
| **P2** | Problem Scoping & Network Requirements | Define project scope, network requirements, topology needs and measurable objectives clearly | CO8 \| PO2 |
| **P3** | Communication & Testing Strategy | Plan team communication, testing procedures, experiment validation and task coordination | CO10 \| PO9 |
| **P4** | Networking/Security Solution Design | Propose suitable routing, congestion control, topology or security solution with alternatives and justification | CO8 \| PO3 |
| **P5** | Professional Toolchain & Resource Usage | Select and use appropriate networking/simulation/security tools and configure project environment properly | CO7 \| PO5 |
| **P6** | End-to-End Implementation | Develop and integrate complete networking/security solution using multiple syllabus concepts and tools | CO7, CO8 \| PO3 |
| **P7** | System Testing & Troubleshooting | Execute testing, troubleshoot errors and verify correct working of routing, topology or security implementation | CO7, CO8 \| PO5 |
| **P8** | Result Evaluation & Performance Analysis | Evaluate outputs against objectives and analyze routing, congestion or security performance using observations/metrics | CO8 \| PO6 |
| **P9** | Technical Analysis & Documentation | Perform comparative analysis, maintain screenshots/logs and prepare structured technical documentation/report | CO8, CO10 \| PO2, PO4 |
| **P10** | Professional Presentation & Teamwork | Deliver project presentation/demo professionally and demonstrate teamwork and task sharing | CO10 \| PO8, PO9 |
| **P11** | Project Planning & Resource Management | Plan implementation stages, manage available lab/software resources and justify tool utilization | CO10 \| PO10 |
| **P12** | Skill Development & Learning Reflection | Reflect on learning outcomes, networking/security skills gained and individual contribution to the project | CO9 \| PO11 |
| **P13** | Professional Ethics & Responsible Practice | Demonstrate ethical conduct, originality, responsible use of networking/security tools and proper documentation practices | CO9 \| PO7 |

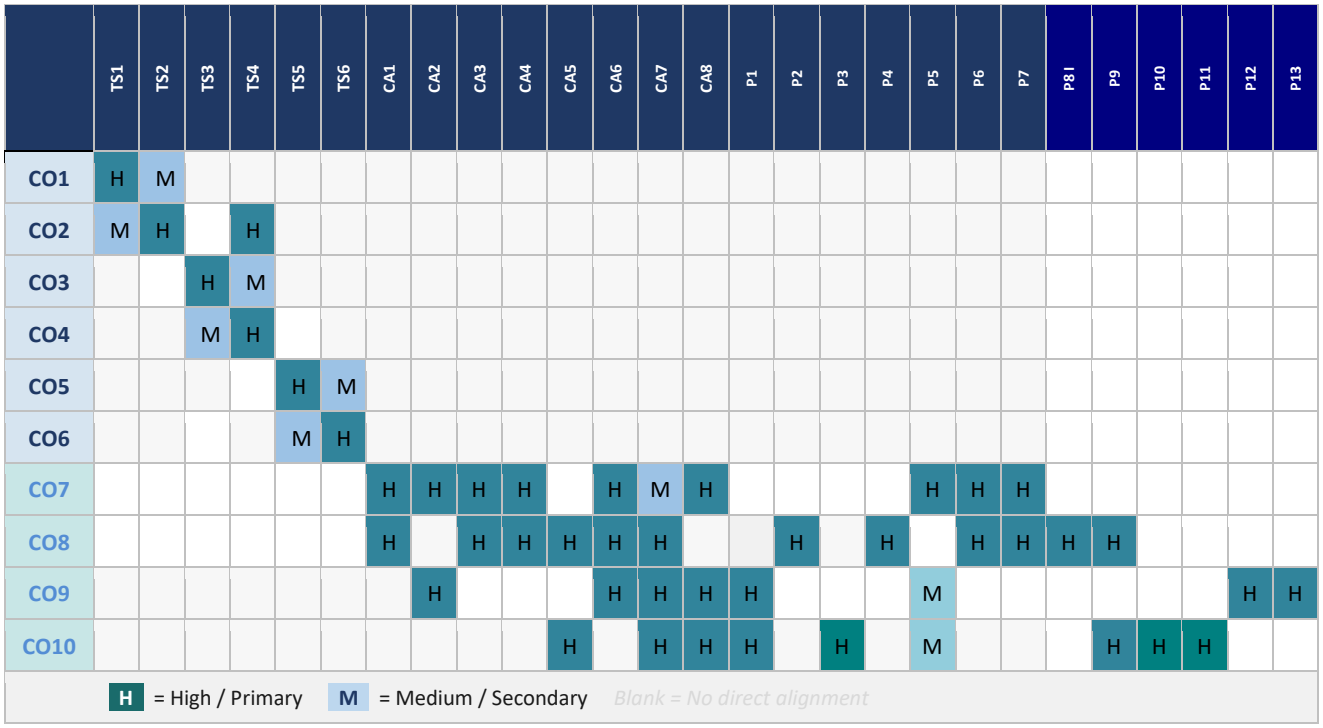
## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | CA Skill Dimensions | Project Skill Dimensions |
|---|---|---|---|



| | TS1 | TS2 | TS3 | TS4 | TS5 | TS6 | CA1 | CA2 | CA3 | CA4 | CA5 | CA6 | CA7 | CA8 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 I | P9 | P10 | P11 | P12 | P13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | | H | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | | | M | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | | | | | H | H | H | H | | H | M | H | | | | | H | H | H | | | | | | |
| CO8 | | | | | | | H | | H | H | H | H | H | | | H | | H | | H | H | H | H | | | | |
| CO9 | | | | | | | | H | | | | H | H | H | H | | | | M | | | | | | | H | H |
| CO10 | | | | | | | | | | | H | | H | H | H | | H | | M | | | | H | H | H | | |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

## PART IV
# COMBINED MAPPINGS & REFERENCE
*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | – | – | 1 | – | – | – | – | – | 1 | 2 | 1 | – |
| CO2 | 3 | 3 | 1 | 2 | 1 | – | – | – | – | – | 1 | 2 | 2 | – |
| CO3 | 3 | 3 | 2 | 2 | 2 | 2 | – | – | – | – | 1 | 3 | 3 | 2 |
| CO4 | 2 | 3 | 2 | 3 | 2 | – | – | – | – | – | 1 | 2 | 3 | 2 |
| CO5 | 2 | 2 | 1 | 1 | 1 | – | – | – | – | – | 1 | 2 | 2 | 1 |
| CO6 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | – | – | 2 | 2 | 2 | 2 |
| CO7 | – | 1 | 2 | 1 | 3 | – | – | – | – | – | – | 2 | 3 | 2 |
| CO8 | – | 2 | 3 | 2 | 2 | 2 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | 1 | 2 | 2 | 3 | 1 | 3 | – | 1 | – | 3 | 2 | 3 | 3 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO10 | - | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 3 |
| Avg | 2.50 | 2.10 | 2.00 | 1.80 | 1.90 | 1.80 | 1.67 | 1.50 | 1.50 | 1.00 | 1.38 | 2.10 | 2.50 | 2.25 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | M | | | | | | M |
| CO2 | H | H | M | M | M | | | | | | M |
| CO3 | H | H | M | M | M | M | | | | | M |
| CO4 | M | H | M | H | M | | | | | | M |
| CO5 | M | M | M | M | M | | | | | | M |
| CO6 | M | M | H | M | H | M | M | | | | H |
| CO7 | | M | M | | H | | | | | | M |
| CO8 | | H | H | M | M | M | | | | | M |
| CO9 | | | M | M | H | M | H | M | M | | H |
| CO10 | | M | H | M | M | M | M | H | H | M | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| **SDG 4** | Quality Education | **3 (High)** | Develops strong understanding of computer networking fundamentals, routing, protocols, simulation and security concepts; supports lifelong learning and technical competency development (CO1–CO6, CO9). |
| **SDG 8** | Decent Work & Economic Growth | **3 (High)** | Builds industry-relevant networking, troubleshooting, simulation and security skills using professional tools such as Cisco Packet Tracer and Wireshark (CO7–CO10). |
| **SDG 9** | Industry, Innovation & Infrastructure | **3 (High)** | Supports development of reliable communication networks, routing solutions, congestion control mechanisms and secure networking applications through practical implementation and simulation activities (CO3, CO8, CO10). |
| **SDG 12** | Responsible Consumption & Production | 2 (Moderate) | Encourages efficient network design, optimized routing/configuration practices, ethical usage of networking resources and responsible handling of security tools and data (CO7, CO9, CO10). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**COMPUTER NETWORKS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO5, PO6, PO9, PO11 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Discrete Structures (CSCR2111)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester III | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE - Sharda School of Computing Science & Engineering | **Batch:** | 2026-30 |
| **Program:** | B. Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | III |
| **Course Code:** | CSCR2111 | **Course Type:** | Core - Theory Only |

## 2. Course Details

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No. | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSCR2111** |
| 2 | **Course Title** | **Discrete Structures** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs Classroom + 45 hrs Self Learning = 90 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | 1. Develop mathematical reasoning and logical thinking required in Computer Science.<br>2. Introduce formal structures such as sets, relations, functions, algebraic structures, lattices, and graphs.<br>3. Enable students to model computational problems using discrete mathematical techniques.<br>4. Build analytical and problem-solving skills for algorithms, data structures, cryptography, AI, and software engineering. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>Course Outcomes — Bloom's Level |

| | | |
|---|---|---|
| | | CO1: Explain principles of sets, relations, and functions used in computational systems. L2<br>CO2: Apply propositional and predicate logic to validate mathematical arguments and proofs L3<br>CO3: Analyze and apply algebraic structures including groups, rings, lattices and POSETs L3<br>CO4: Analyze Boolean Algebra, Recurrence Relations, and Generating Functions in digital systems and algorithmic analysis. L4<br>CO5: Design and analyze trees, graphs, and combinatorial techniques L5-L6<br>CO6: Develop computational models using discrete mathematical concepts L6 |
| 8 | **Course Description** | This course introduces the foundations of discrete mathematics essential for computer science applications including logic, proofs, algebraic structures, Boolean algebra, graph theory, recurrence relations, combinatorics, and trees. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1) *C. L. Liu, Elements of Discrete Mathematics, second edition 1985, McGraw-Hill Book Company. Reprinted 2000.*<br>2) Jean Paul Trembley, R Manohar, "Discrete Mathematical Structures with Application to Computer Science", McGraw-Hill.<br>3) *K. H. Rosen, Discrete Mathematics and applications, fifth edition 2003, Tata McGraw Hill Publishing Company.* |
| 12 | **References** | 1) *J .L. Mott, A. Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists and Mathematicians, second edition 1986, Prentice Hall of India.*<br>2) *W.K. Grassmann and J.P.Trembnlay, Logic and Discrete Mathematics, A Computer Science* |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| Unit | Topic | CO Mapping |
|---|---|---|
| **Unit 1:** | **Set Theory, Relations and Functions** | |
| **A** | Sets, subsets, power sets, Cartesian products, multisets, ordered pairs, set identities | **CO1** |
| **B** | Relations: properties, equivalence relations, partial ordering, composition of relations | **CO1** |
| **C** | Functions: injective, surjective, bijective, recursive functions, applications | **CO1** |
| **Unit 2:** | **Logic and Mathematical Induction** | |

| | | |
|---|---|---|
| **A** | Propositional logic, truth tables, tautologies, contradiction, inference theory | **CO1, CO2** |
| **B** | Predicate logic, quantifiers, well-formed formulas, inference rules | **CO2** |
| **C** | Mathematical induction, strong induction, recursive definitions | **CO2** |
| **Unit 3:** | **Algebraic Structures** | |
| **A** | Groups, subgroups, cyclic groups, cosets, Lagrange's theorem | **CO3** |
| **B** | Rings, fields, homomorphisms, modulo arithmetic | **CO3** |
| **C** | POSET, Hasse diagrams, lattice introduction | **CO3** |
| **Unit 4:** | **Lattices and Boolean Algebra** | |
| **A** | Lattices, complemented lattices, modular lattices, distributive lattices | **CO4** |
| **B** | Boolean algebra, K-Maps, logic gates, combinational and sequential circuits | **CO4** |
| **C** | Recurrence relations, generating functions, recursive algorithms | **CO4** |
| **Unit 5:** | **Graph Theory and Combinatorics** | |
| **A** | Trees, binary trees, tree traversal, spanning trees | **CO4, CO5** |
| **B** | Graphs, graph representation, planar graphs, graph coloring, Euler and Hamiltonian graphs | **CO5** |
| **C** | Counting techniques, permutations, combinations, pigeonhole principle, inclusion–exclusion | **CO5, CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | ✓ | | | |
| 2 | 1.B | ✓ | ✓ | ✓ | | | |
| 3 | 1.C | ✓ | ✓ | ✓ | | | |
| 4 | 2.A | ✓ | ✓ | ✓ | ✓ | | |
| 5 | 2.B | ✓ | ✓ | ✓ | ✓ | | |
| 6 | 2.C | ✓ | ✓ | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | ✓ | ✓ | | |
| 8 | 3.B | ✓ | ✓ | ✓ | ✓ | | |
| 9 | 3.C | ✓ | ✓ | ✓ | ✓ | | |
| 10 | 4.A | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 11 | 4.B | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 12 | 4.C | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 13 | 5.A | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 14 | 5.B | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15 | 5.C | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Cognitive Domain is primary for this theory-oriented mathematical course. Affective Domain appears mainly in higher-order analytical and design-oriented COs (CO4–CO6). Psychomotor Domain is limited to computational implementation, mathematical modeling, and programming-oriented activities (P3–P5).*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | | ✓ | | | | | ✓ | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | ✓ | | | | |
| CO3 | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | |
| CO4 | | | | ✓ | | | | | ✓ | | | | | ✓ | | | | |
| CO5 | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | ✓ | | | |
| CO6 | | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

***Interpretation***

CO1 focuses on conceptual understanding of discrete mathematical foundations → primarily L2.
CO2–CO3 involve application and demonstration of logic/algebraic structures → L3 with limited psychomotor mapping due to proof/problem-solving practice.
CO4 emphasizes analytical reasoning → dominant L4 and affective valuation of analytical correctness.
CO5 focuses on design-oriented graph/combinatorial solutions → L4–L5 with organizational affective skills.
CO6 includes development and evaluation of mathematical/computational models → higher-order L4–L6 with stronger psychomotor engagement through implementation/programming activities.

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ *Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Set theory, multisets, set identities | UNIT-1 | 9 |
| DD/MM/YY | Set theory, multisets, set identities | | |
| DD/MM/YY | Set theory, multisets, set identities | | |
| DD/MM/YY | Relations and properties | | |
| DD/MM/YY | Relations and properties | | |
| DD/MM/YY | Relations and properties | | |
| DD/MM/YY | Functions and recursive functions | | |
| DD/MM/YY | Functions and recursive functions | | |

| | | | |
|---|---|---|---|
| **DD/MM/YY** | Functions and recursive functions | | |
| **DD/MM/YY** | Propositional logic and inference | UNIT-2 | 9 |
| **DD/MM/YY** | Propositional logic and inference | | |
| **DD/MM/YY** | Propositional logic and inference | | |
| **DD/MM/YY** | Propositional logic and inference | | |
| **DD/MM/YY** | Predicate logic and quantifiers | | |
| **DD/MM/YY** | Predicate logic and quantifiers | | |
| **DD/MM/YY** | Predicate logic and quantifiers | | |
| **DD/MM/YY** | Mathematical induction | | |
| **DD/MM/YY** | Mathematical induction | | |
| **DD/MM/YY** | Groups, subgroups, cyclic groups | UNIT-3 | 9 |
| **DD/MM/YY** | Groups, subgroups, cyclic groups | | |
| **DD/MM/YY** | Groups, subgroups, cyclic groups | | |
| **DD/MM/YY** | Groups, subgroups, cyclic groups | | |
| **DD/MM/YY** | Rings, fields, modulo arithmetic | | |
| **DD/MM/YY** | Rings, fields, modulo arithmetic | | |
| **DD/MM/YY** | Rings, fields, modulo arithmetic | | |
| **DD/MM/YY** | POSET and Hasse diagrams | | |
| **DD/MM/YY** | POSET and Hasse diagrams | | |
| **DD/MM/YY** | Lattices and Boolean algebra | UNIT-4 | 9 |
| **DD/MM/YY** | Lattices and Boolean algebra | | |
| **DD/MM/YY** | Lattices and Boolean algebra | | |
| **DD/MM/YY** | Lattices and Boolean algebra | | |
| **DD/MM/YY** | K-Maps and logic circuits | | |
| **DD/MM/YY** | K-Maps and logic circuits | | |
| **DD/MM/YY** | K-Maps and logic circuits | | |
| **DD/MM/YY** | Recurrence relations and generating functions | | |
| **DD/MM/YY** | Recurrence relations and generating functions | | |
| **DD/MM/YY** | Trees and binary trees | UNIT-5 | 9 |
| **DD/MM/YY** | Trees and binary trees | | |
| **DD/MM/YY** | Trees and binary trees | | |
| **DD/MM/YY** | Graphs and graph algorithms | | |
| **DD/MM/YY** | Graphs and graph algorithms | | |
| **DD/MM/YY** | Graphs and graph algorithms | | |
| **DD/MM/YY** | Graphs and graph algorithms | | |
| **DD/MM/YY** | Counting techniques and combinatorics | | |
| **DD/MM/YY** | Counting techniques and combinatorics | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L6) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| TS ID | Recommended Dimension | What is Measured | CO/BTL | Assessment |
|---|---|---|---|---|
| TS1 | Set Theory & Mathematical Foundations | Understanding sets, relations, functions, mappings and formal mathematical structures | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | Logical Reasoning & Proof Construction | Ability to formulate logical arguments, truth tables, quantifiers, and mathematical induction proofs | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | Algebraic Structure Application | Application of groups, rings, lattices, and algebraic operations in problem solving | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | Analytical Reasoning & Boolean Evaluation | Analysis of Boolean algebra, recurrence relations, and generating functions | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| TS5 | Graph & Tree Modeling | Design and analysis of trees, graph representations, spanning trees, traversal and graph problems | CO5 \| L4–L5 | ETE Sec B/C |
| TS6 | Computational Modeling & Discrete Problem Solving | Development of mathematical/computational models using combinatorics and discrete techniques | CO6 \| L5–L6 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 | TS2 | TS3 | TS4 | TS5 | TS6 |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO6 | | | | M | M | H |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| **Real-World Case Study (Report)** | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Assignment | Focus Area | CO | TS | Suggested Activity | Evaluation Criteria |
|---|---|---|---|---|---|
| Assignment 1 | Set theory, relations, functions | CO1 | TS1 | Problem-solving worksheet | Assignment submission + evaluation |
| Assignment 2 | Logic, truth tables, induction proofs | CO2 | TS2 | Proof-based exercises | Numerical problems on logic and inference rules. |
| Assignment 3 | Groups, rings, lattices | CO3 | TS3 | Algebraic problem solving | Numerical computation + applications |
| Assignment 4 | Boolean algebra, recurrence relations | CO4 | TS4 | K-map simplification + recurrence solving | Step-by-step numerical trace required |
| Assignment 5 | Graph theory & combinatorics | CO5, CO6 | TS5, TS6 | Graph modeling and counting problems | Algorithm application + performance analysis |
| Video Learning Report | Graph algorithms / cryptography applications | CO4, CO5 | TS4, TS5 | Presentation + report | Report: learning outcomes, key concepts, self-reflection. |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Presentation: 10 min |
| Case Study Report | Real-world discrete math applications in AI/networking/security | CO5, CO6 | TS5, TS6 | Analytical report | Technical depth, data collection, fact finding, comparative analysis |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| Section A | 5 | TS1, TS2 | CO1, CO2 | Short-answer conceptual and proof-based questions covering sets, relations, logic, and induction |
| Section B | 10 | TS3, TS4 | CO2, CO3 | Numerical/problem-solving questions involving algebraic structures, modulo arithmetic, and analytical reasoning |
| TOTAL | 15 | TS1–TS4 | CO1–CO3 | Units 1–3 only. CO4, CO5 and CO6 assessed in ETE only |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 24/60 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| Section A | 15 | TS1, TS2 | CO1, CO2 | Conceptual understanding, logic proofs, definitions, and short analytical questions |
| Section B | 25 | TS3, TS4, TS5 | CO3, CO4, CO5 | Long-answer analytical and numerical problems involving Boolean algebra, lattices, trees, graphs, and recurrence relations |
| Section C | 20 | TS5, TS6 | CO5, CO6 | Case-study/problem-design based questions involving graph modeling, combinatorics, computational modeling, and real-world applications |
| TOTAL | 60 | TS1–TS6 | CO1–CO6 | Comprehensive assessment covering all units and all course outcomes |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Sets, relations, functions | ✓ | ✓ | ✓ | TS1 | PO1 |
| CO2 | Logic and mathematical proofs | ✓ | ✓ | ✓ | TS2 | PO1, PO2 |
| CO3 | Algebraic structures | ✓ | ✓ | ✓ | TS3 | PO1, PO2 |
| CO4 | Boolean algebra & recurrence relations | ✓ | | ✓ | TS4 | PO2, PO4 |
| CO5 | Trees, graphs, combinatorics | ✓ | | ✓ | TS5 | PO3, PO4 |
| CO6 | Computational mathematical modeling | ✓ | | ✓ | TS6 | PO4, PO5 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | – | – | – | – | – | – | – | – | 1 | 2 | – | – |
| CO 2 | 3 | 3 | – | 1 | – | – | – | – | – | – | 1 | 2 | 2 | – |
| CO 3 | 3 | 3 | 1 | 2 | – | – | – | – | – | 1 | 1 | 3 | 2 | – |
| CO 4 | 2 | 3 | 2 | 3 | 1 | – | – | – | – | 2 | 1 | 2 | 3 | – |
| CO 5 | 2 | 3 | 3 | 3 | 2 | – | – | – | – | 1 | 2 | 3 | 3 | 1 |
| CO 6 | 2 | 2 | 3 | 3 | 3 | – | – | – | – | 2 | 2 | 3 | 3 | 2 |
| Avg | 2.5 | 2.7 | 2.25 | 2.4 | 2 | – | – | – | – | 1.5 | 1.3 | 2.5 | 2.6 | 1.5 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | H | M | | | | | | | | | M | H | | |
| CO 2 | H | H | | M | | | | | | | M | H | M | |
| CO 3 | H | H | M | M | | | | | | M | M | H | M | |
| CO 4 | M | H | M | H | M | | | | | M | M | M | H | |
| CO 5 | M | H | H | H | M | | | | | M | M | H | H | M |
| CO 6 | M | M | H | H | H | | | | | M | M | H | H | M |

## 14. Self-Learning Activities (SL: 45 Hours)

| S. No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | Problem-solving assignments on sets, logic, algebraic structures, and recurrence relations | 15 hrs | CO1–CO4 / TS1–TS4 | Accuracy of solutions, logical reasoning, timely submission |
| 2 | Graph theory and combinatorics small project / case study | 15 hrs | CO5, CO6 / TS5, TS6 | Modeling quality, analytical interpretation, presentation |
| 3 | Technical video learning report and computational modeling exercises using discrete mathematics tools/software | 15 hrs | CO3–CO6 / TS3–TS6 | Report quality, conceptual clarity, application-oriented understanding |
| TOTAL Self-Learning Hours | 45 Hours | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the beginning of the semester. | |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**---------- — Discrete Structures (CSCR2111) SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

# COURSE PLAN

## Principles of Operating System (CSCR2512)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | III |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR2512 |
| 2 | **Course Title** | **Principles of Operating System (POS)** |
| 3 | **Credits** | 2 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-4-2 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | 1. Introduce the challenges for designing operating systems.<br>2. Cover different design principles and algorithms for resource management.<br>3. Enable evaluation of algorithms proposed for resource allocation and scheduling.<br>4. Develop the ability to implement and analyze algorithms and OS utilities. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Understand – L1/L2): Identify the challenges and understand the basic concepts, types, structures, and services of an Operating System.<br>CO2 (Explore – L2/L3): Explore process management concepts including process states, inter-process communication, CPU scheduling, synchronization, and deadlocks.<br>CO3 (Apply – L3): Understand and implement algorithms in resource allocation and utilization, including scheduling and deadlock handling techniques. |

| | | |
|---|---|---|
| | | CO4 (Analyze – L4/L5): Integrate and interpret the effectiveness and efficiency of algorithms used for resource management of operating systems.<br>CO5 (Analyze – L4/L5): Analyze various memory management techniques including paging, segmentation, virtual memory, demand paging, and page replacement algorithms.<br>CO6 (Analyze – L2/L4): Understand file system concepts, file operations, disk scheduling algorithms, and I/O management techniques, and analyze their comparative efficiency.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>**CO7 (Apply – L3):** Implement Linux/Unix commands, shell utilities, process management programs, and system calls using professional development tools.<br>**CO8 (Create – L5/L6):** Develop system-level applications using process synchronization, inter-process communication, file operations, and scheduling techniques.<br>**CO9 (Apply – L2/L3):** Demonstrate ethical computing practices, documentation skills, responsible system usage, and reflective learning.<br>**CO10 (Apply – L3):** Collaborate effectively in team-oriented operating system mini-projects and communicate technical solutions professionally. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 60 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | Linux shell scripting exercises, scheduling simulation activities, NPTEL OS labs, system programming assignments, GitHub-based mini projects |
| 11 | **References** | Textbook: Silberschatz, A., Galvin, P.B. & Gagne, G. — Operating System Concepts (10th Ed.), Wiley.<br>Reference:<br>1. Stallings, W. — Operating Systems: Internals and Design Principles, Maxwell Macmillan<br>2. Tanenbaum, A.S. — Operating System: Design and Implementation, Prentice Hall India<br>3. Milenkovic, M. — Operating Systems: Concepts and Design, McGraw Hill |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Unit 1: Introduction to Operating Systems (4-0-10-6 = 20 hrs)** | |
| **A** | Operating System Concepts and functions; Comparison of different Operating Systems | **CO1, CO2, CO3** |
| **B** | Types of Operating Systems: Batch, Multiprogramming, Multi-Tasking, Multiprocessing, Distributed, Real-Time OS | |
| **C** | Operating System Structure: Monolithic, Layered, Microkernel; Operating System Services | |
| **Tools Used** | Linux OS, Virtual Machines, Ubuntu, Shell Terminal, gcc compiler, Virtual Labs | |
| **Activities** | **Objective:** To familiarize students with Linux commands and develop a clear understanding of Shell scipts and different operating systems | |

| | | |
|---|---|---|
| | • Study of Linux Commands<br>  ○ Working with Directories<br>  ○ Understanding of gcc compiler, compiling and executing on Linux Environment.<br>• Understanding shell commands and directory structure<br>• Study of process monitoring utilities<br>• Comparison of Windows and Linux operating systems<br>• Demonstration of system calls and process creation | |
| **Unit 2** | **Process Synchronization (6-0-12-6 = 24 hrs)** | |
| **A** | Process Concepts: PCB, Process States, Process Operations, Inter-Process Communication | **CO2, CO3, CO4** |
| **B** | Critical Section Problem & Solutions; Introduction to Semaphores | |
| **C** | Classical Problems of Synchronization: Producer-Consumer, Readers-Writer, Dining Philosophers | |
| **Tools Used** | Linux Environment, Shell Terminal, gcc, pthread library, synchronization utilities, Virtual Labs | |
| **Activities** | • Creating parent-child processes using fork()<br>• Process synchronization using wait(), sleep(), semaphores<br>• Implementation of IPC mechanisms<br>• Thread creation using pthreads<br>• Simulation of synchronization problems | |
| **Unit 3** | **CPU Scheduling (8-0-16-6 = 30 hrs)** | |
| **A** | Concept of CPU Scheduling; Types of Schedulers (Short, Long, Middle term); Dispatcher; Performance Criteria | CO2, CO3, CO4, CO5 |
| **B** | CPU Scheduling Algorithms: FCFS, SJF, Priority, Round Robin, Multilevel Queue, Multilevel Feedback Queue | |
| **C** | Deadlock Concepts & Handling Techniques: Avoidance, Prevention, Detection & Recovery | |
| **Tools Used** | Linux Environment, Scheduling simulators, Online compilers, Visualization tools | |
| **Activities** | • Scheduling algorithm simulation<br>• Gantt chart analysis<br>• Performance comparison of scheduling algorithms<br>• Deadlock detection case studies<br>• Banker's algorithm implementation | |
| **Unit 4** | **Memory Management & Virtual Memory (8-0-14-6 = 28 hrs)** | |

| | | |
|---|---|---|
| **A** | Memory Hierarchy; Memory Management Unit (MMU) | CO3, CO4, CO5 |
| **B** | Paging; Segmentation | |
| **C** | Virtual Memory Concept; Demand Paging; Page Replacement Algorithms: FIFO, Optimal, LRU | |
| **Tools Used** | Linux Environment, Memory allocation simulators, Visualization tools, Virtual Labs. | |
| **Activities** | • Address translation demonstration<br>• Simulation of page replacement algorithms<br>• Memory fragmentation analysis<br>• Performance comparison of memory allocation techniques<br>• Virtual memory experiments | |
| **Unit 5** | **File Systems & I/O Management (6-0-12-6 = 24 hrs)** | |
| **A** | I/O Interface; Modes of Data Transfer: Programmed, Interrupt-Driven, and DMA | CO3, CO4, CO5, CO6 |
| **B** | Disk Structure; Disk Scheduling: FCFS, SSTF, SCAN, LOOK, C-SCAN, C-LOOK | |
| **C** | File Concept; File Operations; File Directories; Case Study of Windows Operating System | |
| **Tools Used** | Linux Environment, File utilities, Disk management tools, GitHub, Shell scripting. | |
| **Activities** | • File handling using system calls<br>• Disk scheduling simulation<br>• Linux file system navigation<br>• File buffering and descriptor analysis<br>• Team-based case study presentation | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | 3.A | ✓ | ✓ | | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | | | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | ✓ | ✓ | ✓ | | |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | | | | | | | ✓ | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | | | | | | | | | |
| CO5 | | | | ✓ | ✓ | | | ✓ | | | | | | | | | | |
| CO6 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | | ✓ | | | |
| CO8 | | | | | ✓ | ✓ | | | ✓ | | | | | | | ✓ | ✓ | |
| CO9 | | ✓ | ✓ | | | | | | | ✓ | | | | | ✓ | | | |
| CO10 | | | ✓ | | | | | | | ✓ | ✓ | | | | | ✓ | | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | OS Concepts and Functions; Comparison of different Operating Systems | Unit 1 | 4 |
| DD/MM/YY | Types of Operating Systems: Batch, Multiprogramming, Multi-Tasking, Multiprocessing | | |
| DD/MM/YY | Types (contd.): Distributed and Real-Time Operating Systems | | |
| DD/MM/YY | OS Structure: Monolithic, Layered, Microkernel; OS Services | | |
| DD/MM/YY | Process Concepts: PCB, Process States, Process Operations | Unit 2 | 6 |
| DD/MM/YY | Inter-Process Communication (IPC) — Shared Memory and Message Passing | | |
| DD/MM/YY | Critical Section Problem and Solutions (Peterson's Solution) | | |
| DD/MM/YY | Introduction to Semaphores — Binary and Counting | | |
| DD/MM/YY | Classical Problems: Producer-Consumer Problem, Readers-Writer Problem | | |
| DD/MM/YY | Dining Philosophers Problem — Solutions and Analysis | | |
| DD/MM/YY | CPU Scheduling Concepts; Types of Schedulers (Short, Long, Middle Term) | Unit 3 | 8 |
| DD/MM/YY | Dispatcher; Performance Criteria (CPU utilisation, throughput, turnaround, wait time) | | |
| DD/MM/YY | CPU Scheduling Algorithms: FCFS, SJF (Preemptive & Non-Preemptive) | | |
| DD/MM/YY | Priority Scheduling; Round Robin Scheduling — analysis and examples | | |
| DD/MM/YY | Multilevel Queue Scheduling; Multilevel Feedback Queue Scheduling | | |
| DD/MM/YY | Deadlock Concepts: Deadlock Characterization, Resource-Allocation Graph | | |
| DD/MM/YY | Deadlock Handling: Avoidance (Banker's Algorithm), Prevention Techniques | | |
| DD/MM/YY | Deadlock Detection & Recovery Algorithms | | |
| DD/MM/YY | Memory Hierarchy; Memory Management Unit (MMU) | Unit 4 | 6 |
| DD/MM/YY | Paging: Concept, Hardware, Protection, Shared Pages, Page Table Structures | | |
| DD/MM/YY | Segmentation: Concept, Hardware, Protection and Sharing | | |
| DD/MM/YY | Virtual Memory Concept; Demand Paging; Page Fault Handling | | |
| DD/MM/YY | Page Replacement Algorithms: FIFO, Optimal Page Replacement | | |
| DD/MM/YY | Page Replacement Algorithms: LRU; Thrashing and its effects | | |
| DD/MM/YY | I/O Interface; Modes of Data Transfer: Programmed I/O, Interrupt-Driven I/O | Unit 5 | 6 |
| DD/MM/YY | Direct Memory Access (DMA); I/O Subsystem | | |
| DD/MM/YY | Disk Structure; Disk Scheduling: FCFS, SSTF | | |
| DD/MM/YY | Disk Scheduling: SCAN, LOOK, C-SCAN, C-LOOK — comparative analysis | | |
| DD/MM/YY | File Concept; File Operations; File Directories; Access Methods | | |
| DD/MM/YY | Case Study: Windows Operating System — File, Process and Memory Management | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W7: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W8–W12 (teal rows): CO8 (design/real-world). W13-W15: CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Linux installation, terminal usage, basic shell commands, file permissions | CO7 | 3.0 |
| | S-1.2 | Working with directories, file handling commands, command history and manual pages | CO7 | |
| W2 | S-2.1 | Shell scripting basics: variables, input/output, conditional statements | CO7 | 3.0 |
| | S-2.2 | Shell scripting using loops and menu-driven shell programs | CO7 | |
| W3 | S-3.1 | Process creation using fork() and getpid() system calls | CO7 | 3.0 |
| | S-3.2 | Process replacement using exec() family of functions | CO7 | |
| W4 | S-4.1 | Parent-child process communication using wait() and exit() | CO7 | 3.0 |
| | S-4.2 | Creation and analysis of orphan and zombie processes | CO7 | |
| W5 | S-5.1 | Process synchronization using sleep() and synchronization primitives | CO7 | 3.0 |
| | S-5.2 | Semaphore implementation for critical section handling | CO7 | |
| W6 | S-6.1 | Creating multiple threads using pthread library | CO7 | 3.0 |
| | S-6.2 | Thread synchronization using mutex locks | CO7 | |
| W7 | S-7.1 | Producer–Consumer problem implementation using semaphores | CO7 | 3.0 |
| | S-7.2 | Readers–Writers problem implementation and analysis | CO7 | |
| W8 | S-8.1 | CPU Scheduling simulation: FCFS and SJF algorithms | CO8 | 3.0 |
| | S-8.2 | CPU Scheduling simulation: Round Robin and Priority scheduling | CO8 | |
| W9 | S-9.1 | Banker's Algorithm implementation for deadlock avoidance | CO8 | 3.0 |
| | S-9.2 | Deadlock detection and recovery simulation | CO8 | |
| W10 | S-10.1 | FIFO and Optimal Page Replacement algorithm simulation | CO8 | 3.0 |
| | S-10.2 | LRU Page Replacement algorithm and performance comparison | CO8 | |
| W11 | S-11.1 | File handling using open(), read(), write(), close() system calls | CO8 | 3.0 |
| | S-11.2 | File sharing and inter-process communication using files | CO8 | |
| W12 | S-12.1 | File buffering using fopen(), fread(), fwrite(), fflush() | CO8 | 3.0 |
| | S-12.2 | File descriptor table and file pointer manipulation using lseek() and ftell() | CO8 | |
| W13 | S-13.1 | Linux process monitoring utilities: ps, top, htop and background jobs | CO8/CO9 | 3.0 |
| | S-13.2 | Shell scripting for automation tasks with ethical system usage discussion | CO8/CO9 | |
| | S-14.1 | Design and implementation of a mini Linux shell | CO8/CO10 | |

| | | | | |
|---|---|---|---|---|
| **W14** | S-14.2 | Process scheduler simulator with team-based role allocation and peer review | **CO8/CO10** | 3.0 |
| **W15** | S-15.1 | Team-based operating system mini project demonstration and documentation | **CO9/CO10** | 3.0 |
| | S-15.2 | Final presentation, code review, project reflection, and viva voce | **CO9/CO10** | |

ℹ *Instructions: Write Linux/Unix-based C programs, compile and execute using gcc compiler, validate outputs with suitable test cases, and analyze system behavior wherever applicable. Maintain a proper lab record including aim, algorithm, source code, execution steps, output, result, and observations. The completed lab record must be submitted before the next laboratory session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Factual Recall & Conceptual Recognition** | Recall operating system concepts, terminology, process states, scheduling terms, memory hierarchy, file system structures, and Linux/Unix commands; identify correct OS services and functions. | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| **TS2** | **Conceptual Explanation & Logical Interpretation** | Explain process management, synchronization mechanisms, scheduling algorithms, memory management techniques, and file system organization; interpret process execution and resource allocation behaviour | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| **TS3** | **Procedural Application & Problem Solving** | Apply operating system algorithms and Linux system programming concepts to solve scheduling, synchronization, memory allocation, and file handling problems | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| **TS4** | **Analytical Reasoning & Program Tracing** | Analyze process synchronization issues, deadlocks, paging behaviour, CPU utilization, and system performance; trace execution flow and identify resource conflicts | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| **TS5** | **Comparative Evaluation & Algorithmic Justification** | Compare scheduling algorithms, page replacement methods, deadlock handling techniques, and disk scheduling approaches; evaluate efficiency using performance metrics and resource utilization analysis | CO5 \| L5 | ETE Sec B/C |
| **TS6** | **Synthesis & Holistic Design** | Design and develop modular operating system solutions integrating process management, synchronization, memory | CO6 \| L6 | ETE Sec C |

| | | | | |
|---|---|---|---|---|
| | | management, file handling, and Linux utilities for real-world system-level problems | | |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short-answer questions: operating system concepts, process states, scheduling terminology, synchronization concepts, output prediction, Linux command interpretation |
| **Sec B** | **6** | TS3 — Procedural Application TS4 — Analytical Reasoning | **CO3, CO4** | Numerical/problem-solving questions on CPU scheduling, synchronization, deadlock analysis, paging, process tracing, algorithm analysis, and system behaviour interpretation |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions: operating system concepts, process states, synchronization terminology, Linux commands, memory management concepts, file system structures, output tracing, and concept-based MCQs (all units) |
| **Sec B** | **50** | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Medium-answer questions: CPU scheduling problems, deadlock handling, synchronization analysis, page replacement calculations, disk scheduling, algorithm comparison, performance evaluation, and resource utilization analysis |
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long/design questions: design and justify operating system solutions, synchronization mechanisms, memory management strategies, file handling systems, Linux-based system applications, and integrated case studies |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |

| | | | | |
|---|---|---|---|---|
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| **CA1** | **Problem Definition & Metrics** | Define operating system problem statements; identify measurable system parameters such as CPU utilization, turnaround time, waiting time, throughput, memory usage, and synchronization requirements | CO7, CO8 |

| | | | |
|---|---|---|---|
| CA2 | Experimental Design & Tool Setup | Plan experiments; configure Linux/Unix development environment using gcc compiler, shell terminal, process monitoring tools, IDE/debugger, and synchronization libraries | CO7 |
| CA3 | Code Implementation & Execution | Develop correct Linux/Unix-based C programs using system calls, process management, synchronization mechanisms, and file operations; compile and execute successfully | CO7 |
| CA4 | Computational Efficiency & Optimization | Evaluate scheduling efficiency, memory utilization, synchronization overhead, and system performance; identify bottlenecks and propose optimized solutions | CO7 |
| CA5 | Output Analysis & Result Interpretation | Analyze process execution, synchronization behaviour, scheduling outputs, paging performance, and file handling results; justify observations using evidence-based reasoning | CO8 |
| CA6 | Documented Outcome with Verification | Record experimental outcomes formally; validate outputs against expected operating system behaviour and problem specifications | CO7, CO8 |
| CA7 | Algorithmic Design & Solution Planning | Design algorithms, flowcharts, pseudocode, scheduling logic, synchronization strategy, and memory management approaches before implementation; justify design choices | CO7, CO8 |
| CA8 | Lab Record Maintenance & Viva-Voce | Maintain complete laboratory records including aim, algorithm, source code, execution steps, output, and conclusion; demonstrate conceptual understanding through viva voce | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | SDG Alignment & Social Relevance | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | Problem Scoping & Requirements | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | Communication & Testing Strategy | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | Innovative Solution Proposal | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | Professional Toolchain | Select and justify development tools; configure professional project environment | CO7 \| PO5 |
| P6 | End-to-End Implementation | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |

| | | | |
|---|---|---|---|
| P11 | **Financial Feasibility & Planning** | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | **Individual Skill Growth Mapping** | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | **Professional Attitude, Ethics & Responsibility** | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | M | | M | M | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | | | | | H | H | H | M | | M | M | H | | | | | H | M | H | | | | | | | |
| CO8 | | | | | | | M | | M | | H | H | H | | H | H | | H | M | H | M | H | M | | | | | |
| CO9 | | | | | | | | | | | | | | M | | | | | | | | | | | | H | H |
| CO10 | | | | | | | | | | | | | | | | | H | | | | | | M | H | H | | |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | – | – | – | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 2 | 3 | 3 | – | – | – | 2 | 2 | 2 | 1 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | – | – | – | 1 | 1 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 2 | 2 | 2 | 2 | 1 | – | – | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 3 | – | – | – | – | 3 | 3 | 1 | 2 | 3 | – | – |
| CO6 | 3 | 2 | – | – | – | – | – | – | – | 2 | 3 | 2 | 2 | – |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| Avg | 2.50 | 2.14 | 2.33 | 2.25 | 2.00 | 1.67 | 3.00 | 2.00 | 2.20 | 1.86 | 2.29 | 2.38 | 2.25 | 2.00 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | M |
| CO2 | H | M | | | | | | | M | | M |
| CO3 | M | H | M | | M | M | | | M | | M |
| CO4 | M | H | M | H | M | | | | | | M |
| CO5 | M | H | H | M | M | | | | | | M |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | M | | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in operating system concepts, Linux/Unix programming, process management, memory management, and system-level problem solving; promotes lifelong learning and technical competency development (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant system programming, Linux administration, synchronization, scheduling, and file management skills directly applicable to software engineering, cloud computing, cybersecurity, and IT infrastructure domains (CO7, CO8, CO10). |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables development of efficient and optimized operating system solutions; supports innovation through process scheduling, memory optimization, synchronization mechanisms, and real-world system-level mini projects (CO5, CO6, CO8, CO10). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Encourages efficient utilization of computational resources, optimized scheduling and memory allocation techniques, ethical system usage, responsible file handling, and sustainable computing practices (CO5, CO7, CO9). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**POS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Concepts of Machine Learning (CSCF2200)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I**

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | III |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCF2200 |
| 2 | **Course Title** | **Concepts of Machine Learning (PPS)** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-2-3 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | To introduce machine learning concepts, algorithms, and intelligent systems through mathematical foundations, supervised and unsupervised learning approaches, model evaluation, ethical AI practices, and hands-on implementation using professional tools and datasets. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Remember – L1)<br>Define machine learning concepts, learning paradigms, stochastic models, feature engineering concepts, and data preprocessing techniques.<br>CO2 (Understand – L2) |

| | | |
|---|---|---|
| | | Explain supervised and unsupervised learning algorithms, model training procedures, validation methods, and dimensionality reduction techniques.<br>CO3 (Apply – L3)<br>Apply regression, classification, clustering, and dimensionality reduction algorithms to solve real-world machine learning problems.<br>CO4 (Analyze – L4)<br>Analyze machine learning models using feature engineering, validation approaches, statistical measures, and performance evaluation metrics.<br>CO5 (Evaluate – L5)<br>Evaluate learning models, ensemble techniques, optimization methods, and predictive systems for sustainable and intelligent solutions.<br>CO6 (Create – L6)<br>Design intelligent machine learning systems using ethical and professional practices for solving societal and industrial problems.<br><br>**LAB COs — Assessed via Laboratory Assessment only**<br>CO7 (Apply – L3)<br>Implement machine learning algorithms using professional tools such as Python, Jupyter Notebook, Scikit-learn, TensorFlow, and real-world datasets.<br>CO8 (Create – L5/L6)<br>Design and develop machine learning-based applications using supervised and unsupervised learning approaches for real-world problem solving.<br>CO9 (Apply – L3)<br>Demonstrate ethical AI practices, professional documentation standards, reflective learning, and responsible data handling during experimentation and project work.<br>CO10 (Apply – L3)<br>Collaborate effectively in team-based machine learning projects and communicate analytical findings professionally using project management practices. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 45 hrs + Lab Instructions (LI) 30 hrs + Self Learning (SL) 45 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | 1. Kaggle-based ML mini exercises.<br>2. NPTEL videos on Machine Learning.<br>3. Implementation of ML models using Scikit-learn and TensorFlow.<br>4. Research survey on recent AI/ML applications.<br>5. MOOC course on Machine Learning (SWAYAM/Coursera). |
| 11 | **References** | **Textbooks**<br>1. Bishop, C. — Pattern Recognition and Machine Learning, Springer.<br>2. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar — Foundations of Machine Learning, MIT Press.<br>3. Ethem Alpaydin — Introduction to Machine Learning, MIT Press.<br>**Reference Books**<br>4. Russell, S. and Norvig, P. — Artificial Intelligence: A Modern Approach.<br>5. Baldi, P. and Brunak, S. — Bioinformatics: A Machine Learning Approach.<br>6. Cohen, P.R. — Empirical Methods in Artificial Intelligence. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Core Concept of Machine Learning (8-0-6-8 = 22 hrs)** | |
| **A** | Introduction to Machine Learning, ML mindset, learning tasks, ML pipeline, classification, regression, clustering, dimensionality reduction. | CO1, CO2, CO3 |
| **B** | Learning stages, learning scenarios, supervised learning, unsupervised learning, reinforcement learning, generalization. | |
| **C** | Data preprocessing, data cleaning, integration, transformation, feature engineering, normalization, discretization | |
| **Tools Used** | Python, Jupyter Notebook, Google Colab, NumPy, Pandas, Matplotlib, Scikit-learn, Kaggle datasets, GitHub. | |
| **Activities** | Objective: To familiarize students with fundamental machine learning concepts, learning paradigms, and data preprocessing techniques using professional ML tools and datasets.<br>• Installation and configuration of Python, Jupyter Notebook, and ML libraries.<br>• Demonstration of ML workflow using datasets from Kaggle/UCI Repository.<br>• Data preprocessing using Pandas and NumPy libraries.<br>• Visualization of datasets using Matplotlib and Seaborn.<br>• Implementing simple classification and regression examples using Scikit-learn.<br>• Understanding feature engineering, normalization, and discretization techniques. | |
| **Unit 2** | **Supervised Learning Algorithms Part I (10-0-6-10 = 26 hrs)** | |
| **A** | Supervised learning concepts, bias-variance tradeoff, function complexity, dimensionality, noise handling. | CO2, CO3, CO4, CO5 |
| **B** | Linear regression, gradient descent, regularization methods, features scaling, normalization. | |
| **C** | Logistic regression, LDA, model fitting, goodness of fit, applications and comparisons. | |

| | | |
|---|---|---|
| **Tools Used** | Python, Jupyter Notebook, Scikit-learn, Statsmodels, NumPy, Pandas, Google Colab, GitHub. | |
| **Activities** | Objective: To apply supervised learning algorithms for prediction and classification problems while understanding optimization and model fitting techniques.<br>• Implementation of linear regression models using Scikit-learn.<br>• Demonstration of gradient descent optimization techniques.<br>• Comparative analysis of regression and classification algorithms.<br>• Implementation of logistic regression and LDA on real-world datasets.<br>• Feature scaling and normalization using Scikit-learn preprocessing tools.<br>• Evaluation of supervised learning models using performance metrics. | |
| **Unit 3** | **Supervised Learning Algorithms Part II (10-0-6-10 = 26 hrs)** | |
| **A** | Support Vector Machines, kernel trick, empirical risk minimization, parameter selection. | CO2, CO3, CO4, CO5, CO6 |
| **B** | Artificial Neural Networks, backpropagation, gradient optimization, error minimization. | |
| **C** | Decision Trees, ID3 algorithm, Random Forests, overfitting and validation methods. | |
| **Tools Used** | Python, TensorFlow, Keras, Scikit-learn, Jupyter Notebook, Google Colab, GitHub. | |
| **Activities** | To understand advanced supervised learning algorithms and implement intelligent predictive systems using professional ML frameworks.<br>• Implementation of Support Vector Machines with different kernels.<br>• Demonstration of hyperparameter tuning and validation techniques.<br>• Designing Artificial Neural Networks using TensorFlow/Keras.<br>• Training neural networks using back propagation algorithms.<br>• Implementing Decision Trees and Random Forest classifiers. | |

| | | |
|---|---|---|
| | • Comparative performance evaluation of supervised learning algorithms. | |
| **Unit 4** | **Unsupervised Learning (8-0-6-8 = 22 hrs)** | |
| **A** | Clustering methods, Euclidean distance methods, hierarchical clustering. | CO3, CO4, CO5 |
| **B** | K-means clustering, initialization methods, Gaussian mixture models, expectation-maximization. | |
| **C** | Principal Component Analysis (PCA), covariance methods, dimensionality reduction. | |
| **Tools Used** | Python, Scikit-learn, NumPy, Pandas, Matplotlib, Seaborn, Jupyter Notebook, Google Colab. | |
| **Activities** | **Objective: To analyze unlabeled datasets using clustering and dimensionality reduction techniques for knowledge discovery and visualization.**<br>• Implementation of K-means and hierarchical clustering algorithms.<br>• Visualization of clusters using Matplotlib and Seaborn.<br>• Demonstration of Gaussian Mixture Models and EM algorithm.<br>• Applying PCA for dimensionality reduction and feature extraction.<br>• Comparative analysis of clustering algorithms using evaluation metrics.<br>• Visualization of high-dimensional datasets in reduced dimensions. | |
| **Unit 5** | **Parameter Estimation, Model Evaluation and Ensemble Methods (9-0-6-9 = 24 hrs)** | |
| **A** | Parameter estimation, maximum likelihood estimation, confidence intervals. | CO2, CO3, CO4, CO5, CO6 |
| **B** | Model evaluation, cross-validation, ROC curve, bootstrapping. | |
| **C** | Ensemble methods, boosting, bagging, stacking, voting methods. | |
| **Tools Used** | Python, Scikit-learn, TensorFlow, Jupyter Notebook, Google Colab, Matplotlib, Kaggle datasets, GitHub. | |
| **Activities** | **Objective: To evaluate machine learning models and develop robust intelligent systems using ensemble learning and validation techniques.** | |

| | | |
|---|---|---|
| | • Implementation of cross-validation and bootstrapping techniques.<br>• Plotting and interpretation of ROC curves and confusion matrices.<br>• Comparative evaluation of ML models using statistical performance measures.<br>• Implementation of ensemble learning techniques such as Bagging, Boosting, and Stacking.<br>• Performance comparison of individual and ensemble models on benchmark datasets.<br>• Development of mini ML projects using real-world datasets and professional documentation practices. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | ✓ | ✓ | | | | ✓ |
| 5 | 2.B | | ✓ | ✓ | | ✓ | |
| 6 | 2.C | | ✓ | ✓ | ✓ | | |
| 7 | 3.A | | ✓ | ✓ | ✓ | | ✓ |
| 8 | 3.B | | ✓ | ✓ | ✓ | | ✓ |
| 9 | 3.C | | ✓ | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | ✓ | ✓ | | |
| 11 | 4.B | | ✓ | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | | | ✓ | |
| 14 | 5.B | | | ✓ | ✓ | ✓ | |
| 15 | 5.C | | | | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | | | | | | | | | ✓ | | |
| CO6 | | | | | | ✓ | | | ✓ | | | | | | | | ✓ | ✓ |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | |
| CO8 | | | | ✓ | ✓ | | | | ✓ | | | | | | ✓ | ✓ | ✓ | |
| CO9 | | | ✓ | | | | | | ✓ | ✓ | | | | | | | | |
| CO10 | | | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | |

*Legend: ✓ = Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 45 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Machine Learning, AI vs ML, applications of ML | Unit 1 | 08 |
| DD/MM/YY | ML mindset, learning tasks, ML workflow and pipeline | | |
| DD/MM/YY | Classification and regression techniques overview | | |
| DD/MM/YY | Clustering and dimensionality reduction concepts | | |
| DD/MM/YY | Learning stages and learning scenarios | | |
| DD/MM/YY | Supervised learning and unsupervised learning | | |
| DD/MM/YY | Reinforcement learning and generalization concepts | | |
| DD/MM/YY | Data preprocessing: cleaning, integration, transformation, normalization, feature engineering | | |
| DD/MM/YY | Introduction to supervised learning, training/testing datasets | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Bias-variance tradeoff and function complexity | Unit 2 | 10 |
| DD/MM/YY | Dimensionality issues and noise handling | | |
| DD/MM/YY | Linear Regression: hypothesis and cost function | | |
| DD/MM/YY | Gradient Descent optimization techniques | | |
| DD/MM/YY | Regularization methods and feature scaling | | |
| DD/MM/YY | Normalization techniques and preprocessing review | | |
| DD/MM/YY | Logistic Regression and binary classification | | |
| DD/MM/YY | Linear Discriminant Analysis (LDA) | | |
| DD/MM/YY | Model fitting, goodness of fit, applications and comparisons | | |
| DD/MM/YY | Support Vector Machines and hyperplanes | Unit 3 | 10 |
| DD/MM/YY | Kernel trick and kernel functions | | |
| DD/MM/YY | Empirical risk minimization and parameter selection | | |
| DD/MM/YY | Introduction to Artificial Neural Networks | | |
| DD/MM/YY | Neural network architecture and activation functions | | |
| DD/MM/YY | Backpropagation algorithm and gradient optimization | | |
| DD/MM/YY | Error minimization and training techniques | | |
| DD/MM/YY | Decision Trees: entropy and information gain | | |
| DD/MM/YY | ID3 algorithm and Random Forests | | |
| DD/MM/YY | Overfitting, underfitting and validation methods | | |
| DD/MM/YY | Introduction to clustering and similarity measures | Unit 4 | 08 |
| DD/MM/YY | Euclidean distance and hierarchical clustering | | |
| DD/MM/YY | Agglomerative and divisive clustering methods | | |
| DD/MM/YY | K-means clustering algorithm | | |
| DD/MM/YY | Initialization methods in K-means | | |
| DD/MM/YY | Gaussian Mixture Models and Expectation-Maximization | | |
| DD/MM/YY | Principal Component Analysis (PCA) and covariance methods | | |
| DD/MM/YY | Singular Value Decomposition (SVD) and dimensionality reduction | | |
| DD/MM/YY | Parameter estimation and Maximum Likelihood Estimation (MLE) | Unit 5 | 09 |
| DD/MM/YY | Confidence intervals and statistical inference | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Model evaluation and validation strategies | | |
| DD/MM/YY | Cross-validation and bootstrapping techniques | | |
| DD/MM/YY | ROC curve, confusion matrix, precision and recall | | |
| DD/MM/YY | Ensemble learning concepts and voting methods | | |
| DD/MM/YY | Bagging and Random Forest ensemble methods | | |
| DD/MM/YY | Boosting and stacking techniques | | |
| DD/MM/YY | Comparative analysis of ensemble models and course review | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Installation of Python, Jupyter Notebook, Scikit-learn | CO7 | 3 |
| | S-1.2 | Load and visualize datasets | CO7 | |
| W2 | S-2.1 | Simple Linear Regression using housing dataset | CO7 | 3 |
| | S-2.2 | Logistic Regression using cancer dataset | CO7 | |
| W3 | S-3.1 | Gradient Descent implementation | CO7 | 3 |
| | S-3.2 | Regularized Linear Regression | CO7 | |
| W4 | S-4.1 | Regularized Logistic Regression | CO7 | 3 |
| | S-4.2 | Data normalization and preprocessing | CO7 | |
| W5 | S-5.1 | Support Vector Machine implementation | CO7 | 3 |
| | S-5.2 | ANN with Backpropagation | CO7 | |
| W6 | S-6.1 | Decision Tree implementation | CO7 | 3 |
| | S-6.2 | Random Forest classifier | CO7 | |
| W7 | S-7.1 | K-means clustering | CO7 | 3 |
| | S-7.2 | Hierarchical clustering | CO7 | |
| W8 | S-8.1 | PCA implementation | CO7 | 3 |

| | | | | |
|---|---|---|---|---|
| | S-8.2 | Feature reduction and visualization | CO7 | |
| W9 | S-9.1 | Training and testing dataset split | CO7 | 3 |
| | S-9.2 | Cross-validation techniques | CO7 | |
| W10 | S-10.1 | Ensemble methods using bagging | CO8 | 3 |
| | S-10.2 | Ensemble methods using boosting | CO8 | |
| W11 | S-11.1 | Comparative evaluation of ML models | CO8 | 3 |
| | S-11.2 | ROC and confusion matrix analysis | CO8 | |
| W12 | S-12.1 | ML mini project proposal and SDG mapping | CO8 | 3 |
| | S-12.2 | Dataset collection and preprocessing | CO8 | |
| W13 | S-13.1 | ML project implementation | CO8 | 3 |
| | S-13.2 | Model optimization and tuning | CO8 | |
| W14 | S-14.1 | Ethical AI practices and documentation | CO9 | 3 |
| | S-14.2 | Reflective learning and self-assessment | CO9 | |
| W15 | S-15.1 | Team project presentation and viva | CO10 | 3 |
| | S-15.2 | Final project demonstration and reporting | CO10 | |

ℹ Write Python programs and implement machine learning models using professional tools such as Jupyter Notebook, Google Colab, Scikit-learn, TensorFlow, NumPy, and Pandas. Execute, validate, and evaluate the models using suitable datasets and performance metrics. Lab record (aim, dataset description, algorithm/model, code, output, result analysis, and conclusion) must be submitted before the next session.

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Concept Recall | ML terminology, learning paradigms, preprocessing concepts | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| TS2 | Conceptual Understanding | Interpretation of algorithms and workflows | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| TS3 | Algorithmic Application | Applying ML algorithms to problems | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| TS4 | Analytical Reasoning | Validation, feature analysis, performance analysis | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| TS5 | Comparative Evaluation | Comparing models and optimization methods | CO5 \| L5 | ETE Sec B/C |
| TS6 | Intelligent System Design | Designing complete ML solutions | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short-answer: definitions, output prediction, syntax identification |
| **Sec B** | **6** | TS3 — Algorithmic Application TS4 — Analytical Reasoning | **CO3, CO4** | Program writing; program tracing — detect errors and trace execution |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions: definitions, syntax, output tracing, concept MCQs (all units) |
| **Sec B** | **50** | TS3 — Algorithmic Application<br>TS4 — Analytical Reasoning<br>TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Medium questions: program writing, debugging, algorithm comparison, complexity analysis |

| | | | | |
|---|---|---|---|---|
| **Sec C** | **25** | TS5 — Comparative Evaluation<br>TS6 — Intelligent System Design | **CO5, CO6** | Long/design questions: design modular solutions, justify choices, complete application |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | ≤ **30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |

| | | | | |
|---|---|---|---|---|
| | | P10 — Professional presentation quality and delivery | | |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| **CA1** | **Problem Definition & Metrics** | Define machine learning experiment problems; identify datasets, measurable attributes, evaluation metrics, parameters, and success criteria for predictive and analytical tasks. | CO7, CO8 |
| **CA2** | **Experimental Design & Tool Setup** | Plan machine learning experiments; configure development environments such as Python, Jupyter Notebook, Google Colab, Scikit-learn, TensorFlow, and dataset repositories. | CO7 |
| **CA3** | **Model Implementation & Execution** | Implement machine learning algorithms correctly; execute models using appropriate datasets and generate expected predictive or analytical outputs. | CO7 |
| **CA4** | **Computational Efficiency & Optimization** | Evaluate computational efficiency, model complexity, optimization techniques, hyperparameter tuning, and identify bottlenecks in machine learning systems. | CO7 |
| **CA5** | **Output Analysis & Result Interpretation** | Analyze model outputs critically using accuracy, precision, recall, F1-score, ROC curves, confusion matrix, and explain deviations with evidence-based reasoning. | CO8 |
| **CA6** | **Documented Outcome with Verification** | Record experimental outcomes formally; verify machine learning results against stated objectives and dataset requirements using proper documentation practices. | CO7, CO8 |
| **CA7** | **Algorithmic Design & Solution Planning** | Design ML workflows, algorithms, flowcharts, preprocessing pipelines, and model selection strategies before implementation; justify design choices logically. | CO7, CO8 |
| **CA8** | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records including aim, dataset description, algorithm, code, output, and result analysis; demonstrate conceptual understanding through viva-voce. | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | SDG Alignment & Social Relevance | Map machine learning projects to relevant SDGs; articulate societal impact, sustainability, ethical AI practices, and real-world application relevance. | P1 |
| P2 | Problem Scoping & Requirements | Define machine learning problem boundaries; prepare formal problem statements with datasets, constraints, measurable objectives, and performance goals. | P2 |

| | | | |
|---|---|---|---|
| P3 | Communication & Testing Strategy | Develop communication plans, model testing strategies, validation procedures, and coordinate collaborative ML project activities effectively. | P3 |
| P4 | Innovative Solution Proposal | Propose intelligent ML-based solutions with alternative algorithms/models; justify model selection using performance, scalability, and design criteria. | P4 |
| P5 | Professional Toolchain | Select and justify professional development tools such as Python, Jupyter Notebook, Google Colab, Scikit-learn, TensorFlow, GitHub, and cloud-based ML platforms. | P5 |
| P6 | End-to-End Implementation | Build complete machine learning systems integrating preprocessing, feature engineering, model training, validation, evaluation, and deployment using multiple syllabus concepts. | P6 |
| P7 | System Commissioning & Testing | Deploy and evaluate machine learning systems; conduct edge-case testing, validation, hyperparameter tuning, and performance stress testing on datasets. | P7 |
| P8 | Measurable Impact & Outcome | Evaluate ML project outcomes using accuracy, precision, recall, F1-score, ROC analysis, and quantify impact against predefined success metrics. | P8 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis of machine learning models; prepare structured technical reports with visualizations, inference, and evidence-based conclusions. | P9 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentations demonstrating ML workflow, dataset analysis, results interpretation, and effective team collaboration with assigned responsibilities. | P10 |
| P11 | Financial Feasibility & Planning | Estimate computational resources, cloud services, software/hardware costs, and justify cost-effective implementation strategies for ML projects. | P11 |
| P12 | Individual Skill Growth Mapping | Document pre/post technical skill development, ML competency enhancement, contribution tracking, and reflective learning outcomes during project execution. | P12 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate responsible AI practices, ethical handling of datasets, fairness, transparency, integrity, and professional conduct throughout the ML project lifecycle. | P13 |

## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1: Prob. Def. | CA2 Exp. Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc. Outcome | CA7 Algo. Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys. Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | M | | M | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | | | | | H | H | H | M | | M | M | H | | | | | H | M | H | | | | | | |
| CO8 | | | | | | | M | | M | | H | H | H | | H | H | | H | M | H | M | H | M | | | | |
| CO9 | | | | | | | | | | | | | | M | | | | | | | | | | | | H | H |
| CO10 | | | | | | | | | | | | | | | | | H | | | | | | M | H | H | | |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | – | – | 1 | – | – | – | – | – | 1 | 2 | 1 | – |
| CO2 | 3 | 2 | – | 1 | 1 | – | – | – | 1 | – | 2 | 2 | 2 | – |
| CO3 | 3 | 3 | 2 | 2 | 2 | 2 | – | – | 1 | – | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 3 | 2 | 1 | – | – | – | – | 2 | 2 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 2 | 2 | 2 | – | – | – | – | 2 | 2 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 3 |
| CO7 | – | 1 | 2 | 1 | 3 | 1 | – | – | 1 | – | – | 2 | 3 | 3 |
| CO8 | – | 2 | 3 | 2 | 3 | 3 | 1 | 1 | 1 | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | 1 | 1 | 3 | 1 | – | – | 3 | – | 1 | 2 |
| CO10 | – | 1 | 1 | 1 | 1 | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| Avg | 2.50 | 2.00 | 2.00 | 1.75 | 1.90 | 1.86 | 2.00 | 1.75 | 1.40 | 2.00 | 2.13 | 2.22 | 2.30 | 2.38 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | M | | | | | | M |
| CO2 | H | M | | M | M | | | | M | | M |
| CO3 | M | H | M | M | M | M | | | M | | M |
| CO4 | M | H | M | H | M | M | | | | | M |
| CO5 | M | H | H | M | M | M | | | | | M |
| CO6 | M | M | H | M | H | H | M | M | M | M | H |
| CO7 | | M | M | | H | M | | | | | M |
| CO8 | | M | H | M | M | H | | M | | | M |
| CO9 | | | | | H | M | H | | | | H |
| CO10 | | | | | M | | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| **SDG 4** | **Quality Education** | 3 (High) | Builds strong foundations in machine learning, intelligent systems, data analysis, and lifelong learning through theoretical understanding and practical implementation of AI/ML techniques (CO1–CO6, CO9). |
| **SDG 8** | **Decent Work & Economic Growth** | 3 (High) | Develops industry-relevant machine learning, data analytics, and AI development skills using professional tools such as Python, TensorFlow, Scikit-learn, and cloud-based platforms, enhancing employability in technology sectors (CO7, CO8, CO10). |
| **SDG 9** | **Industry, Innovation & Infrastructure** | 3 (High) | Enables development of innovative intelligent systems, predictive analytics solutions, and AI-driven applications for real-world industrial and societal challenges through ML model design and deployment (CO6, CO8, CO10). |
| **SDG 11** | **Sustainable Cities & Communities** | 2 (Moderate) | Supports smart and sustainable solutions using machine learning applications in healthcare, transportation, smart governance, and urban analytics for community benefit (CO5, CO6, CO8). |
| **SDG 12** | **Responsible Consumption & Production** | 2 (Moderate) | Promotes optimized computational models, efficient use of datasets and resources, ethical AI practices, and responsible handling of data during experimentation and deployment (CO5, CO7, CO9). |
| **SDG 16** | **Peace, Justice & Strong Institutions** | 2 (Moderate) | Encourages ethical AI development, fairness, transparency, responsible decision-making, and professional conduct in intelligent system design and data-driven applications (CO6, CO9). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |

| | | | |
|---|---|---|---|
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | ≥ 20 / 50 | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | ≥ 40 / 100 | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**
**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Professional Skills, Data Structures & Web Technologies (SKP2301)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester III | Batch 2026–2030*

*Lab-Only Course Plan — All 6 Lab COs (CO1–CO6) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I COURSE SYLLABUS** *Course Identification, Details, Outcomes, BTL Mapping & Session Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | III |
| **Course Code:** | SKP 2301 | **Course Type:** | Core |

## 2. Course Details

**LAB-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), Course Examination (CE), and End Semester Examination (ESE). No theory lecture component.**

| | | |
|---|---|---|
| **1** | **Course Code** | SKP 2301 |
| **2** | **Course Title** | Professional Skills, Data Structures & Web Technologies |
| **3** | **Credits** | 3 |
| **4** | **Contact Hours (L-T-P-SL)** | 0-0-6-0 (Tutorial: 0 hrs \| Lab: 90 hrs \| Self Learning: 0 hrs \| Total: 90 hrs) |
| **5** | **Course Status** | Core |
| **6** | **Course Objectives** | The objective of this course is to develop learners into confident, professional, and industry-ready individuals by enhancing their verbal ability, workplace communication, presentation skills, leadership qualities, employability competencies, quantitative aptitude, and logical reasoning through practical activities, simulations, and collaborative learning approaches. The course further aims to build foundational computational thinking, problem-solving, and application development skills through the study of Data Structures, Data Analytics fundamentals, and modern Web Development practices, enabling students to design efficient solutions, |

| | | |
|---|---|---|
| | | develop responsive applications, and apply analytical and programming tools for real-world problem solving. |
| 7 | **Course Outcomes (COs)** | After successful completion of this course, the students will be able to:<br>**CO1 (Remember – BTL1):** Professional Communication & Computational Fundamentals<br>Recall the fundamental concepts of professional communication, workplace etiquette, data analytics, computational complexity, web technologies, and development environments required for academic and professional problem solving.<br>**CO2 (Understand – BTL2): Business** Communication & Computational Concepts<br>Explain the principles of business communication, presentation skills, data preprocessing techniques, semantic web structures, algorithmic approaches, and foundational computing concepts used in modern professional environments.<br>**CO3 (Apply – BTL3):** Application Development & Professional Interaction Skills<br>Apply frontend development tools, searching and sorting techniques, spreadsheet analytics, verbal communication, presentations, group discussions, leadership activities, and collaborative problem-solving skills in practical situations.<br>**CO4 (Analyze – BTL4):** Critical Thinking, Data Structures & Workplace Problem Solving<br>Analyze workplace scenarios, communication challenges, linked list operations, UI/UX principles, responsive layouts, reading passages, and analytical problems using critical thinking and structured reasoning approaches.<br>**CO5 (Evaluate – BTL5):** Employability, Analytical Workflows & Solution Effectiveness<br>Evaluate professional communication practices, resumes, networking strategies, stacks, queues, responsive design methods, and Python-based analytical workflows for improved employability and system efficiency.<br>**CO6 (Create – BTL6):** Integrated Solution Development & Professional Content Creation<br>Design and develop integrated projects, responsive applications, analytical solutions, and professional content using data structures, frontend technologies, quantitative aptitude, logical reasoning, and workplace communication skills for real-world applications. |
| 8 | **Course Description** | This course provides an interdisciplinary foundation in professional communication, employability skills, computational problem solving, data structures, data analytics, and frontend application development. The course focuses on enhancing verbal ability, workplace communication, leadership, quantitative aptitude, logical reasoning, and professional writing through presentations, discussions, simulations, and collaborative activities, while also developing analytical thinking, algorithmic problem solving, and responsive application development skills using modern web technologies, |

| | | |
|---|---|---|
| | | data handling techniques, visualization tools, and programming practices. The course emphasizes practical implementation, critical thinking, teamwork, industry-relevant workflows, and real-world problem-solving abilities aligned with modern professional and technology-driven environments. |
| **9** | **Teaching & Learning Scheme** | Tutorial (T): 90 hrs\| Total: 90 hrs \| Credits: 3 |
| **10** | **Mode of Examination** | CA: 30% \| CE: 30% \| ESE: 40% \| Total: 100 marks |
| **12** | **Textbook** | 1. Narasimha Karumanchi, Data Structures and Algorithms Made Easy, CareerMonk Publications, Latest Edition.<br>2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, MIT Press, Latest Edition.<br>3. Jon Duckett, HTML and CSS: Design and Build Websites, Wiley Publications.<br>4. Wes McKinney, Python for Data Analysis, O'Reilly Publications.<br>5. Aruna Koneru, Professional Communication, Oxford University Press.<br>6. R.S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publications. |
| **13** | **References** | 6. Reema Thareja, Data Structures Using C, Oxford University Press.<br>7. E. Balagurusamy, Programming in ANSI C, McGraw Hill.<br>8. Herbert Schildt, Python: The Complete Reference, McGraw Hill.<br>9. David Flanagan, JavaScript: The Definitive Guide, O'Reilly Publications.<br>10. Raymond Murphy, English Grammar in Use, Cambridge University Press.<br>11. Norman Lewis, Word Power Made Easy, Goyal Publishers.<br>12. Sanjay Kumar & Pushp Lata, Communication Skills, Oxford University Press.<br>13. Alex K., Soft Skills, S. Chand Publications.<br>14. Arun Sharma & Meenakshi Upadhyay, How to Prepare for Verbal Ability and Reading Comprehension, McGraw Hill.<br>15. Online Resources: NPTEL, GeeksforGeeks, LeetCode, Kaggle Learn, MDN Web Docs, W3Schools, British Council Learning English, Toastmasters International, TED Talks, LinkedIn Learning, GitHub Learning Lab, Newspaper Editorials (The Hindu / Indian Express). |

## 3. Outline Syllabus — Units with CO Mapping

*i All CO mappings refer to COs (CO1–CO6). This is a practical course; all assessment is via CA, CE, and ESE.*

| | Topic / Activity | CO Mapping |
|---|---|---|
| | **Unit 1: Professional Communication, Web Fundamentals & Analytical Thinking** | |
| **A** | Corporate Etiquette, Workplace Ethics, Professional Behaviour, Introduction to Data Analytics/Web Fundamentals, Development Environment & HTML Workflow | **CO1** |

| | | |
|---|---|---|
| **B** | Communication Readiness, Networking, Recruitment Platforms, Data Analytics Lifecycle, Static vs Dynamic Websites | **CO1** |
| **C** | Complexity Analysis, Recursion Fundamentals, Negotiation & Conflict Resolution through Case Studies and Simulations | **CO1** |
| | **Unit 2: Business Writing, Web Design & Data Processing Skills** | |
| **A** | Email Writing, Business Writing, Technical & Creative Writing, Data Collection & Preprocessing, Semantic HTML & Webpage Structuring | **CO2** |
| **B** | Essay Writing, Precis Writing, SOP & LOM Drafting, Data Cleaning & Transformation, Responsive Page Design | **CO2** |
| **C** | Arrays, Strings, Sliding Window Techniques, Pattern Matching & Problem Solving | **CO2** |
| | **Unit 3: Public Speaking, Leadership & Programming Fundamentals** | |
| **A** | Presentation Skills, TED Talk Practices, Toastmasters Sessions, Introduction to Python, Variables, Data Types & Operators | **CO3** |
| **B** | Debates, JAM Sessions, Group Discussions, Responsive Design Principles, CSS Grid & UI Development | **CO3** |
| **C** | Leadership, Team Building, Video Resume Development, Multi-section Frontend Project Development | **CO3** |
| | **Unit 4: Verbal Ability, Data Structures & Problem Solving** | |
| **A** | Grammar & Error Detection, Reading Comprehension, Vocabulary Building, Stack & Queue Fundamentals | **CO4, CO6** |
| **B** | Paragraph Jumbles, Cloze Tests, Logical Interpretation, Applications of Stacks & Queues | **CO4, CO6** |
| **C** | Min Stack, Queue using Stacks, Problem Solving & Analytical Reasoning Exercises | **CO4, CO6** |
| | **Unit 5: Quantitative Aptitude, Logical Reasoning & Employability Readiness** | |
| **A** | Simplification, Approximation, Vedic Maths, Percentage, Ratio & Proportion, Profit & Loss | **CO5, CO6** |
| **B** | Coding-Decoding, Number Systems, Calendars, Alphanumeric Series, Logical Arrangement & Venn Diagrams | **CO5, CO6** |
| **C** | Resume Building, ATS Optimization, Employability Skills, Analytical & Non-Verbal Reasoning Practice | **CO5, CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A – Professional communication, workplace etiquette & networking | ✓ | ✓ | | | | |
| 2 | 1.B – Web fundamentals, HTML workflow & computational thinking | | ✓ | ✓ | | | |
| 3 | 1.C – Complexity analysis, recursion & analytical problem solving | | ✓ | ✓ | ✓ | ✓ | |
| 4 | 2.A – Business writing, email drafting & technical documentation | ✓ | ✓ | ✓ | | | |
| 5 | 2.B – Semantic HTML, responsive design & frontend structuring | | ✓ | ✓ | | | |
| 6 | 2.C – Arrays, strings, dataset preprocessing & spreadsheet analytics | | ✓ | ✓ | ✓ | ✓ | |
| 7 | 3.A – Presentation skills, public speaking & group discussions | | ✓ | ✓ | ✓ | | |
| 8 | 3.B – Leadership, collaboration & professional interaction | | ✓ | ✓ | ✓ | ✓ | |
| 9 | 3.C – Python fundamentals, CSS Grid & UI development | | | ✓ | ✓ | ✓ | ✓ |
| 10 | 4.A – Grammar fundamentals, parts of speech & sentence correction | ✓ | ✓ | ✓ | ✓ | | |
| 11 | 4.B – Reading comprehension, vocabulary & verbal reasoning | | ✓ | ✓ | ✓ | ✓ | |
| 12 | 4.C – Stacks, queues, searching, sorting & logical reasoning | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 13 | 5.A – Quantitative aptitude & analytical reasoning | ✓ | ✓ | ✓ | ✓ | | |
| 14 | 5.B – Resume building, ATS optimization & GitHub workflow | | ✓ | ✓ | ✓ | ✓ | |
| 15 | 5.C – UI/UX principles, integrated projects & employability readiness | | | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

*i Only strong/dominant alignments are mapped. Lab COs span all three domains — Cognitive (L3–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of lab and project work.*

| | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | | Psychomotor (P1–P7) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | ✓ | | | | ✓ | ✓ | | | | | |
| CO2 | | ✓ | ✓ | | | | | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | | |
| CO3 | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | |
| CO4 | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | |
| CO5 | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| CO6 | | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| | *Legend: ✓= Strong / Dominant mapping only.* | | | | | | | | | | | | | | | | | |

## 6. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs & Skill Dimensions Assessed |
|---|---|---|---|
| **Continuous Assessment (CA)** | 30% | **30** | CO1–CO6 \| Professional Communication, Verbal Ability, Aptitude, Web Development, Data Structures, Data Analytics, Leadership & Employability Skills \| Activity-based evaluation, worksheets, coding exercises, presentations, assignments, communication tasks |
| **Course Examination (CE)** | 30% | **30** | CO1–CO6 \| Analytical Thinking, Problem Solving, Writing Skills, Frontend Development, Programming Fundamentals, Logical Reasoning \| Practical assessment + Viva + Problem-solving activities |
| **End Semester Examination (ESE)** | 40% | **40** | CO1–CO6 \| Coding Implementation, Analytical Problem Solving, Communication Effectiveness, Responsive Webpage Development, Data Structures & Employability Readiness \| Practical implementation + Viva + Project/Case-based evaluation |
| **TOTAL** | **100%** | **100** | All COs assessed through practical, analytical, communication, coding, presentation, and problem-solving based evaluation methods |

## 7. Continuous Assessment (CA) — 30 Marks

### 7.1 Per-Experiment CA Rubric (3.0 Marks each)

| Criterion | Marks | Skill Dimensions Covered | Marking Guide | CO |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Communication, Problem Understanding & Planning** | 1.0 | Professional communication, analytical thinking, problem understanding, presentation of approach, workplace interaction, algorithmic thinking | 1.0: Clear understanding & structured approach \| 0.5: Partial understanding \| 0: Unable to explain/problem not attempted | CO1–CO4 |
| **Practical Implementation / Technical Execution** | 1.0 | HTML/CSS implementation, Python exercises, frontend tasks, data structures, aptitude/problem-solving activities, spreadsheet/data analytics tasks | 1.0: Correct implementation/execution \| 0.5: Minor errors/incomplete \| 0: Not executed | CO2–CO5 |
| **Output Analysis & Lab Documentation** | 0.75 | Output analysis, webpage presentation, coding output, communication tasks, resume/document drafting, lab/activity records, project demonstration | 0.75: Complete & well-presented \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO3–CO6 |
| **Professional & Ethical Conduct** | 0.25 | Teamwork, leadership, workplace ethics, collaboration, communication etiquette, participation in activities/discussions | 0.25: Consistent & professional \| 0.10: Occasional participation \| 0: Poor participation | CO1-CO6 |
| **Total** | **3.0** | Communication, technical, analytical, presentation, employability, and professional skill dimensions covered | | CO1–CO6 |

## 7.2 Best-N-of-15 Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| >10 | Best 10 | **30 Marks** | Best 10 of all sessions (3 marks × 10 = 30) |
| < 10 | All attended | **≤ 30 Marks** | Each missed session = zero; cannot be compensated |

# 8. Continuous Evaluation (CE) — 30 Marks

*ℹ CE is a mid-point practical examination covering Units 1–3 (CO1–CO3). CO4, CO5, and CO6 are assessed in ESE only.*

| Section | Marks | Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Sec A** | 10 | Professional communication, workplace readiness, HTML/CSS implementation, frontend fundamentals, analytical/problem-solving ability | CO1, CO2 | Communication activity, webpage creation, responsive design task, professional writing task, or analytical/problem-solving exercise with practical implementation |
| **Sec B** | 10 | Python/programming fundamentals, arrays/strings/problem solving, data analytics/spreadsheet activities, logical reasoning and implementation skills | CO2, CO3 | Coding/problem-solving activity, spreadsheet/data analysis task, frontend implementation, Python exercise, or practical analytical task with output demonstration |
| **Sec C (Viva)** | 10 | Presentation skills, conceptual understanding, communication clarity, leadership/team participation, output interpretation, professional behaviour | CO1–CO3 | Viva, presentation, demonstration, communication-based questioning, output explanation, project/activity discussion, and conceptual interpretation |
| **TOTAL** | **30** | Communication, analytical, technical, coding, presentation, professional, and employability skill dimensions covered | CO1–CO3 | Units 1–3 based practical, communication, coding, frontend, analytical, and activity-oriented evaluation |

## 9. End Semester Examination (ESE) — 40 Marks

*ℹ ESE is comprehensive — all 5 units and all 6 COs. Minimum 16/40 required to pass.*

| Section | Marks | Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Sec A** | 10 | Communication skills, verbal ability, grammar, professional writing, frontend/web fundamentals, | CO1, CO2, CO4 | Communication activity, grammar/verbal ability task, HTML/CSS implementation, responsive webpage exercise, aptitude/reasoning problem-solving, or analytical interpretation task |

| | | | | |
|---|---|---|---|---|
| | | aptitude and logical reasoning basics | | |
| **Sec B** | 20 | Data structures, programming fundamentals, analytical thinking, problem solving, Python/programming implementation, searching/sorting, arrays, stacks, queues, frontend/problem-solving activities | CO3, CO4, CO5 | Coding/problem-solving tasks, implementation exercises, algorithmic analysis, frontend development activities, Python exercises, data structure implementation, logical interpretation and analytical problem-solving |
| **Sec C** | 10 | Leadership, employability readiness, presentation skills, project/problem-solving approach, analytical evaluation, professional communication, innovation and collaborative skills | CO5, CO6 | Viva, presentation, resume/ATS evaluation, project demonstration, analytical discussion, communication-based evaluation, problem-solving explanation, leadership/teamwork assessment, and practical interpretation |
| **TOTAL** | **40** | | CO1–CO6 | Comprehensive practical, coding, communication, aptitude, analytical, frontend, and activity-oriented evaluation covering all Unit |

## 9.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (30) | CE (30) | ESE (40) | Skill Dims | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Recall professional communication, workplace etiquette, web fundamentals, data analytics basics, and computational concepts | ✓ | ✓ | ✓ | Communication readiness, conceptual understanding, workplace interaction, analytical thinking | PO1, PO8, PO9 |
| **CO2** | Explain business communication, presentation principles, semantic web | ✓ | ✓ | ✓ | Professional writing, presentation | PO1, PO2, PO9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | structures, data preprocessing, and computational approaches | | | | skills, frontend/web structuring, analytical interpretation | |
| **CO3** | Apply frontend development, programming fundamentals, presentations, group discussions, leadership, and collaborative problem solving | ✓ | ✓ | ✓ | Coding implementation, frontend development, teamwork, communication, practical problem solving | PO1, PO3, PO5, PO8 |
| **CO4** | Analyze communication challenges, reading passages, UI/UX layouts, linked list operations, and structured reasoning problems | ✓ | — | ✓ | Critical thinking, analytical reasoning, data structures, logical interpretation, problem analysis | PO1, PO2, PO3 |
| **CO5** | Evaluate employability practices, responsive designs, analytical workflows, stacks, queues, and professional strategies | ✓ | — | ✓ | Aptitude, employability skills, analytical evaluation, reasoning, responsive design analysis | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Design integrated projects, responsive applications, analytical solutions, and professional content for real-world applications | ✓ | — | ✓ | Project development, innovation, frontend implementation, leadership, collaborative solution design | PO3, PO5, PO9, PO11 |

*⚠ CO4, CO5, and CO6 are comprehensively assessed in CA and ETE components through analytical, coding, frontend, aptitude, communication, and project/problem-solving activities. MTE primarily focuses on Units 1–3 and assesses foundational communication, programming, analytical, and frontend implementation skills related to CO1–C.*

**PART III COMBINED MAPPINGS & REFERENCE** *CO–PO Matrix, CO–PO Alignment, Bloom's Reference, Attendance & Pass/Fail*

## 10. CO–PO and CO–PSO Mapping Matrix

*Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | - | 1 | - | - | 2 | 2 | 1 | - | 2 | 1 | 1 |
| CO2 | 2 | 2 | 2 | - | 2 | - | - | 2 | 2 | 1 | - | 2 | 2 | 1 |
| CO3 | 2 | 3 | 2 | - | 3 | - | - | 2 | 3 | 2 | - | 2 | 3 | 3 |
| CO4 | 3 | 3 | 2 | - | 2 | - | - | 2 | 2 | 2 | - | 3 | 2 | 2 |
| CO5 | 3 | 3 | 2 | - | 2 | - | - | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| CO6 | 2 | 3 | 3 | - | 3 | - | - | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| Avg | 2.50 | 2.67 | 2.40 | – | 2.17 | – | – | 2.33 | 2.50 | 2.00 | 2.50 | 2.33 | 2.17 | 2.00 |

## 11. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | M | | | | | M | M | | | M | | |
| CO2 | M | M | M | | M | | | M | M | | | M | M | |
| CO3 | M | H | H | | H | | | M | H | M | | M | H | H |
| CO4 | H | H | M | | M | | | M | M | M | | H | M | M |
| CO5 | H | H | M | | M | | | H | H | M | M | H | M | M |
| CO6 | M | H | H | | H | | | H | H | H | H | M | H | H |

*H = High / Primary alignment M = Medium / Secondary alignment Blank = No direct alignment*

## 12. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — **Remember:** Recall facts, definitions, terminology, communication rules, syntax, and concepts. **L2 — Understand:** Explain communication | A1 — Receiving: Awareness, willingness to attend A2 — Responding: Active participation and reaction A3 — Valuing: Demonstrating professionalism, | P1 — Perception: Observing cues and identifying processes P2 — Set: Readiness for practical execution and participation P3 — Guided coding, implementation, |

| | | |
|---|---|---|
| principles, analytical concepts, coding logic, and web structures. **L3 — Apply:** Use programming, analytical reasoning, frontend development, and communication skills in practical tasks **L4 — Analyze:** Examine logical patterns, communication challenges, algorithms, UI structures, and analytical **L5 — Evaluate:** Assess solutions, frontend designs, employability strategies, and analytical outcomes **L6 — Create:** Design projects, responsive interfaces, analytical solutions, and integrated applications | teamwork, and ethical conduct A4 — Organizing: Integrating professional values, collaboration, and leadership qualities A5 — Internalized professional behavior and ethical responsibility | and practical exercises P4 — Independent and confident practical execution P5 — Skilled implementation and problem-solving performance P6 — Adaptation: Modifying and improving solutions for specific requirements P7 — Origination: Creating innovative technical and communication-based solutions |

*ℹ OBE Compliance Statement: This is a practical, activity-oriented, and skill-integrated course. All 6 COs span Cognitive (L2–L6) as the primary domain, Psychomotor (P2–P7) for implementation and technical execution, and Affective (A2–A5) for teamwork, professionalism, communication, leadership, and collaborative learning.*

# 13. Attendance Policy & Pass/Fail Criteria

## 13.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Lab / Practical Sessions** | **75%** | Coding labs, communication activities, presentations, group discussions, frontend tasks, analytical exercises, practical implementations | Debarred from ETE if attendance falls below prescribed limit |

*⚠ Minimum 75% attendance is mandatory in practical/activity sessions. Non-submission of self-learning tasks, coding activities, analytical exercises, or communication assignments directly impacts internal assessment and is not compensable through external examination performance.*

## 13.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ESE Score** | **≥ 16 / 40** | **MANDATORY** | 40% of ESE marks required; failing ESE means failing the course regardless of CA + CE performance |
| **Overall Total (CA + CE + ESE)** | **≥ 40 / 100** | **Must pass overall** | CA 30 + CE 30 + ESE 40 = 100; 40% overall minimum required |

**_____—COURSE PLAN — MEASUREMENT ARCHITECTURE**

11 Programme Outcomes → 6 Lab COs (CO1–CO6) → 3 Assessment Instruments → Skill Dimensions

CO1–CO3: Apply/Analyse → CA + CE + ESE

CO4–CO5: Analyse/Evaluate → CA + ESE

CO6: Create → CA + ESE Sec C

**Marks: CA 30 + CE 30 + ESE 40 = Total 100**

| School: SSCSE | | Batch: 2026-2030 | |
|---|---|---|---|
| Program: B.Tech. | | Current Academic Year: 2027-28 | |
| Branch: CSE-AIML | | Semester: III | |
| 1 | Course Code | CSCR2600 | |
| 2 | Course Title | Project Based Learning -1 | |
| 3 | Credits | 1 | |
| 4 | Contact Hours (L-T-P) | 0-0-2 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. To align student's skill and interests with a realistic problem or project<br>2. To understand the significance of problem and its scope<br>3. Students will make decisions within a framework | |
| 6 | Course Outcomes | Students will be able to:<br>CO1: Identify and formulate problem statement with systematic approach.<br>CO2: Develop teamwork and problem-solving skills, along with the ability to communicate effectively with others.<br>CO3: Design the problem solution as per the problem statement framed.<br>CO4: Classify and understand techniques for software verification and validation of project successfully.<br>CO5: Fabricate and implement the solution by using different aspects of programming language.<br>CO6: Develop a glory of the need to engage in life-long learning. | |
| 7 | Course Description | In PBL-1, the students will learn how to define the problem for developing projects, identifying the skills required for developing the project based on given a set of specifications and all subjects of that Semester. | |
| 8 | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | Problem Definition, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any. | CO1, CO2 |
| | **Unit 2** | Develop a work flow or block diagram for the proposed system/software. | CO2, CO3 |
| | **Unit 3** | Design algorithms for the proposed problem. | CO3 |
| | **Unit 4** | Implementation of work under the guidance of a faculty member and obtain the appropriate results. | CO3, CO4 |
| | **Unit 5** | Demonstrate and execute Project with the team. Validate and verify the project modules. | CO4, CO5, CO6 |
| | | Report should include Abstract, Hardware / Software Requirement, Problem Statement, Design/Algorithm, Implementation Detail. Validation Reports.<br>References if any.<br>The presentation, report, work done during the term supported by the documentation, forms the basis of assessment. | |

| | | | | |
|---|---|---|---|---|
| | | | | |
| | Mode of examination | **Lab** | | |
| | Weight age Distribution | **CA** | **CE** | **ETE** |
| | | 30% | 30% | 40% |

**CO and PO Mapping**

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | CO1: Identify and formulate problem statements with systematic approach. | PO1, PO2, PO4, PO9, PO10, PO11, PSO1, PSO2, PSO3 |
| 2. | CO2: Develop teamwork and problem-solving skills, along with the ability to communicate effectively with others. | PO1, PO2, PO4, PO7, PO9, PO10, PO11, PSO3 |
| 3. | CO3: Design the problem solution as per the problem statement framed. | PO1, PO2, PO5, PO9, PO10, PO11, PSO1, PSO2 |
| 4. | CO4: Classify and understand techniques for software verification and validation of project successfully. | PO1, PO2, PO6, PO9, PO10, PO11, PSO2 |
| 5. | CO5: Fabricate and implement the solution by using different aspects of programming language. | PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2, PSO3 |
| 6. | CO6: Develop a glory of the need to engage in life-long learning. | PO1, PO2, PO4, PO9, PO10, PO11, PSO3 |

**PO and PSO mapping with level of strength for Course Name Project Based Learning -1 (Course Code CSCR2600)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | 3 | | | | 3 | 3 | 2 | 3 | 2 | 2 | 1 |
| **CO2** | 3 | 2 | | 3 | | 2 | | 3 | 3 | 2 | 3 | | | 1 |
| **CO3** | 3 | 2 | | | 2 | | | 3 | 3 | 2 | 3 | 2 | 2 | |
| **CO4** | 3 | 3 | | | | 2 | | 3 | 3 | 2 | 3 | | 2 | |
| **CO5** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | |
| **CO6** | 3 | 3 | | 3 | | | | 3 | 3 | 2 | 3 | | | 1 |
| **Avg PO attained** | **3** | **2.7** | **0.34** | **1.84** | **0.67** | **0.67** | **0.84** | **0.5** | **3** | **3** | **2** | **1** | **1.4** | **0.5** |

**Strength of Correlation: 21.46**
**1.** Addressed to **Slight (Low=1) extent**
**2.** Addressed to **Moderate (Medium=2) extent**
**3.** Addressed to **Substantial (High=3) extent**

# COURSE PLAN

## Data Structures (CSCR2511)

*School of Computing Science & Engineering (SSCSE) |B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I**

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | III |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR2511 |
| 2 | **Course Title** | **Data Structures** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-2-4 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | 1. Learn the basic concepts of Data Structures and algorithms.<br>2. Design and Implementation of Various Basic and Advanced Data Structures.<br>3. Learn the concepts of various searching, Sorting and Hashing Techniques.<br>4. Choose the appropriate data structures and algorithm design method for a specified application. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Remember – L1): Recall and list fundamental concepts of data structures, including types (linear vs. non-linear), static vs. dynamic memory allocation, and asymptotic notations (Big-O, Omega, Theta). |

| | | |
|---|---|---|
| | | CO2 (Understand – L2): Explain the working and internal representation of linear data structures (arrays, linked lists, stacks, queues) and nonlinear data structures (trees, graphs), including their traversal mechanisms.<br>CO3 (Apply – L3): Select and use appropriate linear data structures like stacks and queues to solve real-world computational problems such as expression evaluation, job scheduling, and palindrome checking.<br>CO4 (Analyze – L4): Analyze and compare various searching algorithms (linear, binary) and sorting algorithms (bubble, selection, insertion, merge, quick) in terms of time and space complexity.<br>CO5 (Evaluate – L5): Evaluate different hashing techniques (division, mid-square, folding) and collision resolution methods (chaining, open addressing) to design an efficient hash function for a given application.<br><br>CO6 (Create – L6): Design, implement, and demonstrate complete algorithmic solutions by integrating nonlinear data structures (trees, graphs) and advanced algorithms (traversal, shortest path, MST) to solve complex, real-world problems.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Implement operations like traversal, insertion, deletion, and searching on various linear and nonlinear data structures using professional tools (GCC, Linux CLI, debuggers) and maintain structured lab records.<br>CO8 (Apply – L3): Apply linear data structures (stacks, queues, linked lists) to solve given problems and develop complete executable solutions with proper modularization.<br>CO9 (Create – L5/L6): Design and develop applications using nonlinear data structures (trees, graphs) and hashing techniques, demonstrating optimized solutions with justification of data structure selection.<br>CO10 (Evaluate – L5): Choose and justify the most appropriate data structure(s) for a given problem by evaluating trade-offs in time, space, and implementation complexity, while collaborating and presenting solutions effectively in a team. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 45 hrs + Lab Instructions (LI) 30 hrs + Self Learning (SL) 45 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | 1. 5 assignments of 3h each. Total = 15h<br>2. 5 small coding-based problems of 3h each. Total = 15h<br>3. Self-learning on-line course Total = 15h |
| 11 | **References** | Textbook: Lipschutz, “Data Structures” Schaum’s Outline Series, TMH<br>Reference: Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein “Data Structures Using C and C++” , PHI<br>Reference: Horowitz and Sahani, “Fundamentals of Data Structures”, Galgotia Publication. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction (9-0-6-9 = 24 hrs)** | |
| **A** | Data Structure – Definition, Operations and Applications, Abstract Data Types, Algorithm – Definition, Introduction to Complexity, Big OH notation, Time and Space tradeoffs. | CO1 |
| **B** | Dynamic Memory Allocation( Malloc, calloc, realloc, free), Recursion – Definition, Examples- Tower of Hanoi problem, Tail Recursion | |
| **C** | Arrays: Implementation of One Dimensional Arrays, Multidimensional Arrays, Applications of Arrays, Address Calculation, Matrix Operations, Sparse martices | |

| | | |
|---|---|---|
| **Tools Used** | Linux Environment, GCC compiler with memory debugging tools (Valgrind), Virtual Labs, whiteboards, sticky notes for ADT modeling, online complexity visualizers. | |
| **Activities** | **Objective:** To understand asymptotic complexity, ADT concept, and dynamic memory management by implementing array-based structures and recursive solutions.<br><br>Implement programs to compute time complexity of simple algorithms using Big-O notation.<br>Use malloc/calloc to create dynamic arrays and compare with static allocation.<br>Implement Tower of Hanoi recursively and trace tail recursion.<br>Perform address calculation for row-major and column-major 2D arrays.<br>Represent and manipulate sparse matrices using triplet representation.<br>Use Valgrind to detect memory leaks in dynamic allocation. | |
| **Unit 2** | **Linked List (9-0-6-9 = 24 hrs)** | |
| **A** | Concept of Linked List, Garbage Collection, Overflow and Underflow, Array Implementation and Dynamic Implementation of Singly Linked Lists | CO2, CO3 |
| **B** | Array Implementation and Dynamic Implementation of Doubly Linked List, Circularly Linked List | |
| **C** | Operations on a Linked List- Insertion, Deletion, Traversal, Polynomial Representation and Addition | |
| **Tools Used** | Linux Environment, GCC, Competitive coding platforms (Leetcode, Hackerrank), Virtual Labs, whiteboards, online linked list visualizers (VisuAlgo), GitHub for version control. | |
| **Activities** | **Objective:** To apply dynamic memory allocation to implement linear linked structures and compare array vs. linked representations.<br><br>Implement singly linked list with insertion, deletion, traversal, and search.<br>Compare array implementation vs. dynamic implementation of linked lists.<br>Implement doubly linked list and circular linked list with menu-driven programs.<br>Represent a polynomial using linked list and perform addition of two polynomials.<br>Detect and handle overflow/underflow conditions.<br>Solve real-world problems (e.g., student record management) using linked lists. | |
| **Unit 3** | **Stack and Queue (9-0-6-9 = 24 hrs)** | |

| | | |
|---|---|---|
| **A** | Stacks: Definitions, Primitive operations, Application of stacks – Conversion of Infix Expression to Postfix form, Evaluation of Postfix Expressions | CO3 |
| **B** | Queues: Definition, Primitive Operations, Implementation of Circular Queues, Priority Queues | |
| **C** | Deques, Application of Queues. Implementation - Linked Stacks, Linked Queues. | |
| **Tools Used** | Linux Environment, GCC, Competitive coding platforms, Virtual Labs, expression tree visualizers, online stack/queue simulators, GitHub. | |
| **Activities** | **Objective:** To design and implement linear data structures (Stack & Queue) using both array and linked representations for real-world applications.<br><br>Implement stack using array and linked list with push/pop/peek operations.<br>Convert infix expression to postfix using stack (handling operator precedence).<br>Evaluate postfix expression using stack.<br>Implement linear queue, circular queue, and priority queue using array.<br>Implement queue using linked list to avoid overflow limitations.<br>Simulate real-world problems: palindrome checking (stack), job scheduling (queue), undo-redo functionality. | |
| **Unit 4** | **Tree and Graphs (9-0-6-9 = 24 hrs)** | |
| **A** | Trees: Terminologies, Binary tree, Representation, Applications, Binary search Tree – Operations on Binary Search Trees (Traversing, Insertion, deletion etc.), Binary Search Algorithm, AVL Tree | CO4, CO6 |
| **B** | Graph: Terminology, Representation, Traversals- Depth First Search, Breadth First Search. | |
| **C** | Graph Applications – Minimum Spanning Trees – Prim's and Kruskal's Algorithms | |
| **Tools Used** | Linux Environment, GCC, Graph visualization tools (Graphviz), Virtual Labs, BST visualizers, online graph traversal simulators, Leetcode, GitHub. | |
| **Activities** | **Objective:** To implement nonlinear data structures (trees and graphs) and apply traversal, search, and optimization algorithms.<br><br>Implement binary tree and BST with insertion, deletion, and three traversals (inorder, preorder, postorder).<br>Implement AVL tree with rotation operations (LL, RR, LR, RL).<br>Represent graphs using adjacency matrix and adjacency list.<br>Implement DFS and BFS traversals on graphs.<br>Implement Prim's and Kruskal's algorithms for MST.<br>Apply BST for dictionary/phonebook application.<br>Analyze time complexity of tree/graph operations. | |

| | | |
|---|---|---|
| **Unit 5** | **Searching, Sorting and Hashing (9-0-6-9 = 24 hrs)** | |
| **A** | Implementation and Analysis - Linear search, Binary Search | CO5, CO6 |
| **B** | Implementation and Analysis- Bubble Sort, Insertion Sort, Selection Sort, Tree sort | |
| **C** | Hashing: Concepts and Applications, Hash Functions, Collisions, Methods of Resolving Collisions | |
| **Tools Used** | Linux Environment, GCC, Hashing visualizers, Sorting algorithm analyzers (Big-O simulators), Competitive coding platforms, Virtual Labs, GitHub. | |
| **Activities** | **Objective:** To compare searching and sorting algorithms empirically and design efficient hash functions with collision resolution.<br><br>Implement linear search and binary search; compare their time complexities.<br>Implement bubble sort, insertion sort, selection sort, and tree sort.<br>Count and compare number of comparisons/swaps for each sorting algorithm on different input sizes.<br>Design a hash function (e.g., division method, mid-square) for integer/string keys.<br>Implement collision resolution using chaining (linked list) and open addressing (linear probing, quadratic probing).<br>Create a complete dictionary application using hashing.<br>Analyze best-case, average-case, and worst-case scenarios empirically | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | | ✓ | | | |
| 5 | 2.B | | | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | | | ✓ | ✓ | | ✓ |
| 8 | 3.B | ✓ | ✓ | | | ✓ | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12 | 4.C | | | ✓ | | | |
| 13 | 5.A | ✓ | ✓ | | ✓ | ✓ | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | | ✓ | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✔ | | | | | | | | | | | | | | | | | |
| CO2 | | ✔ | | | | | | | | | | | | | | | | |
| CO3 | | | ✔ | | | | | | | | | | | ✔ | | | | |
| CO4 | | | | ✔ | | | | | | | | | | ✔ | | | | |
| CO5 | | | | | ✔ | | | | | | | | | | ✔ | | | |
| CO6 | | | | | | ✔ | | ✔ | | | | | | | | ✔ | ✔ | |
| CO7 | | | ✔ | | | | | | | | | ✔ | ✔ | | | | | |
| CO8 | | | | ✔ | ✔ | | | | | | | | | ✔ | ✔ | | | |
| CO9 | | | ✔ | | | | ✔ | ✔ | | | | | | | | | | |
| CO10 | | | ✔ | | | | | | ✔ | | | ✔ | | | | | | |

*Legend: ✔ = Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Data Structure – Definition, Operations, Applications, Abstract Data Types (ADT) | Unit 1 | 4 |
| DD/MM/YY | Algorithm – Definition, Introduction to Complexity, Asymptotic Notations (Big-O, Omega, Theta) | Unit 1 | |
| DD/MM/YY | Time and Space Tradeoffs, Analysis of Simple Algorithms | Unit 1 | |
| DD/MM/YY | Dynamic Memory Allocation: malloc, calloc, realloc, free; Garbage Collection Concepts | Unit 1 | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Recursion – Definition, Examples (Factorial, Fibonacci), Tail Recursion | Unit 1 | 6 |
| DD/MM/YY | Tower of Hanoi Problem – Recursive Implementation and Complexity Analysis | Unit 1 | |
| DD/MM/YY | Arrays: 1D Array – Declaration, Initialization, Memory Representation, Address Calculation | Unit 1 | |
| DD/MM/YY | Multidimensional Arrays (2D, 3D) – Row-major and Column-major Address Calculation | Unit 1 | |
| DD/MM/YY | Matrix Operations (Addition, Multiplication, Transpose), Sparse Matrices – Triplet Representation | Unit 1 | |
| DD/MM/YY | Concept of Linked List – Advantages over Arrays, Garbage Collection, Overflow/Underflow | Unit 2 | |
| DD/MM/YY | Singly Linked List – Array Implementation vs Dynamic Implementation | Unit 2 | 8 |
| DD/MM/YY | Singly Linked List Operations: Insertion (Beginning, End, Position), Deletion, Traversal, Search | Unit 2 | |
| DD/MM/YY | Doubly Linked List – Dynamic Implementation, Operations (Insert, Delete, Traverse) | Unit 2 | |
| DD/MM/YY | Circularly Linked List – Dynamic Implementation, Operations, Applications | Unit 2 | |
| DD/MM/YY | Polynomial Representation Using Linked List, Polynomial Addition | Unit 2 | |
| DD/MM/YY | Stack: Definition, Primitive Operations (Push, Pop, Peek), Array Implementation | Unit 3 | |
| DD/MM/YY | Stack: Linked List Implementation, Applications – Reversal, Palindrome Checking | Unit 3 | |
| DD/MM/YY | Stack Application: Infix to Postfix Conversion – Algorithm and Examples | Unit 3 | |
| DD/MM/YY | Stack Application: Evaluation of Postfix Expression | Unit 3 | 6 |
| DD/MM/YY | Queue: Definition, Primitive Operations (Enqueue, Dequeue), Array Implementation | Unit 3 | |
| DD/MM/YY | Circular Queue – Need, Implementation, Overflow/Underflow Conditions | Unit 3 | |
| DD/MM/YY | Priority Queue – Types (Ascending/Descending), Array Implementation | Unit 3 | |
| DD/MM/YY | Deque (Double Ended Queue) – Input Restricted, Output Restricted, Applications | Unit 3 | |
| DD/MM/YY | Linked Queue – Implementation Using Linked List, Comparison with Array Queue | Unit 3 | |
| DD/MM/YY | Queue Applications – Job Scheduling, CPU Scheduling Simulation | Unit 3 | 6 |
| DD/MM/YY | Tree: Terminologies (Root, Parent, Child, Leaf, Depth, Height), Binary Tree – Properties | Unit 4 | |
| DD/MM/YY | Binary Tree Representation – Array Representation, Linked Representation | Unit 4 | |
| DD/MM/YY | Binary Tree Traversals – Inorder, Preorder, Postorder (Recursive and Iterative) | Unit 4 | |
| DD/MM/YY | Binary Search Tree (BST) – Definition, Operations: Insertion, Deletion, Searching | Unit 4 | |

| | | | |
|---|---|---|---|
| DD/MM/YY | AVL Tree – Need, Balance Factor, Rotations (LL, RR, LR, RL), Insertion | | |
| DD/MM/YY | Graph: Terminology (Vertex, Edge, Directed/Undirected, Weighted/Unweighted) | Unit 4 | |
| DD/MM/YY | Graph Representation – Adjacency Matrix, Adjacency List | Unit 4 | |
| DD/MM/YY | Graph Traversals – Depth First Search (DFS) – Algorithm and Example | Unit 4 | |
| DD/MM/YY | Graph Traversals – Breadth First Search (BFS) – Algorithm and Example | Unit 4 | |
| DD/MM/YY | Minimum Spanning Tree – Prim's Algorithm (Concept, Example, Complexity) | Unit 4 | |
| DD/MM/YY | Minimum Spanning Tree – Kruskal's Algorithm (Concept, Example, Complexity) | Unit 4 | |
| DD/MM/YY | Searching Algorithms – Linear Search (Algorithm, Complexity, Analysis) | Unit 5 | |
| DD/MM/YY | Searching Algorithms – Binary Search (Algorithm, Complexity, Analysis, Recursive & Iterative) | Unit 5 | |
| DD/MM/YY | Sorting Algorithms – Bubble Sort (Algorithm, Complexity, Example) | Unit 5 | |
| DD/MM/YY | Sorting Algorithms – Insertion Sort (Algorithm, Complexity, Example) | Unit 5 | |
| DD/MM/YY | Sorting Algorithms – Selection Sort (Algorithm, Complexity, Example) | Unit 5 | |
| DD/MM/YY | Sorting Algorithms – Tree Sort (Using BST, Complexity, Comparison with Other Sorts) | Unit 5 | |
| DD/MM/YY | Hashing: Concepts and Applications, Hash Functions (Division, Mid-Square, Folding) | Unit 5 | |
| DD/MM/YY | Collision Resolution – Chaining (Separate Chaining Using Linked List) | Unit 5 | |
| DD/MM/YY | Collision Resolution – Open Addressing (Linear Probing, Quadratic Probing, Double Hashing) | Unit 5 | |
| DD/MM/YY | Performance Analysis of Hashing – Load Factor, Rehashing | Unit 5 | |
| DD/MM/YY | Revision and Problem Solving – Unit 1 & 2 | All Units | |
| DD/MM/YY | Revision and Problem Solving – Unit 3 & 4 | All Units | |
| DD/MM/YY | Revision and Problem Solving – Unit 5 & Previous Year Questions | All Units | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Setting up environment: Linux commands, gcc, first C program — professional tool setup | CO7 | 3.0 |
| | S-1.2 | Calculate average of three integers; Four-fours digit problem | CO7 | |
| W2 | S-2.1 | Currency denominations (Rs. 10, 50, 100); Gross salary calculator | CO7 | 3.0 |
| | S-2.2 | Reverse a 5-digit number; Interchange contents of two variables | CO7 | |
| W3 | S-3.1 | Calculate area of triangle; Area & circumference of circle | CO7 | 3.0 |
| | S-3.2 | Bitwise operations on a number: set, check, toggle, and clear a bit | CO7 | |
| W4 | S-4.1 | Character classification; Find roots of quadratic equation | CO7 | 3.0 |
| | S-4.2 | Find youngest of three (Ram, Shyam, Ajay); Leap year check | CO7 | |
| W5 | S-5.1 | Check vowel/consonant via Switch-Case; Calculator for +, –, ×, ÷ | CO7 | 3.0 |
| | S-5.2 | Income tax calculator with personal allowance and child allowance slabs | CO7 | |
| W6 | S-6.1 | Check if a number is Armstrong (e.g., 153 = $1^3+5^3+3^3$) | CO7 | 3.0 |
| | S-6.2 | Print star patterns up to Nth line: pyramid and diamond shapes | CO7 | |
| W7 | S-7.1 | Calculate Permutation & Combination; refactor into modular functions | CO7 | 3.0 |
| | S-7.2 | Recursive function for sum of array; recursive exponentiation | CO7 | |
| W8 | S-8.1 | Menu-driven 1D array: display, sum, average | CO7 | 3.0 |
| | S-8.2 | Extend W8.1: minimum, maximum, search, bubble sort — all via functions | CO7 | |
| W9 | S-9.1 | Menu-driven 2D arrays: row sums, column sums, diagonal sums | CO7 | 3.0 |
| | S-9.2 | Extend W9.1: matrix addition and multiplication via functions | CO7 | |
| W10 | S-10.1 | Dynamic 1D array; functions for insert and delete operations | CO7 | 3.0 |
| | S-10.2 | Extend W10.1: Linear Search vs Binary Search with performance comparison | CO7 | |
| W11 | S-11.1 | Extract characters at Fibonacci index positions from string; name formatter | CO7 | 3.0 |
| | S-11.2 | Count character frequency; word count in a string; print frequency table | CO7 | |
| W12 | S-12.1 | Dynamic array of size n1; expand by n2; print all values | CO7 | 3.0 |
| | S-12.2 | Dynamic array with auto-doubling at 75% occupancy — efficiency analysis | CO7 | |
| W13 | S-13.1 | Structure 'product': name, price, qty, amount — real-world application with SDG context | CO8 | 3.0 |
| | S-13.2 | Structure 'student_record' with nested 'date'; array of structures — societal relevance discussion | CO8 | |
| W14 | S-14.1 | Complex number ADT using structures: design, document, and reflect — CO9 reflection form submitted | CO8/CO9 | 3.0 |
| | S-14.2 | Implement simple linked list — team implementation, role assignment, peer review session | CO8/CO10 | |

| | | | | |
|---|---|---|---|---|
| **W15** | S-15.1 | Merge & sort files — ethical data handling; skill self-assessment form submitted | **CO8/CO9** | 3.0 |
| | S-15.2 | Text file to lowercase; frequency counts — team code review, final presentation, group reflection | **CO9/CO10** | |

ℹ *Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Factual Recall & Conceptual Recognition** | Recall basic definitions: Data Structure, ADT, Algorithm, Complexity notations (Big-O, Omega, Theta), Tree/Graph terminologies, Hash functions, Sorting algorithm names | CO1 | L1–L2 |
| **TS2** | **Conceptual Explanation & Logical Interpretation** | Explain working of linear structures (stack, queue, linked list), nonlinear structures (tree, graph), recursion (Tower of Hanoi), collision resolution methods, MST algorithms (Prim's, Kruskal's) | CO2 | L2 |
| **TS3** | **Procedural Application & Problem Solving** | Apply stacks (infix to postfix, postfix evaluation), queues (circular, priority), linked lists (insertion/deletion/polynomial addition), BST (insertion/deletion/traversal), sorting (bubble, insertion, selection) | CO3 | L3 |
| **TS4** | **Analytical Reasoning & Program Tracing** | Trace recursive functions (Tower of Hanoi, Fibonacci), analyze complexity of sorting/searching algorithms, detect bugs in BST/AVL operations, analyze collision resolution performance, compare DFS vs BFS traversal paths | CO4 | L4 |
| **TS5** | **Comparative Evaluation & Algorithmic Justification** | Compare array vs linked list implementation, linear vs binary search, various sorting algorithms (bubble/insertion/selection/merge/quick), different hash functions, Prim's vs Kruskal's for MST, AVL vs BST | CO5 | L5 |
| **TS6** | **Synthesis & Holistic Design** | Design complete solutions integrating multiple data structures (e.g., hash table with linked list chaining, graph with adjacency list, expression evaluation using stack + tree), optimize using appropriate DS for real-world problems (dictionary, job scheduling, shortest path) | CO6 | L6 |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 MidTerm Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | 4 | TS1 — Factual Recall & Conceptual Recognition | CO1, CO2 | Short-answer: definitions of ADT, Big-O, Stack, Queue, Linked List; complexity of algorithms; predict output of recursive functions (e.g., Tower of Hanoi step); identify correct linked list operation |
| **Sec B** | 6 | TS2 — Conceptual Explanation & Logical Interpretation | CO3 | Program writing: implement stack using array, infix to postfix conversion, singly linked list insertion/deletion, circular queue operations |
| **TOTAL** | 10 | | CO1,CO2, CO3 | |

### 9.2 EndTerm Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions: definitions, syntax, output tracing, concept MCQs (all units) |
| **Sec B** | **50** | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Medium questions: program writing, debugging, algorithm comparison, complexity analysis |
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long/design questions: design modular solutions, justify choices, complete application |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |

| | | | |
|---|---|---|---|
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | ≤ **30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| **CA1** | **Problem Definition & Metrics** | Define the data structure problem clearly (e.g., implement BST insertion, infix to postfix conversion, graph DFS). Identify measurable parameters: number of operations (insertions/deletions), time taken, memory usage, collision count in hashing, tree height, sorting comparisons | CO7, CO8 |
| **CA2** | **Experimental Design & Tool Setup** | Plan the sequence of operations for the experiment. Configure development environment: Linux CLI, GCC compiler, Valgrind (memory leak detection), GDB debugger, GitHub for version control | CO7 |
| **CA3** | **Code Implementation & Execution** | Write correct C code implementing the specified data structure operation (e.g., stack push/pop, linked list traversal, AVL rotation). Compile and execute to produce expected output without errors | CO7 |

| | | | |
|---|---|---|---|
| CA4 | Computational Efficiency & Optimization | Evaluate time complexity (Big-O) and space complexity of the implemented data structure operation. Identify bottlenecks (e.g., $O(n^2)$ sorting, collision chain length in hashing). Propose optimizations (e.g., using balanced BST instead of linear search) | CO7 |
| CA5 | Output Analysis & Result Interpretation | Analyze program output critically (e.g., inorder traversal of BST must be sorted, postfix evaluation must match manual calculation). Explain deviations from expected results. Draw evidence-based inferences about data structure behavior | CO8 |
| CA6 | Documented Outcome with Verification | Record final outcome formally in the lab record. Verify outputs against the problem statement using test cases (e.g., empty list insertion, duplicate key handling in BST, collision resolution in hash table) | CO7, CO8 |
| CA7 | Algorithmic Design & Solution Planning | Produce algorithm, flowchart, or pseudocode before coding (e.g., algorithm for DFS traversal, steps for heap insertion). Justify design choices (e.g., why linked list over array for polynomial addition, why linear probing over chaining) | CO7, CO8 |
| CA8 | Lab Record Maintenance & Viva-Voce | Maintain complete, organized, and timely lab records with problem statements, code, outputs, and analysis. Demonstrate conceptual understanding orally during viva (e.g., explain AVL rotations, compare BFS vs DFS, justify hash function choice) | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | SDG Alignment & Social Relevance | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | Problem Scoping & Requirements | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | Communication & Testing Strategy | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | Innovative Solution Proposal | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | Professional Toolchain | Select and justify development tools; configure professional project environment | CO7 \| PO5 |
| P6 | End-to-End Implementation | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1: Prob. Def. | CA2 Exp. Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc. Outcome | CA7 Algo. Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys. Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | M | | M | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | | | | | H | H | H | M | | M | M | H | | | H | M | H | | | | | | | | |
| CO8 | | | | | | | M | | M | | H | H | H | | H | M | H | M | H | H | H | M | H | M | | | |
| CO9 | | | | | | | | | | | | | | M | | | | | | | | | | | | H | H |
| CO10 | | | | | | | | | | | | | | | | | H | | | | | | | H | | | |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | – | – | – | – | – | – | – | – | 1 | 2 | 1 | – |
| CO2 | 3 | 2 | – | – | – | – | – | – | 1 | – | 2 | 2 | 2 | – |
| CO3 | 3 | 3 | 2 | – | 2 | 2 | – | – | 1 | – | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 2 | – | 2 | 1 | 1 | 3 | 3 | 3 | 3 |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| **Avg** | **2.5** | **2.14** | **2.33** | **1.75** | **2.33** | **1.8** | **3** | **2.5** | **1.5** | **2** | **2.13** | **2.22** | **2.3** | **2.38** |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |
| CO2 | H | M | | | | | | | | M | |
| CO3 | M | H | M | | M | M | | | M | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO7 | | | M | | H | M | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | | M | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| **SDG 4** | **Quality Education** | **3 (High)** | Builds strong foundation in computational thinking and structured programming; aligned with lifelong learning (CO1–CO6, CO9). |
| **SDG 8** | **Decent Work & Economic Growth** | **3 (High)** | Develops industry-relevant programming and professional tool skills (CO7) directly applicable to employment in technology sectors. |
| **SDG 9** | **Industry, Innovation & Infrastructure** | **3 (High)** | Enables development of efficient software solutions; fosters innovation through real-world application design (CO6, CO8) and team-based projects (CO10). |
| **SDG 12** | **Responsible Consumption & Production** | **2 (Moderate)** | Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |

| | | | |
|---|---|---|---|
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | ≥ 20 / 50 | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | ≥ 40 / 100 | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE ProgrammeOutcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

| Semester 4, Credits: 23 | |
|---|---|
| **COURSE CODE** | **COURSE NAME** |
| CSCR2514 | Data Base Management System |
| CSCR2110 | Theory of Computation & Compiler Design |
| CSAI2301 | Neural Networks & AI Programming Framework |
| CSAI200** | Program Elective-1 |
| SKP2401 | Skills & Informatics-2: Integrated Professional Communication and Intelligent Computing |
| CSAI2101 | Machine Learning Operations & Agentic AI |
| CSCR2601 | Project Based Learning (PBL) -2 (AI Applications in Computer Network) |

# COURSE PLAN

## Data Base Management System (CSCR2514)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester IV | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR2514 |
| 2 | **Course Title** | **Data Base Management System** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-2-3 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | The course aims to develop students' ability to design, implement, and manipulate databases, provide foundational knowledge for constructing database management systems, and foster the application of DBMS concepts across diverse examples and real-world scenarios. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Remember – L1): Explain the basics concepts of data base.<br>CO2 (Understand – L2): Demonstrate the knowledge of databases to E-R modelling. |

| | | |
|---|---|---|
| | | CO3 (Apply – L3): Ability to design entity relationship and convert entity relationship diagrams into RDBMS and formulate SQL queries on the respective data.<br>CO4 (Analyze – L4): Apply normalization techniques to reduce redundancy from the database.<br>CO5 (Evaluate – L5): To appraise the basic issues of Transaction processing, Serializability& concurrency control.<br>CO6 (Create – L6): Design & develop database for real life problems.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Understand – L2): Understand and apply SQL commands for database creation, retrieval, and manipulation.<br>CO8 (Apply – L3): Create and execute SQL queries using SELECT statements, filtering, grouping, and reporting functions.<br>CO9 (Apply – L3): Perform database operations using DML commands such as INSERT, UPDATE, and DELETE to manage data effectively.<br>CO10 (Create – L6): Develop database-driven applications/projects by applying various SQL concepts and commands in real-world scenarios. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 60 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self-Learning (SL: 30 hrs)** | 1. Advanced SQL Queries, Joins, Subqueries, and Reporting Functions. 2. Database Security, Transactions, Backup, and Recovery Mechanisms. 3. Mini Project on Database Application Development using DBMS. |
| 11 | **References** | Textbook: Korth, Silberschatz & Sudarshan, Data base Concepts, Tata McGraw-Hill, Latest Edition.<br>Reference: Elmasri, Navathe, Fundamentals of Database Systems, Pearson Education Inc.<br>Reference: Thomas Connolly, Carolyn Begg, Database Systems: A Practical Approach to design, Implementation and Management, Pearson Education, Third Edition. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction to Databases: (4-0-10-6 = 20 hrs)** | |
| **A** | Introduction of DBMS, Characteristic of DBMS, Data Models, Database languages, Database Administrator, Database Users. | CO1, CO2, CO6 |
| **B** | Three Schema architecture of DBMS, Data Models, Hierarchical, Network, Data independence and database language, DDL, DML, Data Modeling using Entity Relationship Model. | |
| **C** | Strong Entity, Weak entity, Specialization and generalization, converting ER Model to relational tables. | |
| **Tools Used** | MySQL Workbench, Oracle Database, XAMPP, phpMyAdmin, Microsoft Visio, Draw.io, SQLite, PostgreSQL | |
| **Activities** | • **Objective:** To understand the fundamentals of DBMS, data models, database languages, schema architecture, and ER modeling concepts for designing relational databases. | |

| | | |
|---|---|---|
| | • Design an Entity Relationship (ER) diagram for a Library/Student Management System, identify strong and weak entities, apply specialization/generalization, convert the ER model into relational tables, and perform basic DDL and DML operations using SQL. | |
| **Unit 2** | **Relational Database Language and Interfaces: (6-0-12-6 = 24 hrs)** | |
| **A** | Relational data model concepts, Concept of keys, Mapping Constraints. | CO2, CO3 |
| **B** | Null Values, Domain Constraints, Referential Integrity Constraints. | |
| **C** | Unary Relational Operations: SELECT and PROJECT Relational Algebra Operations from Set Theory, Binary Relational Operations: JOIN and DIVISION, SQL. | |
| **Tools Used** | MySQL Workbench, Oracle Database, PostgreSQL, SQLite, Online GDB, Virtual Labs, Draw.io | |
| **Activities** | • **Objective:** To understand relational data model concepts, relational algebra operations, integrity constraints, and SQL queries for effective database design and data manipulation.<br>• Create relational tables with primary and foreign keys, apply domain and referential integrity constraints, perform SELECT, PROJECT, JOIN, and DIVISION operations using SQL queries, and practice query execution using MySQL/PostgreSQL in a Linux environment or online compiler. | |
| **Unit 3** | **Normalization in Design of Databases: (8-0-16-6 = 30 hrs)** | |
| **A** | Functional Dependency, Different anomalies in designing a Database, loss less join decompositions. | CO1, CO3, CO4, CO6 |
| **B** | Normalization: first second and third normal forms, Boyce-Codd normal form, dependency preservation. | |
| **C** | Multi-valued dependencies, fourth normal forms, Inclusion dependencies. | |
| **Tools Used** | MySQL Workbench, Oracle Database, PostgreSQL, SQLite, phpMyAdmin, Draw.io, Microsoft Visio, Lucidchart, DB Fiddle, Online GDB | |
| **Activities** | • **Objective:** To understand functional dependencies, normalization techniques, decomposition methods, and dependency preservation for designing efficient and anomaly-free relational databases.<br>• Identify functional dependencies and different anomalies (insertion, deletion, updation) in given database tables.<br>• Perform decomposition of relations and verify lossless join and dependency preservation properties.<br>• Normalize database relations from 1NF to BCNF and 4NF using suitable examples. | |

| | | |
|---|---|---|
| | • Analyze multivalued dependencies and inclusion dependencies in relational schemas.<br>• Implement normalized relational tables using SQL in MySQL/PostgreSQL. | |
| **Unit 4** | **Transaction Management: (6-0-12-6 = 24 hrs)** | |
| **A** | Transaction processing system, schedule and recoverability, Testing of serializability. | CO5 |
| **B** | Serializability of schedules, conflict & view serializable schedule. | |
| **C** | Recovery from transaction failures, deadlock handling. | |
| **Tools Used** | MySQL Workbench, Oracle Database, PostgreSQL, SQLite, DB Fiddle, XAMPP, Linux, Virtual Lab, Online GDB, GitHub. | |
| **Activities** | **Objective:** To understand transaction processing concepts, serializability, recoverability, concurrency control, and deadlock handling mechanisms in DBMS.<br>• Simulate transaction schedules and test for serializability using conflict and view serializability methods.<br>• Analyze recoverable and non-recoverable schedules with suitable examples.<br>• Perform concurrency control experiments using simultaneous transactions in SQL.<br>• Implement transaction control commands such as COMMIT, ROLLBACK, and SAVEPOINT.<br>• Demonstrate deadlock situations and apply deadlock prevention and recovery techniques.<br>• Study transaction failure scenarios and perform database recovery operations using logs/checkpoints. | |
| **Unit 5** | **Concurrency Control: (6-0-10-6 = 22 hrs)** | |
| **A** | Two-Phase Locking Techniques for Concurrency Control, Concurrency Control Based on Timestamp Ordering. | CO5, CO6 |
| **B** | Multi-version Concurrency Control Techniques, Validation (Optimistic) Concurrency Control Techniques. | |
| **C** | Granularity of Data Items and Multiple Granularity Locking. | |
| **Tools Used** | MySQL Workbench, Oracle Database, PostgreSQL, SQLite, DB Fiddle, Linux, Virtual Labs, GitHub, Online GDB, Draw.io | |
| **Activities** | • **Objective:** To understand various concurrency control techniques, locking protocols, timestamp ordering, multi-version | |

| | | |
|---|---|---|
| | concurrency control, and multiple granularity locking mechanisms in DBMS.<br>• Simulate Two-Phase Locking (2PL) protocols for concurrent transactions.<br>• Implement timestamp ordering protocols and analyze transaction execution order.<br>• Perform experiments on optimistic concurrency control and validation techniques.<br>• Demonstrate Multi-version Concurrency Control (MVCC) using database transactions.<br>• Analyze lock granularity levels such as row-level, page-level, and table-level locking. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | | ✓ | ✓ | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | | ✓ | ✓ | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | | | ✓ | ✓ | | |
| 8 | 3.B | | | | ✓ | ✓ | |
| 9 | 3.C | | | | ✓ | ✓ | |
| 10 | 4.A | | | ✓ | ✓ | | |
| 11 | 4.B | | | | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | | ✓ | |
| 13 | 5.A | | | ✓ | ✓ | | |
| 14 | 5.B | | | | ✓ | ✓ | |
| 15 | 5.C | | | | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | ✓ | ✓ | | | | | ✓ | | | | | |
| CO3 | | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | ✓ | | | |
| CO4 | | | ✓ | ✓ | | | | | ✓ | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | | ✓ | ✓ | | | | | | | | |
| CO6 | | | | | | ✓ | | | | ✓ | ✓ | | | | | | ✓ | |
| CO7 | | ✓ | ✓ | | | | | ✓ | | | | | ✓ | ✓ | | | | |
| CO8 | | | ✓ | | | | | | ✓ | ✓ | | | | ✓ | ✓ | | | |
| CO9 | | | ✓ | | | | | | ✓ | | | | | ✓ | ✓ | | | |
| CO10 | | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | | ✓ | ✓ | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to DBMS, Characteristics of DBMS, Advantages of DBMS | Unit 1 | 4 |
| DD/MM/YY | Data Models, Database Languages, DBA and Database Users | | |
| DD/MM/YY | Three Schema Architecture, Data Independence, Hierarchical & Network Models | | |
| DD/MM/YY | ER Model, Strong & Weak Entity, Specialization, Generalization, ER to Relational Tables | | |
| DD/MM/YY | Relational Data Model Concepts, Relational Schema and Instances | Unit 2 | 6 |
| DD/MM/YY | Concept of Keys and Mapping Constraints | | |
| DD/MM/YY | Null Values, Domain Constraints, Referential Integrity Constraints | | |
| DD/MM/YY | Relational Algebra: SELECT and PROJECT Operations | | |
| DD/MM/YY | Set Operations, JOIN and DIVISION Operations | | |
| DD/MM/YY | Introduction to SQL and Basic SQL Queries | | |
| DD/MM/YY | Functional Dependency and Types of Dependencies | Unit 3 | 8 |
| DD/MM/YY | Database Anomalies and Lossless Join Decomposition | | |
| DD/MM/YY | First Normal Form (1NF) | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Second Normal Form (2NF) | | |
| DD/MM/YY | Third Normal Form (3NF) | | |
| DD/MM/YY | Boyce-Codd Normal Form (BCNF) and Dependency Preservation | | |
| DD/MM/YY | Multivalued Dependencies and Fourth Normal Form (4NF) | | |
| DD/MM/YY | Inclusion Dependencies and Normalization Case Studies | | |
| DD/MM/YY | Transaction Processing System and Transaction States | Unit 4 | 6 |
| DD/MM/YY | Schedules and Recoverability | | |
| DD/MM/YY | Testing of Serializability | | |
| DD/MM/YY | Conflict and View Serializable Schedules | | |
| DD/MM/YY | Recovery from Transaction Failures | | |
| DD/MM/YY | Deadlock Handling Techniques | | |
| DD/MM/YY | Introduction to Concurrency Control and Two-Phase Locking | Unit 5 | 6 |
| DD/MM/YY | Timestamp Ordering Concurrency Control | | |
| DD/MM/YY | Multi-version Concurrency Control Techniques | | |
| DD/MM/YY | Validation (Optimistic) Concurrency Control | | |
| DD/MM/YY | Granularity of Data Items | | |
| DD/MM/YY | Multiple Granularity Locking and Case Studies | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (Understand and apply SQL commands). W13–W15 (teal rows): CO8 (Create and execute SQL queries), CO9 (Perform database operations), CO10 (Develop database-driven applications/projects). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Study and classification of SQL commands | CO7 | 3.0 |
| | S-1.2 | Identify and use different SQL data types | CO7 | |
| W2 | S-2.1 | Create tables using different data types | CO7 | 3.0 |
| | S-2.2 | Demonstrate constraints with SQL data types | CO7 | |
| W3 | S-3.1 | Write SQL statements using character and numeric data types | CO8 | 3.0 |
| | S-3.2 | Mini exercise on SQL syntax and database creation | CO10 | |
| W4 | S-4.1 | Create tables using DDL commands | CO7 | 3.0 |
| | S-4.2 | Modify table structure using ALTER TABLE | CO7 | |
| | S-5.1 | Remove tables using DROP TABLE | CO7 | |

| | | | | |
|---|---|---|---|---|
| **W5** | S-5.2 | Apply PRIMARY KEY and FOREIGN KEY constraints | **CO8** | 3.0 |
| **W6** | S-6.1 | Create databases for Student/Employee Management System | **CO10** | 3.0 |
| | S-6.2 | Implement NOT NULL, UNIQUE, and CHECK constraints | **CO8** | |
| **W7** | S-7.1 | Insert records into tables using INSERT command | **CO8** | 3.0 |
| | S-7.2 | Retrieve records using SELECT statement | **CO9** | |
| **W8** | S-8.1 | Update records using UPDATE command | **CO9** | 3.0 |
| | S-8.2 | Delete records using DELETE command | **CO9** | |
| **W9** | S-9.1 | Use aggregate functions SUM, AVG, COUNT, MAX, MIN | **CO8** | 3.0 |
| | S-9.2 | Develop queries for real-world database applications | **CO10** | |
| **W10** | S-10.1 | Perform sorting using ORDER BY clause | **CO8** | 3.0 |
| | S-10.2 | Group records using GROUP BY clause | **CO8** | |
| **W11** | S-11.1 | Filter grouped records using HAVING clause | **CO8** | 3.0 |
| | S-11.2 | Apply aggregate functions with grouping clauses | **CO8** | |
| **W12** | S-12.1 | Generate summary reports using SQL queries | **CO10** | 3.0 |
| | S-12.2 | Create SQL queries for data analysis and reporting | **CO10** | |
| **W13** | S-13.1 | Execute simple and nested subqueries | **CO8** | 3.0 |
| | S-13.2 | Implement INNER JOIN and OUTER JOIN queries | **CO8** | |
| **W14** | S-14.1 | Perform SELF JOIN and CROSS JOIN operations | **CO8** | 3.0 |
| | S-14.2 | Create and use SQL Views | **CO9** | |
| **W15** | S-15.1 | Create database triggers for INSERT/UPDATE operations | **CO10** | 3.0 |
| | S-15.2 | Mini project using Joins, Views, Subqueries, and Triggers | **CO10** | |

ℹ *Instructions: Write and execute SQL queries using appropriate DBMS software. Perform database creation, table manipulation, data retrieval, and reporting operations with suitable examples and test cases. Lab record (aim, query/procedure, output, and result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Factual Recall & Conceptual Recognition** | Ability to remember and identify fundamental DBMS concepts, terminology, architectures, data models, and SQL commands. | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| **TS2** | **Conceptual Explanation & Logical Interpretation** | Ability to explain database concepts, relational models, constraints, normalization, and transaction management logically. | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| **TS3** | **Procedural Application & Problem Solving** | Ability to apply SQL queries, normalization techniques, relational algebra, and database operations to solve problems. | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| **TS4** | **Analytical Reasoning & Program Tracing** | Ability to analyze dependencies, transaction schedules, concurrency issues, and trace SQL/query execution logically. | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| **TS5** | **Comparative Evaluation & Algorithmic Justification** | Ability to compare normalization forms, concurrency control methods, locking techniques, and justify suitable approaches. | CO5 \| L5 | ETE Sec B/C |
| **TS6** | **Synthesis & Holistic Design** | Ability to design complete database systems, ER models, relational schemas, and real-world database applications. | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short-answer: definitions, output prediction, syntax identification |
| **Sec B** | **6** | TS3 — Procedural Application TS4 — Analytical Reasoning | **CO3, CO4** | Program writing; program tracing — detect errors and trace execution |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions: definitions, syntax, output tracing, concept MCQs (all units) |
| **Sec B** | **50** | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Medium questions: program writing, debugging, algorithm comparison, complexity analysis |

| | | | | |
|---|---|---|---|---|
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long/design questions: design modular solutions, justify choices, complete application |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |

| | | | | |
|---|---|---|---|---|
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Ability to identify database problems, define objectives, requirements, constraints, and expected outcomes for SQL-based tasks. | CO7, CO8 |
| CA2 | **Experimental Design & Tool Setup** | Ability to configure DBMS tools/software, create databases, tables, and prepare the environment for executing SQL operations. | CO7 |
| CA3 | **Code Implementation & Execution** | Ability to write, execute, and debug SQL queries, DDL, DML commands, joins, subqueries, views, and triggers correctly. | CO7 |
| CA4 | **Computational Efficiency & Optimization** | Ability to optimize SQL queries, reduce redundancy through normalization, and improve database performance and consistency. | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Ability to analyze query outputs, validate results, and interpret database reports and transaction outcomes logically. | CO8 |
| CA6 | **Documented Outcome with Verification** | Ability to document aim, procedure, SQL queries, outputs, results, and verify correctness using suitable test cases. | CO7, CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Ability to design ER models, relational schemas, normalization strategies, and structured database solutions for applications. | CO7, CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Ability to maintain systematic lab records and effectively explain SQL queries, concepts, and implementation during viva-voce. | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | **SDG Alignment & Social Relevance** | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | **Problem Scoping & Requirements** | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | **Communication & Testing Strategy** | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | **Innovative Solution Proposal** | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | **Professional Toolchain** | Select and justify development tools; configure professional project environment | CO7 \| PO5 |

| | | | |
|---|---|---|---|
| P6 | End-to-End Implementation | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

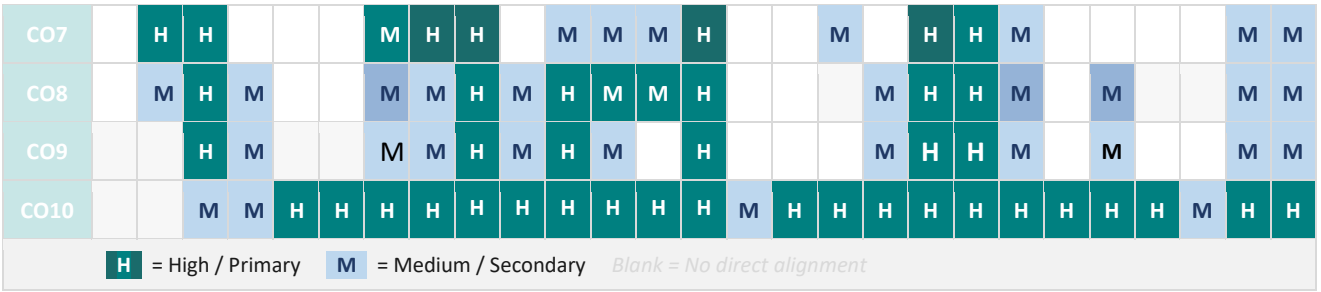
## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 -Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | M |
| CO2 | M | H | M | | | | M | M | | | | | M | M | | | M | | M | | | | | | | M | M |
| CO3 | | M | H | M | | M | H | M | H | M | H | M | H | M | | M | M | H | H | H | M | | M | M | | H | M |
| CO4 | | M | H | H | M | | M | | H | H | H | M | M | M | | | | M | M | M | M | | H | | | H | M |
| CO5 | | M | M | H | H | | M | | M | M | H | M | | M | | | M | M | M | M | H | M | H | M | | M | H |
| CO6 | | | | M | M | H | H | H | H | H | H | H | H | H | M | H | H | H | H | H | H | H | H | H | M | H | M |




PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | – | – | – | – | 2 | – | – | – | – | – | 3 | 3 | – |
| CO2 | 2 | – | – | – | 3 | 2 | – | – | 2 | – | – | 3 | 3 | – |
| CO3 | 3 | 3 | 3 | – | 3 | 2 | – | – | – | – | – | 2 | 3 | – |
| CO4 | 3 | 3 | 3 | 3 | – | 2 | – | 2 | 3 | – | – | – | – | 3 |
| CO5 | 2 | 3 | 2 | – | 2 | 2 | – | 2 | – | – | – | – | 3 | – |
| CO6 | 3 | 3 | 3 | 3 | 3 | 3 | – | 3 | 3 | – | – | – | – | 3 |
| CO7 | 3 | – | – | – | 2 | – | – | – | – | – | 2 | 3 | 3 | 2 |
| CO8 | – | 3 | 3 | 3 | 2 | – | – | – | 3 | – | 2 | 2 | 3 | 3 |
| CO9 | – | 2 | 2 | 2 | 2 | – | – | – | 3 | – | 2 | 2 | 2 | 3 |
| CO10 | – | 2 | 2 | 2 | 3 | – | – | – | 3 | – | 3 | 3 | 2 | 3 |
| Avg | 2.7 | 2.7 | 2.5 | 2.6 | 2.5 | 2.1 | - | 2.3 | 2.8 | - | 2.2 | 2.5 | 2.7 | 2.8 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | M |
| CO2 | H | M | M | | M | | | | M | | M |
| CO3 | H | H | H | M | H | | | M | M | | M |
| CO4 | H | H | M | H | M | | | | | | M |
| CO5 | H | H | M | H | M | M | M | | M | | M |
| CO6 | H | H | H | H | H | M | M | H | H | H | H |
| CO7 | M | M | | | H | | | | | | M |
| CO8 | M | H | M | M | H | | | | M | | M |
| CO9 | M | H | M | M | H | | | | | | M |
| CO10 | H | H | H | H | H | M | M | H | H | H | H |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in computational thinking and structured programming; aligned with lifelong learning (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant programming and professional tool skills (CO7) directly applicable to employment in technology sectors. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables development of efficient software solutions; fosters innovation through real-world application design (CO6, CO8) and team-based projects (CO10). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Theory of Computation & Compiler Design (CSCR2110)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester IV | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

# COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech. | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |
| **Course Code:** | CSCR2110 | **Course Type:** | Core - Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR2110 |
| 2 | **Course Title** | **Theory of Computation & Compiler Design** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-1-0-4 (Theory: 60 hrs. Classroom + 60 hrs. Self-learning = 120 hrs. total) |

| | | |
|---|---|---|
| 5 | **Course Status** | **Core - Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | The objective of this course is to introduce formal models of computation, automata theory, formal languages, and compiler design principles. Students will learn finite automata, regular expressions, context-free grammars, pushdown automata, parsing techniques, syntax-directed translation, intermediate code generation, and code optimization methods. The course develops analytical and problem-solving skills required for language processing systems and compiler implementation. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Remember – L1)<br>Recall the concepts of formal languages, finite automata, regular expressions, and automata models.<br><br>CO2 (Understand – L2)<br>Explain grammars, context-free languages, compiler phases, and language processing mechanisms.<br><br>CO3 (Apply – L3)<br>Apply automata construction techniques, grammar transformations, and pushdown automata design methods.<br><br>CO4 (Analyze – L4)<br>Analyze parsing techniques, lexical analysis methods, and syntax analysis algorithms.<br><br>CO5 (Evaluate – L5)<br>Evaluate syntax-directed translation schemes, semantic analysis approaches, and intermediate code generation techniques.<br><br>CO6 (Create – L6)<br>Design optimized compiler components using code generation and optimization techniques. |
| 8 | **Course Description** | This course provides a comprehensive study of automata theory and compiler design. It covers finite automata, regular expressions, context-free grammars, pushdown automata, lexical analysis, parsing techniques, semantic analysis, intermediate code generation, and optimization strategies. Students learn mathematical foundations of computation and practical compiler construction methodologies. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 60 hrs., Self Learning (SL): 60 hrs., Total: 120 hrs. |
| 10 | **Mode of Examination** | **Theory Only. CA: 25%, MTE: 15%, ETE: 60%, Total: 100 marks** |
| 11 | **Textbook** | 1. Hopcroft, Motwani & Ullman – Introduction to Automata Theory, Languages and Computation.<br>2. Aho, Lam, Sethi & Ullman – Compilers: Principles, Techniques and Tools. |
| 12 | **References** | 1. Peter Linz – Formal Languages and Automata.<br>2. Raymond Greenlaw – Fundamentals of the Theory of Computation.<br>3. Kenneth Louden – Compiler Construction Principles and Practice. |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Finite Automata and Regular Expressions** | |
| **A** | Introduction to Languages, Alphabets, Strings, Kleene Closure, Finite Automata, DFA, NFA | **CO1** |
| **B** | Regular Expressions, ε-NFA, Regular Expression to Automata Conversion, Arden's Theorem | **CO1, CO2** |
| **C** | Moore Machine, Mealy Machine, FA with Output and Equivalence | **CO1, CO2** |
| | **Unit 2: Regular and Context Free Languages** | |
| **A** | Grammars, Chomsky Hierarchy, Context-Free Grammar, Ambiguous and Unambiguous Grammar | **CO1, CO2, CO3** |
| **B** | Simplification of CFGs, Normal Forms, Derivations and Parse Trees | **CO2, CO3** |
| **C** | Compiler Overview, Compiler Phases, Passes, Bootstrapping and Cross Compiler | **CO2, CO3** |
| | **Unit 3: Pushdown Automata** | |
| **A** | Definition and Description of PDA, Deterministic and Non-Deterministic PDA | **CO3** |
| **B** | Acceptance by Final State and Empty Stack, PDA Construction | **CO3** |
| **C** | Two Stack PDA and Applications of PDA | **CO3, CO4** |
| | **Unit 4: Lexical Analysis, Syntax Analysis and Parsing Techniques** | |
| **A** | Lexical Analysis, Tokens, Patterns, Lexemes, Lexical Analyzer Design | **CO3, CO4, CO5** |
| **B** | FIRST and FOLLOW, Predictive Parsing, LL (1) Parsing, Operator Precedence Parsing | **CO3, CO4, CO5** |
| **C** | Shift Reduce Parsing, LR (0), SLR (1), CLR (1), LALR (1) Parsing Techniques | **CO3, CO4, CO5** |

| | Unit 5: Semantic Analysis and Code Generation | |
|---|---|---|
| A | Syntax Directed Definitions, Attributes, Translation Schemes | CO5 |
| B | Intermediate Code Generation, Three Address Code, Quadruples and Triples | CO5, CO6 |
| C | Code Optimization, Machine Independent and Machine Dependent Optimization, Code Generation | CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | ✓ | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | ✓ | ✓ | | | |
| 7 | 3.A | | ✓ | ✓ | ✓ | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | ✓ | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | | ✓ | ✓ | ✓ | |
| 14 | 5.B | | | ✓ | ✓ | ✓ | ✓ |
| 15 | 5.C | | | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | ✓ | ✓ | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | ✓ | | | | | ✓ | ✓ | | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | | | | |
| CO5 | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | | | | |
| CO6 | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | ✓ |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 60 Lectures / 60 Hours)

ℹ *Total classroom contact: 60 hours across 5 units. Self-Learning activities (60 hrs) are structured separately in Section 11.*

| Date | Smart Contract Basics | UNIT | Total Lectures |
|---|---|---|---|
| **DD/MM/YY** | Introduction to Languages and Formal Languages | UNIT-1 | 12 |
| **DD/MM/YY** | Kleene Closure and Language Operations | | |
| **DD/MM/YY** | Finite Automata and Transition Graphs | | |
| **DD/MM/YY** | Deterministic Finite Automata (DFA) | | |
| **DD/MM/YY** | Non-Deterministic Finite Automata (NFA) | | |
| **DD/MM/YY** | DFA Design Tutorial Problems | | |
| **DD/MM/YY** | Regular Expressions | | |
| **DD/MM/YY** | ε-NFA and Conversion Techniques | | |
| **DD/MM/YY** | NFA to DFA Conversion Tutorial | | |
| **DD/MM/YY** | Arden's Theorem | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Moore and Mealy Machines | | |
| DD/MM/YY | Regular Expression Construction Tutorial | | |
| DD/MM/YY | Grammar Fundamentals | UNIT-2 | 12 |
| DD/MM/YY | Chomsky Hierarchy of Languages | | |
| DD/MM/YY | Ambiguous and Unambiguous Grammar | | |
| DD/MM/YY | CFG Simplification | | |
| DD/MM/YY | Normal Forms for CFG | | |
| DD/MM/YY | CFG Simplification Tutorial | | |
| DD/MM/YY | Derivation and Parse Trees | | |
| DD/MM/YY | Compiler Fundamentals | | |
| DD/MM/YY | Compiler Phases and Passes | | |
| DD/MM/YY | Bootstrapping and Cross Compiler | | |
| DD/MM/YY | Parse Tree Construction Tutorial | | |
| DD/MM/YY | Chomsky Normal Form Exercises | | |
| DD/MM/YY | Introduction to Pushdown Automata (PDA) | UNIT-3 | 12 |
| DD/MM/YY | Deterministic and Non-Deterministic PDA | | |
| DD/MM/YY | Working of PDA | | |
| DD/MM/YY | Acceptance by Final State | | |
| DD/MM/YY | Acceptance by Empty Stack | | |
| DD/MM/YY | PDA Design Tutorial Problems | | |
| DD/MM/YY | CFG to PDA Conversion | | |
| DD/MM/YY | PDA to CFG Conversion | | |
| DD/MM/YY | Two Stack PDA | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Applications of PDA | | |
| DD/MM/YY | PDA Construction Exercises | | |
| DD/MM/YY | CFG–PDA Conversion Tutorial | | |
| DD/MM/YY | Lexical Analysis Fundamentals | UNIT-4 | 12 |
| DD/MM/YY | Tokens, Patterns and Lexemes | | |
| DD/MM/YY | Lexical Analyzer Design | | |
| DD/MM/YY | Role of Parsers | | |
| DD/MM/YY | Top-Down Parsing Techniques | | |
| DD/MM/YY | FIRST and FOLLOW Computation Tutorial | | |
| DD/MM/YY | Predictive Parsing and LL(1) Grammars | | |
| DD/MM/YY | Operator Precedence Parsing | | |
| DD/MM/YY | Bottom-Up Parsing Concepts | | |
| DD/MM/YY | LR Parsing Techniques (SLR, CLR, LALR) | | |
| DD/MM/YY | LL(1) Parsing Table Construction Tutorial | | |
| DD/MM/YY | Shift Reduce and LR Parsing Exercises | | |
| DD/MM/YY | Syntax Directed Definitions (SDD) | UNIT-5 | 12 |
| DD/MM/YY | Synthesized Attributes | | |
| DD/MM/YY | Inherited Attributes | | |
| DD/MM/YY | Evaluation Order for SDDs | | |
| DD/MM/YY | Syntax Directed Translation Schemes | | |
| DD/MM/YY | Attribute Grammar Tutorial | | |
| DD/MM/YY | Intermediate Code Generation | | |
| DD/MM/YY | Three Address Code | | |
| DD/MM/YY | Variants of Three Address Code | | |

| | | | |
|---|---|---|---|
| **DD/MM/YY** | Code Optimization Techniques | | |
| **DD/MM/YY** | Machine Dependent and Machine Independent Optimization | | |
| **DD/MM/YY** | Intermediate Code & Optimization Tutorial | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Automata & Language Fundamentals | Recall concepts of formal languages, automata theory, DFA, NFA, regular expressions, finite state machines, and language representations | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | Grammar & Compiler Foundation Understanding | Explain regular languages, CFGs, grammar simplification, Chomsky hierarchy, compiler phases, and language processing concepts | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | Pushdown Automata & Language Recognition Application | Apply PDA concepts, CFG-PDA conversions, acceptance mechanisms, and context-free language recognition techniques | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | Semantic Processing & Translation Scheme Design | Evaluate syntax-directed definitions, attribute grammars, semantic rules, and translation schemes for language processing | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |

| | | | | |
|---|---|---|---|---|
| TS5 | Semantic Processing & Translation Scheme Design | Evaluate syntax-directed definitions, attribute grammars, semantic rules, and translation schemes for language processing | CO5 \| L4–L5 | ETE Sec B/C |
| TS6 | Code Generation & Compiler Optimization Design | Design intermediate code generation techniques, optimization strategies, and machine code generation mechanisms | CO6 \| L5–L6 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Smart Contract Fundamentals & Conceptual Recall | TS2 Ethereum Platform Understanding & Comparative Interpretation | TS3 Smart Contract Development & Solidity Application | TS4 Smart Contract Analysis & Security Evaluation | TS5 Decentralization & Blockchain System Evaluation | TS6 Smart Contract Platforms & Future Application Analysis |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | M | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 assignments | **10** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5, TS6 |

| | | | | |
|---|---|---|---|---|
| **Assessments 1–2 (Theory / Application-based)** | 2 Assessments (Assessment 1 (10 Marks) + Assessment 2 (5 Marks)) | **15** | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 & Unit 2: DFA, NFA, Regular Expressions, CFGs, Chomsky Hierarchy, Compiler Phases | CO1, CO2, CO3 | TS1, TS2, TS3 | 5h SL | Automata construction, grammar design, language recognition and conceptual understanding |
| **Assignment 2** | Unit 3, Unit 4 & Unit 5: PDA, Parsing Techniques, Syntax Directed Translation, Intermediate Code Generation and Optimization | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5, TS6 | 5h SL | Parser analysis, semantic processing, translation schemes, code generation and optimization evaluation |

### 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 & Unit 2: Automata, Regular Expressions, CFGs and Compiler Basics | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Problem solving, automata design and compiler concept understanding |
| **Assessment 2** | Unit 3 & Unit 4: PDA, Lexical Analysis and Parsing Techniques | CO1, CO2, CO3, CO4, CO5 | TS1,TS2,TS3,TS4,TS5 | 5h SL | Parser construction, PDA analysis and syntax evaluation |

## 10. Mid Term Examination (MTE) - 15 Marks (Units 1–2)

*MTE covers Units 1–2 and CO1-CO6 are assessed in ETE. MTE maps to TS1–TS3.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Automata & Language Fundamentals | CO1 | Short-answer questions: DFA, NFA, finite automata design, regular languages, Moore and Mealy machines |
| TS2 — Grammar & Compiler Foundation Understanding | CO2 | Theory-based questions: regular expressions, CFGs, grammar simplification, compiler phases and language hierarchy |
| TS3 — Pushdown Automata & Language Recognition Application | CO3 | Application-based questions involving PDA design, language recognition and automata conversions |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

*ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 40/100 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Automata & Language Fundamentals<br>TS2 — Grammar & Compiler Foundation Understanding | CO1, CO2 | Short-answer questions: automata, regular expressions, grammars, language hierarchy and compiler concepts |
| TS3 — Pushdown Automata & Language Recognition Application<br>TS4 — Parsing Techniques & Syntax Analysis Evaluation | CO3, CO4, CO5 | Medium questions: PDA design, parsing algorithms, LL/LR parsing, lexical analysis and parser comparison |
| TS5 — Semantic Processing & Translation Scheme Design | CO4, CO5 | Medium/Long questions: syntax-directed definitions, attribute grammars, translation schemes and semantic analysis |
| TS6 — Code Generation & Compiler Optimization Design | CO6 | Long analytical and design questions on intermediate code generation, optimization techniques and machine code generation |
| TS1–TS6 (all) | CO1–CO6 | Scaled from 100 marks to 60 marks |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Design DFA, NFA and finite automata models | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3 |
| CO2 | Apply regular expressions, CFGs and compiler concepts | ✓ | ✓ | ✓ | TS2 | PO1, PO2, PO4 |
| CO3 | Design and analyze Pushdown Automata | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| CO4 | Analyze lexical analysis and parsing techniques | ✓ | – | ✓ | TS4 | PO1, PO2, PO4, PO5 |
| CO5 | Design syntax-directed translation schemes | ✓ | – | ✓ | TS5 | PO1, PO2, PO3, PO5 |
| CO6 | Generate optimized intermediate and machine code | ✓ | – | ✓ | TS6 | PO1, PO3, PO4, PO5 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | - | – | 3 | 1 | 1 | - | - | 1 | 1 | 2 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 2 | 3 | 1 | 2 | 2 | – | - | - | - | 1 | - | 1 | 2 | 2 |
| CO3 | 1 | 2 | 3 | 3 | 2 | – | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO4 | 2 | 1 | 2 | 2 | - | – | 1 | 1 | 1 | 1 | - | 1 | 3 | 2 |
| CO5 | 3 | 2 | 3 | – | – | – | - | - | 2 | 1 | 1 | 1 | 2 | 1 |
| CO6 | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 2 | 1 |
| Avg | 2 | 2 | 2.2 | 1.3 | 1.00 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | 2.2 | 1.3 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | M | | M | | | H | | | | | | | M | |
| CO 2 | M | H | | M | M | | | | | | | | M | M |
| CO 3 | | M | H | H | M | | | | | | | | M | |
| CO 4 | M | | M | M | | | | | | | | | H | M |
| CO 5 | H | M | H | | | | | | M | | | | M | |
| CO 6 | M | H | M | | M | M | | | | | | | M | |
| Avg | 2 | 2 | 2.2 | 1.3 | 1.00 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | 2.2 | 1.3 |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 14. Self-Learning Activities (SL: 60 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 1 | Assignment Writing (5 assignments, theory/problem-solving based; one assignment per unit focus area involving automata construction, grammar conversion, PDA design, parsing and code generation) | 5 Assignments × 6 hrs each = 30 hrs | CO1–CO6 TS1–TS6 | Evaluated based on correctness of automata design, grammar construction, parser development, problem-solving ability, compiler phase understanding, and technical explanation |
| 2 | Technical Video-Based Learning related to Automata Theory, Compiler Design, Parsing Algorithms, Syntax Analysis, Lexical Analysis Tools, and Compiler Construction Frameworks | Video Viewing: 5 hrs Report Preparation: 4 hrs Presentation: 3 hrs Total = 12 hrs | CO2, CO3, CO4 TS2, TS3, TS4 | Report + Presentation based on conceptual understanding, parser construction techniques, compiler workflows, and reflections on learning outcomes |
| 3 | Real-World Case Studies (Compiler Architecture, Programming Language Translators, GCC/LLVM Compiler Frameworks, Parser Generators, Language Processing Systems) | Data Collection/Study: 6 hrs Report Preparation: 12 hrs Total = 18 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on technical depth, analysis of compiler systems, optimization strategies, semantic processing techniques, and comparative evaluation |
| | **TOTAL Self-Learning Hours** | **60 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (60 hrs.) | Incomplete SL affects CA score directly |

*Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | ≥ 40 / 100 | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**- Theory of Computation & Compiler Design Summary**

*Theory-Only Course | 6 COs (CO1–CO6) | 2 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Evaluate/Create → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

# COURSE PLAN

## Neural Networks & AI Programming Framework (CSAI2301)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027-28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI2301 |
| 2 | **Course Title** | **Neural Networks & AI Programming Framework** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-2-3 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | This course aims to provide fundamental knowledge of neural networks and AI programming frameworks. It focuses on designing, implementing, and evaluating intelligent models using modern AI tools and techniques for real-world applications. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>**CO1 (Remember – L1):** Recall the fundamental concepts of artificial intelligence, neural networks, learning paradigms, and AI programming frameworks. |

| | | |
|---|---|---|
| | | **CO2 (Understand – L2):** Explain the architecture and working of artificial neurons, activation functions, feedforward networks, and learning algorithms.<br>**CO3 (Apply – L3):** Apply neural network models and optimization techniques to solve basic AI and pattern recognition problems.<br>**CO4 (Analyze – L4):** Analyze the performance of deep learning architectures such as CNNs, RNNs, and transformer-based models for different applications.<br>**CO5 (Evaluate – L5):** Evaluate AI models using suitable metrics, regularization methods, and hyperparameter tuning techniques for improved performance.<br>**CO6 (Create – L6):** Design and develop intelligent AI solutions using modern frameworks such as TensorFlow, Keras, and PyTorch for real-world applications.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>**CO7 (Apply – L3):** Implement neural network and deep learning models using Python-based AI programming frameworks and development tools.<br>**CO8 (Create – L5/L6):** Design and develop AI-based applications for tasks such as image classification, prediction, and intelligent automation using modern frameworks.<br>**CO9 (Apply – L2/L3):** Demonstrate ethical, professional, and responsible practices while developing and evaluating AI systems and applications.<br>**CO10 (Apply – L3):** Collaborate effectively in team-based AI projects, communicate technical findings, and present AI solutions using appropriate tools and methodologies. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 45 hrs + Lab Instructions (LI) 30 hrs + Self Learning (SL) 45 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | Coding exercises on AI/ML platforms such as Kaggle, HackerRank, or LeetCode — minimum 10 AI programming problems.<br>Virtual Labs/NPTEL experiments on Neural Networks and Deep Learning frameworks.<br>MOOC course on Artificial Intelligence, Neural Networks, or Deep Learning through SWAYAM, Coursera, or edX. |
| 11 | **References** | Textbook: Nielsen, Michael — Neural Networks and Deep Learning, Determination Press.<br>Textbook: Goodfellow, Ian; Bengio, Yoshua; and Courville, Aaron — Deep Learning, MIT Press.<br>Reference: Géron, Aurélien — Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd Ed.), O'Reilly Media.<br>Reference: Raschka, Sebastian and Mirjalili, Vahid — Python Machine Learning (3rd Ed.), Packt Publishing.<br>Reference: Russell, Stuart and Norvig, Peter — Artificial Intelligence: A Modern Approach (4th Ed.), Pearson. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|

| | | |
|---|---|---|
| **Unit 1** | Introduction to Artificial Intelligence and Neural Networks (4-0-10-6 = 20 hrs) | |
| **A** | Introduction to Artificial Intelligence, Machine Learning, and Deep Learning; History and evolution of Neural Networks; Applications of AI in real-world systems | CO1, CO2 |
| **B** | Biological neuron vs Artificial neuron, McCulloch-Pitts model, Perceptron model, Learning paradigms: Supervised, Unsupervised, and Reinforcement Learning | |
| **C** | Activation functions, Types of Neural Networks, Basic architecture of ANN, Challenges and limitations of AI systems | |
| **Tools Used** | Python, Jupyter Notebook, Google Colab, Whiteboards, Virtual Labs | |
| **Activities** | **Objective:** To familiarize students with AI programming environments and develop a fundamental understanding of neural network concepts and AI applications.<br>• Installation and setup of Python, Jupyter Notebook, and AI libraries<br>• Demonstration of basic Python programs for AI applications<br>• Visualization of artificial neuron and perceptron models<br>• Comparative study of supervised, unsupervised, and reinforcement learning techniques<br>• Mini exercises on activation functions and neural network architectures | |
| **Unit 2** | **Neural Network Architectures and Learning Algorithms (6-0-12-6 = 24 hrs)** | |
| **A** | Feedforward Neural Networks, Multilayer Perceptron (MLP), Network architecture design, Weight initialization techniques | CO2, CO3, CO5 |
| **B** | Backpropagation algorithm, Gradient Descent optimization, Loss functions, Hyperparameter tuning | |
| **C** | Overfitting and underfitting, Regularization techniques, Dropout, Batch normalization, Model evaluation metrics | |
| **Tools Used** | TensorFlow, Keras, Python Libraries, Virtual Labs | |
| **Activities** | **Objective:** To develop practical understanding of neural network training, optimization, and evaluation techniques.<br>• Implementing perceptron and MLP models using Python<br>• Demonstration of forward and backward propagation | |

| | | |
|---|---|---|
| | • Experimentation with different activation and loss functions<br>• Training neural networks with varying hyperparameters<br>• Performance comparison using evaluation metrics and regularization methods | |
| **Unit 3** | **Deep Learning Models and Advanced Neural Networks (8-0-16-6 = 30 hrs)** | |
| **A** | Convolutional Neural Networks (CNN), Pooling operations, Image feature extraction, Transfer learning | CO3, CO4, CO6 |
| **B** | Recurrent Neural Networks (RNN), LSTM and GRU networks, Sequence modeling and time-series prediction | |
| **C** | Autoencoders, Generative Adversarial Networks (GANs), Attention mechanisms, Introduction to Transformers and Large Language Models | |
| **Tools Used** | PyTorch, TensorFlow, Google Colab, GPU-enabled platforms | |
| **Activities** | **Objective:** To explore advanced deep learning architectures and their applications in image, speech, and sequence processing tasks.<br>• Implementing CNN models for image classification<br>• Demonstration of transfer learning using pre-trained models<br>• Sequence prediction using RNN/LSTM networks<br>• Basic implementation of autoencoders and GAN models<br>• Case studies on transformer models and modern AI applications | |
| **Unit 4** | **AI Programming Frameworks and Model Development (6-0-12-6 = 24 hrs)** | |
| **A** | Python programming for AI, NumPy, Pandas, Matplotlib, Data preprocessing and visualization techniques | CO3, CO5, CO6 |
| **B** | Scikit-learn fundamentals, TensorFlow architecture, Keras API, Model building and training workflows | |
| **C** | PyTorch basics, Model deployment concepts, GPU acceleration, AI development environments and debugging techniques | |
| **Tools Used** | Python, TensorFlow, PyTorch, Scikit-learn, Jupyter Notebook | |
| **Activities** | **Objective:** To provide hands-on experience in AI model development using modern programming frameworks and development tools.<br>• Data preprocessing and visualization using Python libraries<br>• Building machine learning models using Scikit-learn<br>• Developing deep learning models using TensorFlow and Keras<br>• Implementing AI workflows using PyTorch | |

| | | |
|---|---|---|
| | • Demonstration of model training, testing, and deployment processes | |
| **Unit 5** | **AI Applications, Ethics, and Emerging Trends (6-0-10-6 = 22 hrs)** | |
| **A** | Explainable AI (XAI), Ethical issues in AI, Bias and fairness in intelligent systems, Responsible AI practices | CO4, CO5, CO6 |
| **B** | Edge AI, TinyML, Federated Learning, AI model lifecycle and MLOps fundamentals | |
| **C** | Applications of AI in healthcare, cybersecurity, finance, robotics, and smart systems; Future trends in AI and Neural Networks | |
| **Tools Used** | Cloud AI Platforms, Streamlit, AI Deployment Tools, Virtual Labs | |
| **Activities** | **Objective:** To understand ethical AI practices, emerging AI technologies, and real-world deployment of intelligent systems.<br>• Case studies on ethical issues and bias in AI systems<br>• Demonstration of Edge AI and TinyML applications<br>• Mini projects on AI applications in healthcare or smart systems<br>• Presentation and discussion on future trends in AI and deep learning<br>• Deployment of simple AI models using cloud or web-based platforms | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | ✓ | ✓ | | |
| 5 | 2.B | | | ✓ | ✓ | | |
| 6 | 2.C | | | ✓ | ✓ | ✓ | |
| 7 | 3.A | | | ✓ | ✓ | | ✓ |
| 8 | 3.B | | ✓ | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | ✓ | | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | 5.A | | ✓ | ✓ | ✓ | ✓ | |
| 14 | 5.B | | | ✓ | ✓ | ✓ | |
| 15 | 5.C | | | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | ✓ |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | ✓ | ✓ | | | |
| CO4 | | | | ✓ | | | | | | | | | | | ✓ | ✓ | | |
| CO5 | | | | | ✓ | | | | | | | | | | | ✓ | ✓ | |
| CO6 | | | | | | ✓ | | | ✓ | ✓ | | | | | | ✓ | ✓ | |
| CO7 | | | ✓ | | | | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | | | |
| CO8 | | | | | ✓ | ✓ | | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | |
| CO9 | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | | | |
| CO10 | | | ✓ | | | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | |

*Legend: ✓ = Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Artificial Intelligence, Machine Learning, and Deep Learning | Unit 1 | 4 |
| DD/MM/YY | History and Evolution of Neural Networks | | |
| DD/MM/YY | Biological Neuron vs Artificial Neuron and Perceptron Model | | |
| DD/MM/YY | Activation Functions and Learning Paradigms | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Feedforward Neural Networks and ANN Architecture | Unit 2 | 6 |
| DD/MM/YY | Multilayer Perceptron (MLP) | | |
| DD/MM/YY | Backpropagation Algorithm | | |
| DD/MM/YY | Gradient Descent and Optimization Techniques | | |
| DD/MM/YY | Loss Functions and Hyperparameter Tuning | | |
| DD/MM/YY | Regularization, Dropout, and Batch Normalization | | |
| DD/MM/YY | Introduction to Deep Learning Architectures | Unit 3 | 8 |
| DD/MM/YY | Convolutional Neural Networks (CNN) | | |
| DD/MM/YY | Pooling Operations and Feature Extraction | | |
| DD/MM/YY | Transfer Learning Techniques | | |
| DD/MM/YY | Recurrent Neural Networks (RNN) | | |
| DD/MM/YY | LSTM and GRU Networks | | |
| DD/MM/YY | Autoencoders and Generative Adversarial Networks (GANs) | | |
| DD/MM/YY | Attention Mechanisms, Transformers, and Large Language Models | | |
| DD/MM/YY | Python Programming for AI Applications | Unit 4 | 6 |
| DD/MM/YY | NumPy, Pandas, and Data Preprocessing | | |
| DD/MM/YY | Data Visualization using Matplotlib | | |
| DD/MM/YY | Scikit-learn and Machine Learning Workflows | | |
| DD/MM/YY | TensorFlow, Keras, and PyTorch Frameworks | | |
| DD/MM/YY | Model Training, Deployment, and GPU Acceleration | | |
| DD/MM/YY | Explainable AI (XAI) and Responsible AI | Unit 5 | 6 |
| DD/MM/YY | Bias, Fairness, and Ethical Issues in AI | | |
| DD/MM/YY | Edge AI and TinyML | | |
| DD/MM/YY | Federated Learning and MLOps Fundamentals | | |
| DD/MM/YY | AI Applications in Healthcare, Finance, and Cybersecurity | | |
| DD/MM/YY | Future Trends in AI, Neural Networks, and Intelligent Systems | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Installation and setup of Python, Jupyter Notebook, TensorFlow, and PyTorch environments | CO7 | 3.0 |
| | S-1.2 | Basic Python programs for AI applications and data handling | CO7 | |
| W2 | S-2.1 | Implementation of artificial neuron and perceptron model | CO7 | 3.0 |
| | S-2.2 | Demonstration of activation functions and learning paradigms | CO7 | |
| W3 | S-3.1 | Implement Feedforward Neural Network using Python | CO7 | 3.0 |
| | S-3.2 | Design and train Multilayer Perceptron (MLP) models | CO7 | |
| W4 | S-4.1 | Demonstration of forward propagation and backpropagation algorithms | CO7 | 3.0 |
| | S-4.2 | Experiment with different loss functions and optimization techniques | CO7 | |
| W5 | S-5.1 | Hyperparameter tuning and performance evaluation of neural networks | CO7 | 3.0 |
| | S-5.2 | Implement regularization, dropout, and batch normalization techniques | CO7 | |
| W6 | S-6.1 | Build a Convolutional Neural Network (CNN) for image classification | CO7 | 3.0 |
| | S-6.2 | Feature extraction and pooling operations using CNNs | CO7 | |
| W7 | S-7.1 | Transfer learning using pre-trained deep learning models | CO7 | 3.0 |
| | S-7.2 | Comparative analysis of CNN architectures | CO7 | |
| W8 | S-8.1 | Implement Recurrent Neural Networks (RNN) for sequence prediction | CO7 | 3.0 |
| | S-8.2 | Time-series prediction using LSTM and GRU networks | CO7 | |
| W9 | S-9.1 | Implementation of Autoencoders for dimensionality reduction | CO7 | 3.0 |
| | S-9.2 | Basic implementation of Generative Adversarial Networks (GANs) | CO7 | |
| W10 | S-10.1 | Data preprocessing and visualization using NumPy, Pandas, and Matplotlib | CO7 | 3.0 |
| | S-10.2 | Machine learning workflows using Scikit-learn | CO7 | |
| W11 | S-11.1 | Deep learning model development using TensorFlow and Keras | CO7 | 3.0 |
| | S-11.2 | AI model implementation and debugging using PyTorch | CO7 | |
| W12 | S-12.1 | GPU acceleration and model training on Google Colab | CO7 | 3.0 |
| | S-12.2 | Deployment of simple AI models using Streamlit or Flask | CO7 | |

| | | | | |
|---|---|---|---|---|
| **W13** | S-13.1 | Mini project: AI-based image classification system with societal relevance | CO8 | 3.0 |
| | S-13.2 | AI-based prediction system using real-world datasets | CO8 | |
| **W14** | S-14.1 | Case study on Explainable AI (XAI) and ethical AI practices — reflection activity | CO8/CO9 | 3.0 |
| | S-14.2 | Team-based implementation of intelligent AI applications with peer review | CO8/CO10 | |
| **W15** | S-15.1 | AI model evaluation, documentation, and professional reporting — self-assessment submission | CO8/CO9 | 3.0 |
| | S-15.2 | Final project presentation, team discussion, code review, and group reflection | CO9/CO10 | |

ℹ *Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | Fundamental AI Concepts & Terminology | Recall AI terminologies, neural network concepts, learning paradigms, architectures, and programming framework basics | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| **TS2** | Conceptual Understanding of Neural Networks | Explain neuron models, activation functions, ANN architectures, learning algorithms, and deep learning concepts | CO2 \| L2 | MTE Sec A \| ETE Sec A |

| | | | | |
|---|---|---|---|---|
| TS3 | AI Model Development & Application | Apply neural network algorithms, optimization methods, and AI frameworks to solve standard computational problems | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| TS4 | Analytical Reasoning & Model Interpretation | Analyze model performance, compare architectures, interpret outputs, and identify limitations in AI systems | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| TS5 | Evaluation & Optimization of AI Systems | Evaluate AI models using metrics, hyperparameter tuning, regularization methods, and performance trade-offs | CO5 \| L5 | ETE Sec B/C |
| TS6 | Intelligent System Design & Integration | Design and develop complete AI solutions using TensorFlow, Keras, PyTorch, and modern deployment techniques | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | 4 | TS1 — Fundamental AI Concepts & Terminology TS2 — Conceptual Understanding of Neural Networks | CO1, CO2 | Short-answer: AI concepts, neural network terminology, architecture explanation, output interpretation |
| Sec B | 6 | TS3 — AI Model Development & Application TS4 — Analytical Reasoning & Model Interpretation | CO3, CO4 | Problem solving, neural network design, model analysis, performance interpretation, architecture comparison |
| TOTAL | 10 | TS1–TS4 | CO1–CO4 | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | TS1 — Fundamental AI Concepts & Terminology TS2 — Conceptual | CO1, CO2 | Short questions: AI concepts, neural network terminology, architecture explanation, | TS1 — Fundamental AI Concepts & Terminology TS2 — Conceptual Understanding of Neural Networks |

| | | | | |
|---|---|---|---|---|
| | Understanding of Neural Networks | | activation functions, conceptual MCQs (all units) | |
| **Sec B** | TS3 — AI Model Development & Application TS4 — Analytical Reasoning & Model Interpretation TS5 — Evaluation & Optimization of AI Systems | CO3, CO4, CO5 | Medium questions: neural network implementation, model analysis, debugging, optimization techniques, architecture comparison, performance evaluation | TS3 — AI Model Development & Application TS4 — Analytical Reasoning & Model Interpretation TS5 — Evaluation & Optimization of AI Systems |
| **Sec C** | TS5 — Evaluation & Optimization of AI Systems TS6 — Intelligent System Design & Integration | CO5, CO6 | Long/design questions: develop AI solutions, justify framework selection, design deep learning architectures, complete AI-based applications | TS5 — Evaluation & Optimization of AI Systems TS6 — Intelligent System Design & Integration |
| **TOTAL** | TS1–TS6 (all) | CO1–CO6 | Scaled to 50 marks. Minimum 20/50 required to pass. | TS1–TS6 (all) |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (AI model implementation and experiments), CO8, CO9, CO10 (Mini Project and team activities) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |

| | | | |
|---|---|---|---|
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | AI model design, implementation, deployment, presentation & reflection — assesses all Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem identification, dataset understanding, success criteria definition CA2 — Experimental setup, framework/tool configuration CA7 — AI workflow, architecture design, and implementation planning | 1.0: Well-defined with complete design \| 0.5: Partial design \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Correct implementation and execution of AI models CA4 — Optimization, computational efficiency, and model performance evaluation | 1.0: Correct & efficient \| 0.5: Correct but partially optimized \| 0: Execution failure | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Analysis of outputs, metrics, and prediction accuracy CA6 — Documentation of observations and result verification CA8 — Lab record maintenance and viva-voce understanding | 0.75: Thorough analysis \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Ethical AI practices, responsible data usage, and documentation integrity PO7 — Professional responsibility and teamwork conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | ≤ **30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | | Marking Guide | Lab CO / PO |
|---|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — AI application relevance and SDG alignment P2 — Problem definition, dataset identification, and stakeholder requirements P4 — Innovative AI-based solution proposal | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 | P1 — AI application relevance and SDG alignment P2 — Problem definition, dataset identification, and stakeholder requirements P4 — Innovative AI-based solution proposal |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Project planning, milestones, and workflow design P11 — Computational resource planning and feasibility analysis | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 | P2 — Project planning, milestones, and workflow design P11 — Computational resource planning and feasibility analysis |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Selection of AI frameworks and tools P6 — End-to-end AI model development and integration P7 — Model execution, testing, and deployment | 2: Fully functional \| 1–1.5: Partially functional \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 | P5 — Selection of AI frameworks and tools P6 — End-to-end AI model development and integration P7 — Model execution, testing, and deployment |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Model accuracy, validation, and outcome assessment P9 — Comparative analysis, visualization, and technical reporting | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 | P8 — Model accuracy, validation, and outcome assessment P9 — Comparative analysis, visualization, and technical reporting |

| | | | | | |
|---|---|---|---|---|---|
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication strategy and project demonstration P10 — Professional presentation, teamwork, and delivery quality | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 | P3 — Communication strategy and project demonstration P10 — Professional presentation, teamwork, and delivery quality |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Reflection on learning, AI skill enhancement, and self-assessment P13 — Ethical AI practices, responsible data usage, and professional conduct | 1.0: Reflective & ethical \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 | P12 — Reflection on learning, AI skill enhancement, and self-assessment P13 — Ethical AI practices, responsible data usage, and professional conduct |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | AI Problem Definition & Performance Metrics | Define AI problem statements; identify datasets, measurable parameters, evaluation metrics, and success criteria | CO7, CO8 |
| CA2 | Experimental Design & Framework Setup | Plan AI experiments; configure Python environment, Jupyter Notebook, TensorFlow, PyTorch, and related tools | CO7 |
| CA3 | AI Model Implementation & Execution | Develop, train, and execute neural network and machine learning models correctly | CO7 |
| CA4 | Model Efficiency & Optimization | Evaluate model accuracy, computational efficiency, hyperparameter tuning, and optimization techniques | CO7 |
| CA5 | Output Analysis & Result Interpretation | Analyze predictions, loss curves, accuracy metrics, and model behaviour; interpret experimental outcomes | CO8 |
| CA6 | Documentation & Validation of Results | Maintain experimental records, document outcomes formally, and validate results against objectives | CO7, CO8 |
| CA7 | AI Workflow Design & Solution Planning | Develop AI workflows, model architectures, algorithms, and implementation strategies before execution | CO7, CO8 |

| | | | |
|---|---|---|---|
| CA8 | Lab Record Maintenance & Viva-Voce | Maintain complete lab records; demonstrate conceptual and practical understanding through presentations and viva | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | AI Application Relevance & Societal Impact | Map AI project to relevant SDGs; explain societal relevance, sustainability, and practical impact | CO8 \| PO6 |
| P2 | Problem Definition & Requirement Analysis | Define project scope, dataset requirements, objectives, constraints, and measurable success criteria | CO8 \| PO2 |
| P3 | Communication & Experimental Planning | Develop communication strategy, testing workflow, documentation process, and coordinate team activities | CO10 \| PO9 |
| P4 | Innovative AI Solution Design | Propose intelligent AI-based solutions with alternative approaches and justify model/framework selection | CO8 \| PO3 |
| P5 | AI Development Tools & Framework Selection | Select and justify Python libraries, TensorFlow, PyTorch, Jupyter Notebook, and deployment tools | CO7 \| PO5 |
| P6 | End-to-End AI Model Development | Design, train, test, and integrate complete AI systems using multiple syllabus concepts | CO7, CO8 \| PO3 |
| P7 | AI System Deployment & Validation | Deploy AI models, perform testing, validate predictions, and analyze edge-case performance | CO7, CO8 \| PO5 |
| P8 | Performance Evaluation & Impact Analysis | Measure AI model performance using metrics, evaluate outcomes, and assess real-world impact | CO8 \| PO6 |
| P9 | Critical Analysis & Technical Reporting | Perform comparative analysis, visualize results, and prepare structured technical reports | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Team Collaboration | Deliver professional presentations, demonstrate teamwork, and manage collaborative AI development tasks | CO10 \| PO8, PO9 |
| P11 | Resource Planning & Computational Feasibility | Estimate computational resources, execution feasibility, and cost-effectiveness of AI solutions | CO10 \| PO10 |

| | | | |
|---|---|---|---|
| P12 | Skill Development & Reflective Learning | Document skill enhancement, self-assessment, and individual project contributions | CO9 \| PO11 |
| P13 | Ethical AI Practices & Professional Responsibility | Demonstrate responsible AI usage, ethical handling of data/models, and professional conduct | CO9 \| PO7 |

## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS 1 Factual Recall | TS 2 Conceptual Expl. | TS 3 Procedural App. | TS 4 Analytical Rsng | TS 5 Compar. Eval. | TS 6 Synthesis & Design | CA1: Prob. Def. | CA2 Exp. Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc. Outcome | CA7 Algo. Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys. Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | M | | M | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | | | | | H | H | H | M | | M | M | H | | | | | H | M | H | | | | | | |
| CO8 | | | | | | | M | | M | | H | H | H | | H | H | | H | M | H | M | H | M | | | | |
| CO9 | | | | | | | | | | | | | | M | | | | | | | | | | | | H | H |
| CO10 | | | | | | | | | | | | | | | | | H | | | | | | M | H | H | | |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

### CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | – | – | – | – | – | – | – | – | 1 | 2 | 1 | – |
| CO2 | 3 | 2 | – | – | – | – | – | – | 1 | – | 2 | 2 | 2 | – |
| CO3 | 3 | 3 | 2 | – | 2 | 2 | – | – | 1 | – | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 2 | – | 2 | 1 | 1 | 3 | 3 | 3 | 3 |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| Avg | 2.50 | 2.14 | 2.33 | 1.75 | 2.33 | 1.80 | 3.00 | 2.50 | 1.50 | 2.00 | 2.13 | 2.22 | 2.30 | 2.38 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |
| CO2 | H | M | | | | | | | M | | |
| CO3 | M | H | M | | M | M | | | M | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | | M | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in Artificial Intelligence, Neural Networks, and AI programming frameworks; promotes lifelong learning and advanced technical competency (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-oriented AI, machine learning, and deep learning skills relevant to modern technology and intelligent automation sectors (CO7, CO8, CO10). |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Encourages development of innovative AI solutions, intelligent systems, and data-driven applications using modern frameworks and deployment tools (CO6, CO8, CO10). |
| SDG 10 | Reduced Inequalities | 2 (Moderate) | Introduces ethical AI, fairness, bias reduction, and inclusive intelligent systems for equitable technology access and decision-making (CO5, CO9). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Promotes efficient AI model design, optimized computational resource utilization, and responsible AI development practices (CO7, CO9). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, neural network terminologies, AI concepts, and framework components<br><br>L2 — Understand: Explain AI models, learning paradigms, neural architectures, and deep learning principles | A1 — Receiving: Awareness and willingness to learn AI concepts, ethical practices, and intelligent systems<br><br>A2 — Responding: Participate actively in AI experiments, discussions, coding exercises, and teamwork activities | P1 — Perception: Identify datasets, computational tools, and AI workflow requirements through observation<br><br>P2 — Set: Demonstrate readiness to configure AI environments, frameworks, and development tools |

| | | |
|---|---|---|
| L3 — Apply: Implement neural networks, optimization algorithms, and AI programming workflows to solve problems<br><br>L4 — Analyze: Analyze model behaviour, compare architectures, evaluate outputs, and interpret performance metrics<br><br>L5 — Evaluate: Assess AI models, justify framework selection, optimize performance, and validate outcomes<br><br>**L6 — Create:** Design and develop intelligent AI solutions, deep learning systems, and innovative applications | A3 — Valuing: Show commitment toward responsible AI practices, collaboration, and professional coding standards<br><br>A4 — Organizing: Integrate ethical AI values, teamwork, and problem-solving approaches into professional practice<br><br>A5 — Characterizing: Demonstrate consistent ethical conduct, professionalism, and lifelong learning attitude in AI development | P3 — Guided Response: Develop AI models and perform guided experimentation using Python and AI frameworks<br><br>P4 — Mechanism: Execute AI model training, testing, debugging, and deployment with confidence and accuracy<br><br>P5 — Complex Overt Response: Perform advanced AI implementation, optimization, and integrated system development efficiently<br><br>P6 — Adaptation: Modify AI architectures, algorithms, and workflows for specialized real-world applications<br><br>P7 — Origination: Create innovative AI systems, intelligent automation solutions, and novel deep learning applications |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | ≥ 20 / 50 | MANDATORY | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | ≥ 40 / 100 | Must pass overall | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Foundations of Ethical Hacking (CSAI2002)

Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML| Semester V | Batch 2023–2027

Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment

PART I

## COURSE SYLLABUS

Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |
| **Course Code:** | CSAI2002 | **Course Type:** | Core - Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI2002 |
| 2 | **Course Title** | Ethical Hacking |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs. Classroom + 45 hrs. Self Learning = 90 hrs. total) |
| 5 | **Course Status** | Core - Theory Only (No Laboratory Component) |
| 6 | **Course Objectives** | To provide students with knowledge of ethical hacking concepts, the importance of ethical hacking in IT security, and the working structure of hacking. To develop competence in identifying vulnerabilities, applying hacking techniques ethically, and formulating countermeasures. |

| S.No | Attribute | Details |
|---|---|---|
| 7 | Course Outcomes (COs) | After successful completion of this course, students will be able to: CO1 (Remember/Understand – L1/L2): Define the description of ethical hacking, security fundamentals, hacker/cracker distinctions, legal and ethical boundaries, and the attacker's vs. ethical hacker's process. CO2 (Apply – L2/L3): Illustrate types of ethical hacking including footprinting, scanning, enumeration, OS fingerprinting, and system hacking techniques. CO3 (Apply – L3/L4): Explain web and network hacking concepts including malware threats, viruses, worms, Trojans, sniffers, session hijacking, and denial-of-service attacks. CO4 (Analyze – L4/L5): Demonstrate report writing and mitigation strategies; analyze web server, web application, and database hacking methods. CO5 (Evaluate – L5): Formulate the use of safe techniques on the World Wide Web including wireless technologies, IDS, firewalls, honeypots, and physical security measures. CO6 (Create – L5/L6): Analyze various digital forensic problems and evaluate case studies in ethical hacking for comprehensive security assessment. |
| 8 | Course Description | This course introduces ethical hacking concepts and the application of ethical hacking in network security. Students learn to think like attackers to better defend systems, covering tools, techniques, and countermeasures across multiple attack surfaces. |
| 9 | Teaching & Learning Scheme | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | Mode of Examination | Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks |
| 11 | Textbook | 1. EC-Council — Ethical Hacking and Countermeasures: Attack Phases, Delmar Cengage Learning, 2009. 2. Michael T. Simpson, Kent Backman, James E. Corley — Hands-On Ethical Hacking and Network Defense, Cengage Learning, 2012. |
| 12 | References | 3. Patrick Engebretson — The Basics of Hacking and Penetration Testing, Syngress Media, 2nd Ed., 2013. 4. Jon Erickson — Hacking: The Art of Exploitation, No Starch Press, 2nd Ed., 2008. 5. CEH (Certified Ethical Hacker) Study Guide, EC-Council. 6. OWASP Testing Guide (https://owasp.org/www-project-web-security-testing-guide/). |

## 3. Outline Syllabus with CO Mapping

ℹ All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: INTRODUCTION TO ETHICAL HACKING (9-0-0-9)** | |
| A | Security Fundamentals, Security Testing, Hacker and Cracker Descriptions | CO1 |
| B | Test Plans – Keeping It Legal, Ethical and Legality Issues | CO1, CO2 |
| C | The Attacker's Process, The Ethical Hacker's Process, Security and the Stack | CO1, CO2, CO4 |
| | **Unit 2: FOOTPRINTING AND SCANNING (9-0-0-9)** | |
| A | Information Gathering, Determining the Network Range, Identifying Active Machines | CO1, CO2 |
| B | Finding Open Ports and Access Points, OS Fingerprinting, Mapping the Network Attack Surface | CO1, CO2 |
| C | Enumeration, System Hacking | CO1, CO2, CO5, CO6 |
| | **Unit 3: MALWARE THREATS (9-0-0-9)** | |

| | Topic | CO Mapping |
|---|---|---|
| A | Viruses and Worms, Trojans, Covert Communication | CO1, CO2, CO3 |
| B | Keystroke Logging and Spyware, Malware Countermeasures | CO1, CO2, CO3 |
| C | Sniffers, Session Hijacking, Denial of Service and Distributed Denial of Service | CO1, CO2, CO3 |
| | **Unit 4: WEB SERVER HACKING (9-0-0-9)** | |
| A | Web Server Hacking, Web Application Hacking | CO2, CO3, CO4 |
| B | Database Hacking | CO3, CO4 |
| C | Wireless Technologies, Mobile Device Operation and Security, Wireless LANs | CO2, CO4, CO5 |
| | **Unit 5: IDS, FIREWALLS AND HONEYPOTS (9-0-0-9)** | |
| A | Intrusion Detection Systems, Firewalls, Honeypots | CO2, CO5 |
| B | Physical Security, Social Engineering | CO3, CO5, CO6 |
| C | Case Studies in Ethical Hacking and Security Assessment | CO4, CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A – Security Fundamentals, Testing, Hacker/Cracker | ✓ | ✓ | | | | |
| 2 | 1.B – Test Plans, Legal and Ethical Issues | ✓ | ✓ | | | | |
| 3 | 1.C – Attacker's vs Ethical Hacker's Process, Stack | | ✓ | ✓ | | | |
| 4 | 2.A – Information Gathering, Network Range, Active Machines | | ✓ | ✓ | | | |
| 5 | 2.B – Open Ports, OS Fingerprinting, Network Attack Surface | | ✓ | ✓ | | | |
| 6 | 2.C – Enumeration, System Hacking | | ✓ | ✓ | ✓ | | |
| 7 | 3.A – Viruses, Worms, Trojans, | | ✓ | ✓ | | | |

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| | Covert Communication | | | | | | |
| 8 | 3.B – Keystroke Logging, Spyware, Malware Countermeasures | | ✓ | ✓ | ✓ | | |
| 9 | 3.C – Sniffers, Session Hijacking, DoS/DDoS | | | ✓ | ✓ | ✓ | |
| 10 | 4.A – Web Server Hacking, Web Application Hacking | | | ✓ | ✓ | | |
| 11 | 4.B – Database Hacking | | | ✓ | ✓ | ✓ | |
| 12 | 4.C – Wireless Technologies, Mobile Security, Wireless LANs | | ✓ | ✓ | ✓ | | |
| 13 | 5.A – IDS, Firewalls, Honeypots | | ✓ | | | ✓ | |
| 14 | 5.B – Physical Security, Social Engineering | | | ✓ | | ✓ | ✓ |
| 15 | 5.C – Case Studies in Ethical Hacking | | | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for CO3 (simulating tool-based network attack tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of ethical conduct and responsible disclosure.

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | ✓ | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | ✓ | | | | | | | | | |

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO3 | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | ✓ | | | | | | | | ✓ | | |
| CO6 | | | | | ✓ | ✓ | | | | | ✓ | | | | | | ✓ | |

Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) for CO3 (tool simulation). Affective (A3) for CO4 and CO5 (valuing ethical conduct).

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ Total classroom contact: 45 hours across 5 units (9 lectures each). Self-Learning activities (45 hrs) are structured separately in Section 14.

| Date | Topics to be Covered | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Security Fundamentals and Security Testing | UNIT-1 | 9 |
| DD/MM/YY | Hacker and Cracker Descriptions – types and motivations | | |
| DD/MM/YY | Test Plans – keeping it legal and ethical | | |
| DD/MM/YY | Ethical and Legality Issues in penetration testing | | |
| DD/MM/YY | The Attacker's Process – reconnaissance to exploitation | | |
| DD/MM/YY | The Ethical Hacker's Process – methodology and phases | | |
| DD/MM/YY | Security and the Stack – OSI model attack surface overview | | |
| DD/MM/YY | Security testing tools overview and lab setup | | |
| DD/MM/YY | Unit 1 revision and Q&A | | |
| DD/MM/YY | Information Gathering and Footprinting techniques | UNIT-2 | 9 |
| DD/MM/YY | Determining the Network Range – IP enumeration techniques | | |
| DD/MM/YY | Identifying Active Machines – ping sweep, ARP scanning | | |
| DD/MM/YY | Finding Open Ports and Access Points – TCP/UDP scanning | | |
| DD/MM/YY | OS Fingerprinting – active and passive techniques | | |
| DD/MM/YY | Mapping the Network Attack Surface | | |
| DD/MM/YY | Enumeration – NetBIOS, SNMP, LDAP enumeration | | |

| Date | Topics to be Covered | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | System Hacking – password cracking, privilege escalation | | |
| DD/MM/YY | Unit 2 revision; scanning tools comparison | | |
| DD/MM/YY | Viruses and Worms – types, propagation, examples | UNIT-3 | 9 |
| DD/MM/YY | Trojans – types, deployment methods, detection | | |
| DD/MM/YY | Covert Communication – covert channels and backdoors | | |
| DD/MM/YY | Keystroke Logging and Spyware – techniques and detection | | |
| DD/MM/YY | Malware Countermeasures – antivirus, EDR, sandboxing | | |
| DD/MM/YY | Sniffers – passive and active sniffing techniques | | |
| DD/MM/YY | Session Hijacking – TCP hijacking, cookie theft | | |
| DD/MM/YY | Denial of Service and Distributed DoS – types and countermeasures | | |
| DD/MM/YY | Unit 3 revision; malware case study discussion | | |
| DD/MM/YY | Web Server Hacking – vulnerabilities and exploitation methods | UNIT-4 | 9 |
| DD/MM/YY | Web Application Hacking – OWASP Top 10 vulnerabilities | | |
| DD/MM/YY | Web Application Hacking – SQL Injection, XSS, CSRF | | |
| DD/MM/YY | Database Hacking – techniques and security countermeasures | | |
| DD/MM/YY | Wireless Technologies – 802.11 standards and security protocols | | |
| DD/MM/YY | Mobile Device Operation and Security – Android/iOS vulnerabilities | | |
| DD/MM/YY | Wireless LANs – WEP/WPA/WPA2 cracking and countermeasures | | |
| DD/MM/YY | Report Writing and Mitigation – penetration test report structure | | |
| DD/MM/YY | Unit 4 revision; web hacking scenario analysis | | |
| DD/MM/YY | Intrusion Detection Systems – types, rules, evasion techniques | UNIT-5 | 9 |
| DD/MM/YY | Firewalls – types, rules, bypass techniques | | |
| DD/MM/YY | Honeypots – types, deployment, and attacker tracing | | |
| DD/MM/YY | Physical Security – threats, access control, social context | | |
| DD/MM/YY | Social Engineering – phishing, pretexting, vishing, countermeasures | | |
| DD/MM/YY | Case Studies – real-world ethical hacking engagements | | |
| DD/MM/YY | Case Studies – corporate breach analysis and lessons learned | | |
| DD/MM/YY | Safe Techniques on the WWW – HTTPS, VPN, Zero Trust | | |

| Date | Topics to be Covered | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Unit 5 revision and comprehensive case study discussion | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

ℹ Six Theory Skill Dimensions — one per Bloom's progression (L1–L6) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Ethical Hacking Fundamentals & Security Concepts** | Recall security fundamentals, hacker/cracker distinctions, legal and ethical boundaries of penetration testing; identify the attacker's and ethical hacker's process; describe security testing methodologies | CO1 \| L1–L2 | CA \| MTE \| ETE |
| TS2 | **Footprinting, Scanning & Enumeration Techniques** | Explain footprinting and scanning methodologies; illustrate information gathering, network range determination, port scanning, OS fingerprinting, enumeration, and system hacking techniques | CO2 \| L2–L3 | CA \| MTE \| ETE |
| TS3 | **Malware Threats & Network Attack Analysis** | Apply knowledge of viruses, worms, Trojans, spyware, and covert communication; explain sniffers, session hijacking, DoS/DDoS attacks, and corresponding countermeasures | CO3 \| L3–L4 | CA \| MTE \| ETE |
| TS4 | **Web/Database Hacking & Mitigation Reporting** | Analyze web server, web application, and database hacking techniques; demonstrate penetration test report writing and mitigation strategies for discovered vulnerabilities | CO4 \| L4–L5 | CA \| ETE |
| TS5 | **Safe Techniques, Wireless & IDS/Firewall Evaluation** | Evaluate IDS, firewalls, and honeypot effectiveness; formulate safe WWW techniques; analyze wireless technologies, mobile security, and physical security/social engineering countermeasures | CO5 \| L5 | CA \| ETE |
| TS6 | **Digital Forensics, Case Studies & Security Assessment** | Analyze digital forensic problems arising from ethical hacking scenarios; evaluate case studies; design comprehensive security assessment reports for varied technical and non-technical audiences | CO6 \| L5–L6 | CA \| ETE |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.

| CO | TS1 Ethical Hacking Fundamentals | TS2 Footprinting & Scanning | TS3 Malware & Network Attacks | TS4 Web/DB Hacking & Mitigation | TS5 Safe Techniques & IDS | TS6 Case Studies & Assessment |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | M | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 9. Continuous Assessment (CA) — 25 Marks

ℹ CA is formative and covers COs progressively as the syllabus is taught. It includes theory/application-based assignments, in-class assessments, and a real-world case study — mirroring TS1 through TS6.

### 9.1 CA Component Breakdown

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 assignments | **10** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5, TS6 |
| **Assessments 1–2 (Theory / Application-based)** | Assessment 1 (10 Marks) + Assessment 2 (5 Marks) | **15** | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2: Ethical hacking fundamentals, legal/ethical issues, footprinting, scanning, enumeration, and system hacking techniques | CO1, CO2, CO3 | TS1, TS2, TS3 | 5h SL | Report submission + conceptual evaluation of hacking methodology |
| **Assignment 2** | Unit 3, 4 and Unit 5: Malware threats, web/database hacking, wireless security, IDS/firewalls, social engineering, and case study analysis | CO1, CO2, CO3, CO4, CO5, CO6 | TS1–TS6 | 5h SL | Comparative analysis + tool evaluation + mitigation strategy report |

### 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2: Security fundamentals, hacker types, footprinting, scanning, OS fingerprinting, and enumeration | CO1, CO2, CO3 | TS1, TS2, TS3 | 5h SL | Short-answer + scenario-based questions |
| **Assessment 2** | Unit 3 and Unit 4: Malware types, network attacks, web server/application/database hacking, wireless security, report writing | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 | 5h SL | Analytical questions + tool comparison + mitigation report |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–2)

ℹ MTE covers Units 1–2. CO4, CO5, CO6 are assessed in CA and ETE only. MTE maps to TS1–TS3.

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Ethical Hacking Fundamentals & Security Concepts TS2 — Footprinting, Scanning & Enumeration Techniques | **CO1, CO2** | Short-answer: define ethical hacking terms, explain security testing phases, compare hacker types, describe footprinting techniques, identify scanning tools, explain enumeration methods |
| TS3 — Malware Threats & Network Attack Analysis | **CO3** | Application/theory questions: classify malware types, explain DoS/DDoS mechanisms, describe session hijacking steps, compare countermeasures, analyze network attack scenarios |
| TS1–TS3 | **CO1–CO3** | Units 1–2 only. CO4, CO5, CO6 assessed only in CA and ETE. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (synthesis/evaluation). Minimum 40/100 overall required to pass.

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Ethical Hacking Fundamentals & Security Concepts TS2 — Footprinting, Scanning & Enumeration Techniques | **CO1, CO2** | Short questions (all units): definitions, hacker types, legal issues, scanning techniques, enumeration methods, OS fingerprinting, system hacking terminology |
| TS3 — Malware Threats & Network Attack Analysis TS4 — Web/Database Hacking & Mitigation Reporting TS5 — Safe Techniques, Wireless & IDS/Firewall Evaluation | **CO3, CO4, CO5** | Medium questions: malware classification and countermeasures, web application vulnerabilities (OWASP), database attack methods, penetration test report structure, wireless security protocols, IDS/firewall configuration, honeypot deployment |
| TS4 — Web/Database Hacking & Mitigation Reporting TS5 — Safe Techniques, Wireless & IDS/Firewall Evaluation | **CO4, CO5** | Long/evaluation questions: design a mitigation strategy for a given web attack scenario; evaluate wireless network security posture; compare IDS vs firewall effectiveness; analyze social engineering case |
| TS6 — Digital Forensics, Case Studies & Security Assessment | **CO6** | Long question: analyze a given ethical hacking case study; identify vulnerabilities, attacks used, and forensic evidence; produce a comprehensive security assessment report for both technical and management audiences |
| TS1–TS6 (all) | **CO1–CO6** | Scaled from 100 marks to 60 marks. Minimum 40/100 overall required to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Define ethical hacking, security fundamentals, hacker types, legal/ethical issues | ✓ | ✓ | ✓ | **TS1** | PO1, PO2, PO5, PO8, PO12 |
| **CO2** | Illustrate footprinting, scanning, enumeration, and system hacking types | ✓ | ✓ | ✓ | **TS2** | PO1, PO2, PO3 |
| **CO3** | Explain malware threats, web/network attacks, sniffers, session hijacking, DoS | ✓ | ✓ | ✓ | **TS3** | PO1, PO2, PO3, PO5, PO9 |
| **CO4** | Demonstrate report writing, mitigation, and web/database hacking analysis | ✓ | — | ✓ | **TS4** | PO1, PO2, PO4, PO5, PO6 |
| **CO5** | Formulate safe WWW techniques; evaluate IDS, firewalls, wireless, honeypots | ✓ | — | ✓ | **TS5** | PO1, PO2, PO3, PO8, PO9 |
| **CO6** | Analyze digital forensic problems and evaluate ethical hacking case studies | ✓ | — | ✓ | **TS6** | PO1, PO2, PO4, PO6, PO7, PO10, PO11 |

⚠ CO5 and CO6 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.

PART III

# COMBINED MAPPINGS & REFERENCE

CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail

## 12. CO–PO and CO–PSO Mapping Matrix

ℹ Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | – | – | 2 | – | – | 3 | – | – | – | – | – | 3 |
| CO2 | 3 | 3 | 2 | – | – | – | – | – | – | – | – | – | – | 3 |
| CO3 | 3 | 3 | 2 | – | 2 | – | – | – | 2 | – | – | 3 | – | – |
| CO4 | 3 | 3 | – | 3 | 2 | 3 | – | 2 | – | – | – | – | 3 | – |
| CO5 | 3 | 2 | 3 | – | – | – | – | 3 | 3 | – | – | – | 3 | – |
| CO6 | 3 | 3 | – | 3 | 3 | 3 | 3 | – | – | 3 | 3 | 3 | – | – |
| Avg | 3.00 | 2.83 | 2.33 | 3.00 | 2.25 | 3.00 | 3.00 | 2.67 | 2.50 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | | | M | | | H | | | | | | H |
| CO2 | H | H | M | | | | | | | | | | | H |
| CO3 | H | H | M | | M | | | | M | | | H | | |
| CO4 | H | H | | H | M | H | | M | | | | | H | |
| CO5 | H | M | H | | | | | H | H | | | | H | |
| CO6 | H | H | | H | H | H | H | | | H | H | H | | |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | Assignment Writing (2 assignments — Unit 1–2 focus: ethical hacking fundamentals, scanning/enumeration; Unit 3–5 focus: malware, web hacking, IDS, case studies) | 2 assignments × 5 hrs each Total = 10 hrs | CO1–CO6 TS1–TS6 | Assignment submission, conceptual accuracy, tool comparison, mitigation analysis, ethical reasoning |
| 2 | Technical Video-Based Learning (e.g., Kali Linux penetration testing walkthrough, OWASP Top 10 deep-dive, Wireshark network analysis, Metasploit fundamentals, wireless security) | Video viewing: 5 hrs Report: 5 hrs Presentation: 5 hrs Total = 15 hrs | CO2, CO3 TS2, TS3 | Report + Presentation: key attack techniques observed, tools used, countermeasures identified, personal reflection on ethical boundaries |
| 3 | Real-World Case Studies (e.g., major data breach analysis, ransomware incident report, social engineering attack investigation, corporate pen-test case study, OWASP vulnerability exploit) | Data collection: 5 hrs Report: 10 hrs Presentation: 5 hrs Total = 20 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Depth of vulnerability analysis, legal/ethical dimension discussion, quality of mitigation plan, professional report structure, audience-appropriate communication |
| **TOTAL Self-Learning Hours: 45 hours \| CO1–CO6 \| All activities are compulsory. Submission deadlines communicated at the start of the semester.** | | | | |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L6). Psychomotor domain (P3) appears for CO3 (simulated network attack tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of ethical conduct, responsible disclosure, and security professionalism.

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL activities directly impact CA score |

ℹ Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**CSC301 — Ethical Hacking Summary**

Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)

CO1–CO2: Recall / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A

CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B

CO5–CO6: Evaluate / Create → TS5, TS6 → CA + ETE Sec B/C

**CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks**

Sharda University — SSCSE | Theory-Only Course: CA 25 + MTE 15 + ETE 60 = 100 | 6 Theory Skill Dimensions TS1–TS6

# COURSE PLAN

## Information Security (CSAI2302)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester IV | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI2302 |
| 2 | **Course Title** | Information security/ Information security Lab |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-2-2 |
| 5 | **Course Status** | Program Elective |
| 6 | **Course Objective** | . |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Remember – L1): Recall the fundamental concepts of information security, threats, cryptography, authentication, and network security.<br>CO2 (Understand – L2): Explain security mechanisms, access control models, operating system security, and intrusion detection techniques.<br>CO3 (Apply – L3): Apply cryptographic algorithms, authentication methods, and network security techniques to protect information systems. |

| | | |
|---|---|---|
| | | CO4 (Analyze – L4): Analyze cyber threats, attack modes, vulnerabilities, and security incidents in computing environments..<br>CO5 (Evaluate – L5): Evaluate security policies, privacy laws, access control strategies, and intrusion prevention mechanisms for organizational security<br>CO6 (Create – L6): Design secure information systems using authentication, access control, cryptographic, and network security principles.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3):<br>CO8 (Create – L5/L6):<br>CO9 (Apply – L2/L3):<br>CO10 (Apply – L3): |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 30 hrs + Self Learning (SL) 30 hrs = 90 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 45 hrs)** | 1. Explore network and email security tools including firewalls, IDS/IPS, VPN configuration, SSL/TLS setup, and secure email protocols through hands-on practice and case studies. (15 H)<br>2. Analyze recent cyber attacks, phishing incidents, privacy law case studies (DPDP Act, GDPR, HIPAA, PCI DSS), and prepare security assessment reports with recommended countermeasures. (15 H) |
| 11 | **References** | 1. **Information Security: The Complete Reference Paperback – 1 May 2013** by Mark Rhodes-Ousley<br>2. **Information Security: Principles and Practice 1st Edition, Kindle Edition** by Mark Stamp (Author) |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Fundamentals of Information Security:** **(6-0-0-6 = 12hrs)** | |
| **A** | Information Security Fundamentals , CIA Traid, Threats, Vulnerabilities, and Attacks, Security Services and Mechanisms | CO1, CO2, CO3 |
| **B** | Types of Cyber Threats<br>Malware: Viruses, Worms, Trojans, Ransomware , Social Engineering and Phishing Attacks | |
| **C** | Security Policies and Procedures , Security Standards and Frameworks, Risk, Threat, and Asset Identification | |

| | | |
|---|---|---|
| **Tools Used** | NA | |
| **Activities** | **Objective:**<br>• .Understand the fundamental concepts of information security and cybersecurity threats.<br>• Identify malware, phishing, social engineering attacks, and security vulnerabilities.<br>• Apply security policies, standards, frameworks, and risk assessment techniques to protect information assets. | |
| **Unit 2** | **Cryptography and Data Security: (6-0-0-6= 12 hrs)** | |
| **A** | Fundamentals of Cryptography, Steganography, Cryptanalysis | CO1, CO2,CO3,CO5 |
| **B** | Classical Cryptography: substitution and transposition techniques , Block Cipher, stream cipher | |
| **C** | Symmetric and asymmetric key cryptography, Digital Signatures, Hash | |
| **Tools Used** | NA | |
| **Activities** | **Objective:**<br>• Understand the principles of cryptography, steganography, and cryptanalysis for securing information.<br>• Analyze classical encryption techniques, block ciphers, and stream ciphers used in data protection.<br>• Apply symmetric and asymmetric cryptographic algorithms, digital signatures, and hash functions to ensure confidentiality, integrity, and authentication. | |
| **Unit 3** | **Network security and Email security** (6**-0-0-6 = 12 hrs)** | |
| **A** | Introduction to Network Security, Goals of Network Security , Types of Network Attacks | CO2, CO3, CO4, CO5, CO6 |
| **B** | Network Security Mechanisms: Firewalls , Intrusion Detection System (IDS) , Intrusion Prevention System (IPS) , Virtual Private Network (VPN) | |
| **C** | Introduction to Email Security , Email Architecture and Working , Need for Secure Email Communication , Attacks, SSL/TLS for Email Security Secure Email Protocols (SMTP, POP3, IMAP) | |
| **Tools Used** | NA | |

| | | |
|---|---|---|
| | | |
| **Activities** | **Objective:**<br>• Understand the fundamentals of network security, network attacks, and the goals of securing communication systems.<br>• Identify and evaluate network security mechanisms such as Firewalls, IDS, IPS, VPNs, and secure email protocols.<br>• Apply SSL/TLS and secure email communication techniques to protect email systems from common attacks and threats. | |
| **Unit 4** | **Authentication and Access Control (6-0-0-6 = 12 hrs)** | |
| **A** | Identification and Authentication Concepts , Authentication Factors, Authentication protocols, Multi-Factor Authentication (MFA) | CO3, CO4, CO5 |
| **B** | Authentication Mechanisms: Biometric Authentication ,Token and Smart Card Authentication , Single Sign-On (SSO) | |
| **C** | Access Control Fundamentals , Access Control models, Access Control Lists (ACLs) , Principle of Least Privilege | |
| **Tools Used** | NA | |
| **Activities** | **Objective:**<br>• Understand the concepts of identification, authentication, access control, and their role in information security.<br>• Identify authentication mechanisms such as MFA, biometrics, tokens, smart cards, and Single Sign-On (SSO).<br>• Apply access control models, ACLs, and the Principle of Least Privilege to protect organizational resources. | |
| **Unit 5** | **Privacy Laws, Penalties, and Privacy Issues** (6-0-0-6 = 12 hrs) | |
| **A** | Cyber Laws , Data Privacy and Protection | CO2, CO3, CO4, CO5, CO6 |
| **B** | IT Act and Cyber Regulations , DPDP Rule 2025, GDPR, HIPPA , PCI DSS | |
| **C** | Case Studies | |
| **Tools Used** | NA | |
| **Activities** | **Objective:**<br>• Understand cyber laws, data privacy principles, and major regulatory frameworks governing information security. | |

| | | |
|---|---|---|
| | • Identify the key provisions and compliance requirements of the IT Act, DPDP Rules 2025, GDPR, HIPAA, and PCI DSS.<br>• Analyze real-world case studies to evaluate legal, privacy, and security challenges in cyberspace. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | | ✓ | | | |
| 5 | 2.B | | | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | | | ✓ | ✓ | | ✓ |
| 8 | 3.B | | ✓ | ✓ | | ✓ | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | | | |
| 13 | 5.A | | ✓ | ✓ | | ✓ | ✓ |
| 14 | 5.B | | | ✓ | ✓ | | ✓ |
| 15 | 5.C | | | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | ✓ | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | | | | ✓ | | | | | | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | | | | | | | | | ✓ | | |
| CO6 | | | | | | ✓ | | | ✓ | | | | | | | ✓ | ✓ | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | |
| CO8 | | | | | ✓ | ✓ | | | ✓ | | | | | | ✓ | ✓ | ✓ | |
| CO9 | | | ✓ | | | | | | | ✓ | ✓ | | | | | | | |
| CO10 | | | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Information Security Fundamentals , CIA Traid, Threats, Vulnerabilities, and Attacks, | **UNIT-1** | **6** |
| DD/MM/YY | Security Services and Mechanisms | | |
| DD/MM/YY | Types of Cyber Threats<br>Malware: Viruses, Worms, Trojans, Ransomware , Social Engineering and Phishing Attacks | | |
| DD/MM/YY | Security Policies and Procedures | | |
| DD/MM/YY | Security Standards and Frameworks, | | |
| DD/MM/YY | Risk, Threat, and Asset Identification | | |
| DD/MM/YY | Fundamentals of Cryptography | **UNIT-2** | **6** |
| DD/MM/YY | Steganography, Cryptanalysis | | |
| DD/MM/YY | Classical Cryptography: substitution and transposition techniques | | |
| DD/MM/YY | Block Cipher, stream cipher | | |
| DD/MM/YY | Symmetric and asymmetric key cryptography | | |
| DD/MM/YY | Digital Signatures, Hash | | |
| DD/MM/YY | Introduction to Network Security, Goals of Network Security , Types of Network Attacks | **UNIT-3** | **6** |
| DD/MM/YY | Network Security Mechanisms: Firewalls , | | |
| DD/MM/YY | Intrusion Detection System (IDS) , Intrusion Prevention System (IPS) | | |
| DD/MM/YY | Virtual Private Network (VPN) | | |
| DD/MM/YY | Introduction to Email Security , Email Architecture and Working , Need for Secure Email Communication , Attacks, SSL/TLS for Email Security | | |
| DD/MM/YY | Secure Email Protocols (SMTP, POP3, IMAP) | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | **Authentication and Access Control** | **UNIT-4** | **6** |
| DD/MM/YY | Identification and Authentication Concepts , Authentication Factors, Authentication protocols, Multi-Factor Authentication (MFA) | | |
| DD/MM/YY | Authentication Mechanisms: Biometric Authentication ,Token and Smart Card Authentication | | |
| DD/MM/YY | Single Sign-On (SSO) | | |
| DD/MM/YY | Access Control Fundamentals , Access Control models, Access Control Lists (ACLs) | | |
| DD/MM/YY | Principle of Least Privilege | | |
| DD/MM/YY | **Cyber Laws , Data Privacy and Protection** | **UNIT-5** | **6** |
| DD/MM/YY | IT Act and Cyber Regulations | | |
| DD/MM/YY | DPDP Rule 2025 | | |
| DD/MM/YY | GDPR | | |
| DD/MM/YY | HIPPA , PCI DSS | | |
| DD/MM/YY | Case Studies | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| **W1** | S-1.1 | Use Zenmap (the GUI for Nmap) to perform an intense scan against a safe target network host (scanme.nmap.org). Identify all open ports, the versions of services running on them (e.g., SSH, HTTP), and the target's operating system. | **CO7** | 3.0 |
| | | | | |
| **W2** | S-2.1 | Fire up Wireshark to capture live traffic on your network interface. Filter the traffic for unencrypted protocols (like HTTP or FTP) while logging into a mock testing site | **CO7** | 3.0 |
| | | | | |
| **W3** | S-3.1 | Use native operating system command-line utilities (netstat -ano on Windows or ss -tulpn on Linux) to map out all active, listening network connections on your local machine. Identify the Process ID (PID) associated with an open web browser session | **CO7** | 3.0 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| **W4** | S-4.1 | Generate the SHA-256 checksum of a text file using built-in OS utilities (certutil -hashfile in Windows or sha256sum in Linux). Modify a single punctuation mark inside the file, re-calculate the hash, and document the complete change in output (Avalanche Effect).. | **CO7** | 3.0 |
| | | | | |
| **W5** | S-5.1 | Use GnuPG (GPG) or an open-source tool like Klever Notes/GPG4Win to generate a public/private RSA key pair. Export your public key, import a peer's public key, encrypt a confidential document for them, and verify that only their corresponding private key can decrypt it | **CO7** | 3.0 |
| | | | | |
| **W6** | S-6.1 | Use a command-line tool like steghide or a GUI alternative to embed a secret .txt configuration file inside an ordinary .jpg image carrier file using a passcode passphrase. Verify that the image remains visually uncorrupted | **CO7** | 3.0 |
| | | | | |
| **W7** | S-7.1 | Configure your local host firewall (Windows Defender Firewall with Advanced Security or Linux ufw) to deny all incoming traffic by default. Create an explicit inbound rule that allows traffic only from a specific trusted local IP address for a service like ping (ICMP) or Remote Desktop (RDP). | **CO7** | 3.0 |
| | | | | |
| **W8** | S-8.1 | Create a dummy local user account with a weak password on a test system. Use an automated security tool to crack the password | **CO8/CO9** | 3.0 |
| | | | | |
| **W9** | S-9.1 | Download and execute the open-source auditing tool Lynis (on Linux) or a CIS Benchmark auditing script (on Windows) to scan the local machine's system configuration | **CO8/CO10** | 3.0 |
| | | | | |
| **W10** | S-10.1 | Identify at least three security vulnerabilities flagged by the scanner of your choice. | **CO9/CO10** | 3.0 |
| | | | | |
| **W11** | S-11.1 | Set up Multi-Factor Authentication (MFA) on a personal or test account (e.g., GitHub) using Google Authenticator or Authy. Analyze how the secret seed and system clock work together to change the token every 30 seconds, even when the phone is offline. | **CO7** | 3.0 |
| | | | | |
| **W12** | S-12.1 | Use a tool like ExifTool or an offline metadata viewer to inspect a photograph taken by a | **CO7** | 3.0 |

| | | | | |
|---|---|---|---|---|
| | | smartphone | | |
| | | | | |
| **W13** | S-13.1 | Use command-line search filters like grep with regular expressions to scan a local system<br>directory for unencrypted personal data | **CO8** | 3.0 |
| | | | | |
| **W14** | S-14.1 | Implement ACL by Using advanced OS file properties (the Security tab in Windows or setfacl in Linux) to build a multi-user directory structure. Configure explicit permissions so that a "Viewer" user can read files but is strictly blocked from editing or executing files within a project directory | **CO8/CO9** | 3.0 |
| | | | | |
| **W15** | S-15.1 | Perform SQLi to check the validation and sanitisation for target url | **CO8/CO9** | 3.0 |
| | | | | |

ℹ *Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Security Fundamentals & Threat Awareness** | Recall and identify information security fundamentals, CIA Triad, threats, vulnerabilities, attacks, malware types, phishing, social engineering, security policies, standards, frameworks, and risk concepts | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |

| | | | | |
|---|---|---|---|---|
| **TS2** | **Cryptography & Data Protection Concepts** | Explain cryptographic principles, steganography, cryptanalysis, classical encryption methods, symmetric/asymmetric cryptography, digital signatures, and hashing mechanisms | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| **TS3** | **Network & Email Security Implementation** | Apply network security mechanisms such as firewalls, IDS/IPS, VPNs, SSL/TLS, and secure email protocols to solve practical security problems and communication threats | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| **TS4** | **Authentication & Access Control Analysis** | Analyze authentication mechanisms, MFA, SSO, biometric systems, access control models, ACLs, and least privilege principles for secure system access management | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| **TS5** | **Privacy, Compliance & Security Evaluation** | Evaluate cyber laws, privacy regulations (IT Act, DPDP Rules 2025, GDPR, HIPAA, PCI DSS), compare compliance requirements, and justify suitable security/privacy practice | CO5 \| L5 | ETE Sec B/C |
| **TS6** | **Integrated Security Design & Case Study Synthesis** | Design comprehensive security solutions integrating cryptography, network security, authentication, access control, and legal/privacy compliance through real-world case studies | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1 — **Security Fundamentals & Threat Awareness**<br>TS2 — **Cryptography & Data Protection Concepts** | **CO1, CO2** | Short-answer: definitions. |
| **Sec B** | **6** | TS3 — **Network & Email Security Implementation**<br>TS4 — **Authentication & Access Control Analysis** | **CO3, CO4** | Long and descriptive answers |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — **Security Fundamentals & Threat Awareness**<br>TS2 — **Cryptography & Data Protection Concepts** | **CO1, CO2** | Short questions: definitions. |
| **Sec B** | **50** | TS3 — **Network & Email Security**<br>TS4 — **Authentication & Access Control Analysis**<br>TS5 — **Privacy, Compliance & Security Evaluation** | **CO3, CO4, CO5** | Medium questions: Comparison, Tools and Techniques |
| **Sec C** | **25** | TS5 — **Privacy, Compliance & Security Evaluation** | **CO5, CO6** | Long/design questions: Applications, working principles/ |

| | | | | |
|---|---|---|---|---|
| | | TS6 — **Integrated Security Design & Case Study Synthesis** | | |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CA experiments |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project/Case Study** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem identification, forensic objective, scope definition<br>CA2 — Investigation planning, tool/environment selection | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |

| | | | | |
|---|---|---|---|---|
| | | CA7 — Methodology, workflow, attack/defense analysis plan | | |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Correct execution of scanning/sniffing/auditing/crypto tasks<br>CA4 — Efficient and optimized use of tools/scripts | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Packet/log/result analysis and interpretation<br>CA6 — Evidence validation, screenshots, observations and conclusion documentation | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CA6 — Structured report, screenshots, references, conclusion<br>CA8 — Viva-voce understanding and communication<br>PO7/CO9 — Ethical and responsible cybersecurity practices | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |

| | | | | |
|---|---|---|---|---|
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define forensic/security problem; identify measurable attributes, attack indicators, objectives, scope, and success criteria | CO7, CO8 |
| CA2 | **Experimental Design & Tool Setup** | Plan experiment/investigation; configure tools and environments such as VirtualBox, Wine, Nmap, Wireshark, IPCop, cryptographic utilities, Linux CLI, and network settings | CO7 |
| CA3 | **Code Implementation & Execution** | Correctly execute scanning, sniffing, auditing, fingerprinting, firewall, and cryptographic experiments to obtain expected outputs | CO7 |
| CA4 | **Computational Efficiency & Optimization** | Analyze efficiency of scans/captures/configurations; identify bottlenecks, security gaps, and optimization techniques | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Analyze captured packets, logs, scans, fingerprints, and cryptographic outputs; explain findings and derive evidence-based conclusions | CO8 |
| CA6 | **Documented Outcome with Verification** | Record experiment results formally with screenshots/logs/output verification and validate against objectives | CO7, CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Design investigation workflow/steps; prepare procedures, attack-defense methodology, flowcharts, or security audit plans before execution | CO7, CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records, observations, ethical practices, and demonstrate conceptual understanding during viva | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | **SDG Alignment & Social Relevance** | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | **Problem Scoping & Requirements** | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | **Communication & Testing Strategy** | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | **Innovative Solution Proposal** | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | **Professional Toolchain** | Select and justify development tools; configure professional project environment | CO7 \| PO5 |
| P6 | **End-to-End Implementation** | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |

| | | | |
|---|---|---|---|
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

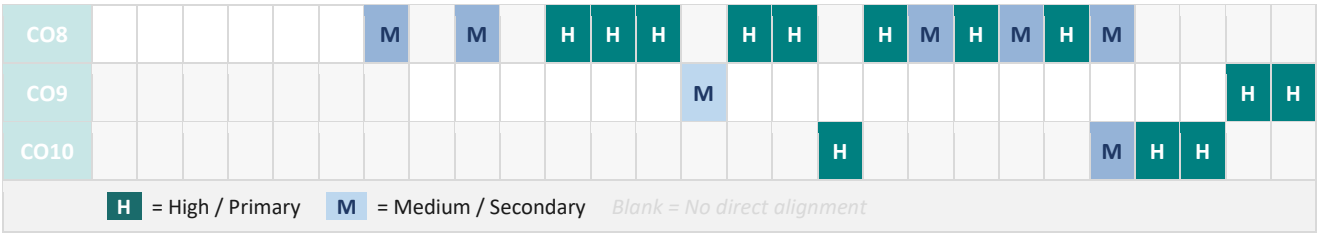
## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | M | | M | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | | | | | H | H | H | M | | M | M | H | | | | | H | M | H | | | | | | |




PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 3 | - | 2 | 2 | - | 1 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 3 | 3 | - | 2 | - | - | 1 | 2 | 3 | 3 | 3 |
| CO4 | 3 | 2 | 2 | 3 | 3 | - | 2 | - | 1 | - | 2 | 3 | 3 | 2 |
| CO5 | 2 | 3 | - | 2 | 2 | 2 | 2 | - | 1 | 2 | 3 | 2 | 3 | 2 |
| CO6 | 2 | 2 | - | - | - | 1 | - | - | 3 | 2 | 2 | 2 | 2 | 2 |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| Avg | 2.50 | 2.29 | 2.20 | 2.17 | 2.57 | 1.67 | 2.33 | 2.00 | 1.80 | 1.67 | 2.25 | 2.44 | 2.50 | 2.30 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | - | M | M | M | H | | | | M |
| CO2 | H | H | M | M | H | - | M | M | - | | M |
| CO3 | M | H | H | H | H | - | M | - | - | | M |
| CO4 | H | M | M | H | H | - | M | - | | - | M |
| CO5 | M | H | - | M | M | M | M | - | | M | H |
| CO6 | M | M | - | - | - | | - | - | H | M | M |
| CO7 | – | – | | – | H | | – | – | – | – | – |
| CO8 | – | | H | | M | H | – | – | – | – | – |
| CO9 | – | – | – | – | – | – | H | – | – | – | H |
| CO10 | – | – | – | – | – | | – | H | H | H | M |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in computational thinking and structured programming; aligned with lifelong learning (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant programming and professional tool skills (CO7) directly applicable to employment in technology sectors. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables development of efficient software solutions; fosters innovation through real-world application design (CO6, CO8) and team-based projects (CO10). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance |

| | | |
|---|---|---|
| L6 — Create: Design, develop, produce new solutions | | P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## IoT Network Analytics (CSAI2004)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester IV | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

# COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |
| **Course Code:** | CSAI2004 | **Course Type:** | Core - Theory Only |

## 2. Course Details

*THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSAI2004** |
| 2 | **Course Title** | **IoT Network Analytics** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs. Classroom + 45 hrs. Self learning = 90 hrs. total) |
| 5 | **Course Status** | **Core - Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | The objective of the course is to introduce fundamental concepts of IoT network analytics with a practical approach to understanding IoT architecture, communication protocols, and network |

| | | |
|---|---|---|
| | | data. To visualize the scope of IoT network analytics and its role in futuristic smart-system development. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Explain the fundamentals of Internet of Things (IoT), IoT architectures, and network analytics concepts.<br>CO2 (Analyze – L3/L4): Analyze IoT communication models, networking technologies, and IoT protocols such as MQTT, CoAP, IPv6, and 6LoWPAN.<br>CO3 (Apply – L2/L3): Apply data collection, preprocessing, and visualization techniques for IoT network traffic and sensor data analytics.<br>CO4 (Evaluate – L4/L5): Evaluate IoT network performance metrics including latency, throughput, bandwidth utilization, and Quality of Service (QoS).<br>CO5 (Analyze – L3/L4): Examine IoT network security threats, intrusion detection methods, anomaly detection techniques, and privacy protection mechanisms.<br>CO6 (Create – L4/L6): Design IoT network analytics solutions for real-time applications such as smart cities, healthcare, industrial IoT, and smart agriculture. |
| 8 | **Course Description** | The fundamental concepts of IoT network analytics, covering IoT architecture, communication protocols, data analytics, security, and real-world applications, have been discussed with a practical, industry-oriented approach. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | **1.** Internet of Things: A Hands-on Approach – Arshdeep Bahga & Vijay Madisetti<br>**2.** The Internet of Things: Key Applications and Protocols – Olivier Hersent, David Boswarthick, Omar Elloumi<br>**3.** Internet of Things and Data Analytics Handbook – Hwaiyu Geng<br>**4.** IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things – David Hanes, Gonzalo Salgueiro, Patrick Grossetete |
| 12 | **References** | **1.** Designing the Internet of Things – Adrian McEwen, Hakim Cassimally<br>**2.** Big Data Analytics for Internet of Things – Tausifa Jan Saleem, Mohammad Ahsan Chishti<br>**3.** Architecting the Internet of Things – Dieter Uckelmann, Mark Harrison, Florian Michahelles<br>**4.** IEEE Communications Magazine<br>**5.** IEEE Transactions on Industrial Informatics<br>**6.** ACM Transactions on Internet of Things |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **UNIT 1: INTRODUCTION TO IoT AND NETWORK ANALYTICS** | |
| A | Introduction to Internet of Things (IoT), Characteristics and Challenges of IoT, IoT Architecture and Functional Layers, IoT Ecosystem and Components. | CO1 |

| | | |
|---|---|---|
| B | Basics of Computer Networks in IoT, IoT Communication Models, Need for IoT Network Analytics. | CO1 |
| C | Descriptive, Predictive and Prescriptive Analytics, IoT Data Sources and Traffic Patterns, Applications of IoT Network Analytics. | CO1 |
| | **UNIT 2: IoT COMMUNICATION AND NETWORKING PROTOCOLS** | |
| A | IoT Networking Technologies, Wireless Sensor Networks (WSN), RFID and NFC, ZigBee. | CO2 |
| B | Bluetooth Low Energy (BLE), Wi-Fi, LoRaWAN, NB-IoT, IPv6 and 6LoWPAN. | CO2 |
| C | Routing Protocols in IoT, MQTT, CoAP, AMQP, Edge, Fog and Cloud Networking, QoS in IoT Networks. | CO2, CO4 |
| | **UNIT 3: IoT DATA ANALYTICS AND VISUALIZATION** | |
| A | IoT Data Collection Techniques, Data Preprocessing and Cleaning, Structured vs Unstructured IoT Data. | CO3 |
| B | Stream Analytics and Real-Time Processing, Network Traffic Analysis, Descriptive Analytics for IoT Networks. | CO3, CO4 |
| C | Data Visualization Techniques, Dashboards and Monitoring Tools, Big Data Analytics in IoT, Introduction to AI/ML in Network Analytics. | CO3, CO6 |
| | **UNIT 4: IoT NETWORK SECURITY AND ANOMALY DETECTION** | |
| A | IoT Security Fundamentals, Threats and Vulnerabilities in IoT Networks, Authentication and Access Control. | CO5 |
| B | Encryption Techniques for IoT, Secure Routing in IoT, Intrusion Detection Systems (IDS). | CO5 |
| C | Anomaly Detection using Analytics, Malware and Botnet Detection, Privacy and Trust Management, Blockchain for IoT Security. | CO5, CO6 |
| | **UNIT 5: IoT APPLICATIONS AND CASE STUDIES** | |
| A | Smart Home Network Analytics, Smart City Traffic Analytics, Healthcare IoT Monitoring. | CO6 |
| B | Industrial IoT (IIoT) Analytics, Agriculture and Environmental Monitoring, Energy and Smart Grid Analytics. | CO6 |
| C | IoT Network Performance Optimization, Predictive Maintenance, Real-Time IoT Monitoring Systems, Emerging Trends in IoT Network Analytics. | CO4, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | **1.A** | ✓ | ✓ | | | | |
| 2 | **1.B** | | ✓ | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | **1.C** | | ✓ | | | | |
| 4 | **2.A** | | | ✓ | | | |
| 5 | **2.B** | | | ✓ | ✓ | | |
| 6 | **2.C** | | | | ✓ | ✓ | |
| 7 | **3.A** | | ✓ | ✓ | | | |
| 8 | **3.B** | | | ✓ | | ✓ | |
| 9 | **3.C** | | | ✓ | | | ✓ |
| 10 | **4.A** | | | ✓ | ✓ | | |
| 11 | **4.B** | | | | ✓ | | |
| 12 | **4.C** | | | | ✓ | | ✓ |
| 13 | **5.A** | | | | ✓ | | ✓ |
| 14 | **5.B** | | | | | | ✓ |
| 15 | **5.C** | | | | | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for procedural mental tracing in CO3. Affective domain appears at A3 (Valuing) and A4 for network performance evaluation in CO2, CO4, and CO5, and A5 (Characterizing) for design-oriented CO6.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | ✓ | ✓ | | | | | | | | | | |
| CO2 | | | ✓ | ✓ | | | | | ✓ | | | | | | | | | |
| CO3 | | ✓ | ✓ | | | | | | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | |
| CO5 | | | ✓ | ✓ | | | | | ✓ | | | | | | | | | |
| CO6 | | | | ✓ | | ✓ | | | | | ✓ | | | | | | | |

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

> ℹ *Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 14.*

| Date | Topic | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to IoT | UNIT-1 | 9 |
| DD/MM/YY | Characteristics and Challenges of IoT | | |
| DD/MM/YY | IoT Architecture and Functional Layers | | |
| DD/MM/YY | IoT Ecosystem and Components | | |
| DD/MM/YY | Basics of Computer Networks in IoT | | |
| DD/MM/YY | IoT Communication Models | | |
| DD/MM/YY | Need for IoT Network Analytics | | |
| DD/MM/YY | Descriptive, Predictive and Prescriptive Analytics | | |
| DD/MM/YY | IoT Data Sources, Traffic Patterns and Applications of IoT Network Analytics | | |
| DD/MM/YY | IoT Networking Technologies | UNIT-2 | 9 |
| DD/MM/YY | Wireless Sensor Networks (WSN) | | |
| DD/MM/YY | RFID and NFC | | |
| DD/MM/YY | ZigBee | | |
| DD/MM/YY | Bluetooth Low Energy (BLE), Wi-Fi | | |
| DD/MM/YY | LoRaWAN, NB-IoT | | |
| DD/MM/YY | IPv6 and 6LoWPAN | | |
| DD/MM/YY | Routing Protocols in IoT, MQTT, CoAP, AMQP | | |
| DD/MM/YY | Edge, Fog and Cloud Networking, QoS in IoT Networks | | |
| DD/MM/YY | IoT Data Collection Techniques | UNIT-3 | 9 |
| DD/MM/YY | Data Preprocessing and Cleaning | | |
| DD/MM/YY | Structured vs Unstructured IoT Data | | |
| DD/MM/YY | Stream Analytics and Real-Time Processing | | |
| DD/MM/YY | Network Traffic Analysis | | |
| DD/MM/YY | Descriptive Analytics for IoT Networks | | |
| DD/MM/YY | Data Visualization Techniques | | |

| | | | |
|---|---|---|---|
| **DD/MM/YY** | Dashboards and Monitoring Tools | | |
| **DD/MM/YY** | Big Data Analytics in IoT, Introduction to AI/ML in Network Analytics | | |
| **DD/MM/YY** | IoT Security Fundamentals | | |
| **DD/MM/YY** | Threats and Vulnerabilities in IoT Networks | | |
| **DD/MM/YY** | Authentication and Access Control | | |
| **DD/MM/YY** | Encryption Techniques for IoT | | |
| **DD/MM/YY** | Secure Routing in IoT | **UNIT-4** | **9** |
| **DD/MM/YY** | Intrusion Detection Systems (IDS) | | |
| **DD/MM/YY** | Anomaly Detection using Analytics | | |
| **DD/MM/YY** | Malware and Botnet Detection | | |
| **DD/MM/YY** | Privacy and Trust Management, Blockchain for IoT Security | | |
| **DD/MM/YY** | Smart Home Network Analytics | | |
| **DD/MM/YY** | Smart City Traffic Analytics | | |
| **DD/MM/YY** | Healthcare IoT Monitoring | | |
| **DD/MM/YY** | Industrial IoT (IIoT) Analytics | | |
| **DD/MM/YY** | Agriculture and Environmental Monitoring | **UNIT-5** | **9** |
| **DD/MM/YY** | Energy and Smart Grid Analytics | | |
| **DD/MM/YY** | IoT Network Performance Optimization | | |
| **DD/MM/YY** | Predictive Maintenance, Real-Time IoT Monitoring Systems | | |
| **DD/MM/YY** | Emerging Trends in IoT Network Analytics | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

*THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.*

★ ***Six Theory Skill Dimensions — one per Bloom's progression (L1–L6) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.***

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | IoT Fundamentals & Conceptual Recall | Recall fundamental concepts of IoT, architecture, functional layers, ecosystem components, and network analytics terminology; identify IoT devices and communication basics for given scenarios | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | IoT Protocol Understanding & Comparative Interpretation | Explain IoT communication models, networking technologies, and protocols including MQTT, CoAP, IPv6, 6LoWPAN; compare wireless standards and interpret protocol trade-offs | CO2 \| L3–L4 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | IoT Data Analytics Application | Apply data collection, preprocessing, and visualization techniques for IoT network traffic and sensor data; demonstrate stream analytics and dashboard interpretation using IoT tools | CO3 \| L2–L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | IoT Network Performance Evaluation | Analyze IoT network architecture, technical constraints and performance metrics; evaluate latency, throughput, bandwidth utilization, reliability and QoS of IoT deployments | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| TS5 | IoT Security & Anomaly Analysis | Analyze IoT network security threats including intrusion, malware, and anomaly patterns; evaluate encryption, authentication and privacy protection mechanisms and their practical implementation challenges | CO5 \| L3–L4 | ETE Sec B/C |
| TS6 | IoT Applications & Solution Design | Analyze real-world IoT applications across smart homes, cities, healthcare, industry and agriculture; design and evaluate IoT network analytics solutions, future trends and comparative platform advantages | CO6 \| L4–L6 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 | TS2 | TS3 | TS4 | TS5 | TS6 |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | | | | M | H |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ ***CA is formative and covers COs progressively as the syllabus is taught. It includes numerical/technical assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.***

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 Assignments | **10** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5, TS6 |
| **Assessments 1–2 (Case Study / Video-based)** | 2 Assessments (Assessment 1 (10 Marks) + Assessment 2 (5 Marks)) | **15** | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 |
| **TOTAL** | — | **25** | **CO1–CO6** | **TS1–TS6** |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2 concepts: IoT fundamentals, architecture, communication protocols and networking technologies | CO1, CO2 | TS1, TS2 | 5h SL | Report submission + conceptual evaluation |
| **Assignment 2** | Unit 3, 4 and Unit 5 concepts: Data analytics techniques, network security, and IoT applications comparison | CO3, CO4, CO5, CO6 | TS3, TS4, TS5, TS6 | 5h SL | Comparative analysis + conceptual explanation |

### 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2 concepts: IoT fundamentals, architecture, protocols, and networking technologies | CO1, CO2, CO3 | TS1, TS2, TS3 | 5h SL | Report submission + conceptual evaluation |
| **Assessment 2** | Unit 3 and Unit 4 concepts: Data analytics, network performance, and IoT security case study | CO3, CO4, CO5 | TS3, TS4, TS5 | 5h SL | Comparative analysis + conceptual explanation |

## 10. Mid Term Examination (MTE) - 15 Marks (Units 1–2)

ℹ *MTE covers Units 1–2 and CO1-CO3 are assessed in ETE. MTE maps to TS1–TS3.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — IoT Fundamentals & Conceptual Recall TS2 — IoT Protocol Understanding & Comparative Interpretation | **CO1, CO2** | Short-answer: define IoT terms, explain IoT architecture, describe communication models, compare wireless protocols, identify network layers and standards |
| TS3 — IoT Data Analytics Application | **CO3** | Application/theory-based questions: describe data preprocessing steps, explain stream analytics workflow, analyze visualization/dashboard design, evaluate data quality approaches |
| **TS1–TS3** | **CO1–CO3** | Units 1–2 only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (design/create). Minimum 40/100 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|

| | | |
|---|---|---|
| TS1 — IoT Fundamentals & Conceptual Recall TS2 — IoT Protocol Understanding & Comparative Interpretation | **CO1, CO2** | Short questions (all units): definitions of IoT, protocol terminology, architecture identification, wireless standard comparison, network layer concepts |
| TS3 — IoT Data Analytics Application TS4 — IoT Network Performance Evaluation TS5 — IoT Security & Anomaly Analysis | **CO3, CO4, CO5** | Medium questions: data preprocessing and visualization design, network performance metric computation, IDS/anomaly detection analysis, security mechanism evaluation |
| TS4 — IoT Network Performance Evaluation TS5 — IoT Security & Anomaly Analysis | **CO4, CO5** | Long/evaluation questions: analysis of network performance trade-offs, comparison of security mechanisms, evaluation of anomaly detection techniques, case-based analysis |
| TS6 — IoT Applications & Solution Design | **CO6** | Long question based on Design, Develop and Create real-world IoT network analytics applications. |
| **TS1–TS6 (all)** | **CO1–CO6** | Scaled from 100 mark to 60 marks. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Explain IoT fundamentals, architecture, and network analytics concepts | ✓ | ✓ | ✓ | **TS1** | PO1, PO2, PO3, PO7 |
| **CO2** | Analyze IoT communication models, networking technologies, and protocols | ✓ | ✓ | ✓ | **TS2** | PO1, PO2, PO3, PO4 |
| **CO3** | Apply data collection, preprocessing, and visualization techniques | ✓ | ✓ | ✓ | **TS3** | PO1, PO3, PO4, PO5 |
| **CO4** | Evaluate IoT network performance metrics and QoS | ✓ | – | ✓ | **TS4** | PO2, PO4, PO9, PO11 |
| **CO5** | Examine IoT network security threats and anomaly detection | ✓ | – | ✓ | **TS5** | PO1, PO5, PO8, PO9, PO10 |
| **CO6** | Design IoT network analytics solutions for real-time applications | ✓ | ✓ | ✓ | **TS6** | PO3, PO4, PO9, PO10, PO11 |

⚠ ***CO4 and CO5 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.***

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the institute's OBE framework.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | - | - | 1 | 1 | - | - | - | 1 | 1 | 2 | 1 |
| CO2 | 2 | 2 | 1 | 2 | 1 | - | - | - | - | 1 | - | 1 | 3 | 2 |
| CO3 | 1 | 2 | 3 | 3 | 2 | - | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO4 | 1 | 2 | 2 | 3 | - | - | 1 | 1 | 2 | 1 | 2 | 1 | 3 | 2 |
| CO5 | 2 | 1 | 1 | 2 | 2 | - | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 1 |
| CO6 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | - | 1 | 1 | 3 | 2 |
| Avg | 1.7 | 1.8 | 2.0 | 2.4 | 1.8 | 1.0 | 1.0 | 1.3 | 2.3 | 1.3 | 1.3 | 1.0 | 2.5 | 1.5 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | M | M | | | M | M | | | | M | M | M | M |
| CO2 | M | M | M | M | M | | | | | M | | M | H | M |
| CO3 | M | M | H | H | M | | M | M | | M | | M | M | M |
| CO4 | M | M | M | H | | | M | M | M | M | M | M | H | M |
| CO5 | M | M | M | M | M | | M | M | H | M | M | M | M | M |
| CO6 | M | H | H | M | M | M | M | M | M | | M | M | H | M |
| Avg | 1.7 | 1.8 | 2.0 | 2.4 | 1.8 | 1.0 | 1.0 | 1.3 | 2.3 | 1.3 | 1.3 | 1.0 | 2.5 | 1.5 |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Assignment Writing (5 assignments, theory/application-based, one per unit focus area)** | 5 assignments × 4 hrs each<br>Total: 20 hrs | **CO1–CO4**<br>**TS1–TS4** | Evaluated based on assignment submission, conceptual understanding, technical accuracy, comparative analysis, and clarity of explanation of IoT concepts |
| 2 | **Technical Video-Based Learning related to the subject (e.g., MQTT/CoAP protocols, IoT dashboards, network security tools, smart city case demos)** | Video viewing: 4 hrs<br>Report preparation: 4 hrs<br>Presentation: 4 hrs<br>Total: 12 hrs | **CO2, CO3**<br>**TS2, TS3** | Report + Presentation based on video learning outcomes; must capture key concepts, protocol workflow, analytics pipeline, and personal reflections |
| 3 | **Real-World Case Studies (e.g., Smart City traffic analytics, Industrial IoT monitoring, IoT security incidents, healthcare IoT deployments)** | Data collection/study: 5 hrs<br>Report preparation: 8 hrs<br>Total: 13 hrs | **CO4, CO5, CO6**<br>**TS4, TS5, TS6** | Evaluated based on in-depth study, technical depth, data collected, fact finding, analytical conclusions, and comparative evaluation of IoT deployments |
| | **TOTAL Self-Learning Hours** | **45 hours** | **CO1–CO6** | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ ***OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L6). Psychomotor domain (P3) appears only for CO3 (procedural mental tracing of data preprocessing workflows). Affective domain (A3–A5) appears for CO2, CO4, CO5, and CO6, reflecting valuing of protocol trade-offs, performance evaluation, and design thinking.***

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

ℹ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | **40 / 100** | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

# CSAI2121 - IoT Network Analytics Summary

*Theory-Only Course | 6 COs (CO1–CO6) | 2 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

*CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks*

# COURSE PLAN

## System Design (CSAI2001)

*Sharda School of Computing Science & Engineering (SCSE) | B.Tech CSE-AIML | Semester IV | Batch 2018–2022*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026-2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027-28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |
| **Course Code:** | CSAI2001 | **Course Type:** | Core — Theory Only |

## 2. Course Details

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSAI2001** |
| 2 | **Course Title** | **System Design** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-1-0-3 (Theory: 30 hrs Classroom + 30 hrs Self Learning = 60 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |

| | | |
|---|---|---|
| 6 | **Course Objectives** | To enable students to analyze existing software systems to understand their architecture, design decisions, and performance. Students will also learn to apply system design principles to optimize and propose scalable, maintainable solutions for real-world applications. |
| 7 | **Course Outcomes (COs)** | After the completion of this course students will be able to:<br><br>CO1: Assess the existing software systems to understand their architecture, design choices, and scalability.<br>CO2: Outline complex systems to extract high-level design and functional<br>requirements.<br>CO3: Apply system design principles, design patterns, and architectural<br>decisions to improve or optimize existing systems.<br>CO4: Examine trade-offs in various design decisions regarding performance, security, and maintainability.<br>CO5: Determine alternative system designs through modeling tools and<br>industry frameworks.<br>CO6: Formulate real-world system case studies to propose scalable,<br>maintainable solutions. |
| 8 | **Course Description** | This course explores system design through case studies and reverse engineering of real-world architecture. Students analyze, deconstruct, and optimize existing systems to understand scalability, performance, and design trade-offs, preparing them to build efficient and maintainable software solutions. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 30 hrs \| Self Learning (SL): 30 hrs \| Total: 60 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1.Martin Fowler, Patterns of Enterprise Application Architecture, Addison-Wesley, 2002.<br>2. Sam Newman, Building Microservices: Designing Fine-Grained Systems, O'Reilly Media, 2021.<br>3. Eric Evans, Domain-Driven Design: Tackling Complexity in the Heart of Software, Addison-Wesley, 2003. |
| 12 | **References** | 1. Mark Richards, Neal Ford, Fundamentals of Software Architecture, O'Reilly Media, 2020.<br>2. Gaurav Sen, System Design Interview – An Insider's |

| | | |
|---|---|---|
| | | Guide, Self-Published, 2022.<br>3. Vladimir Khorikov, Unit Testing: Principles, Practices, and Patterns, Manning Publications, 2020. |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1 Introduction to System Design** | |
| A | Fundamentals of system design, introduction to reverse engineering | CO1 |
| B | Role of system decomposition, design documentation analysis, UML modeling. | CO1 |
| C | Case Study: Reverse Engineering a Monolithic Web Application. | CO1 |
| | **Unit 2: Understanding Large-Scale System Architectures** | |
| A | Microservices vs. monoliths, load balancing, API gateways | CO2, CO4 |
| B | Event-driven architectures, database sharding, CAP theorem, Eventual consistency | CO2, CO4 |
| C | Case Study: Reverse Engineering Twitter's System Architecture. | CO2, CO4 |
| | **Unit 3: Design Patterns & Architectural Styles in Existing Systems** | |
| A | MVC (Model-View-Controller), Layered Architecture, Observer | CO3, CO4 |
| B | Factory, Singleton, CQRS (Command Query | CO3, CO4 |

| | | |
|---|---|---|
| | Responsibility Segregation), Dependency Injection | |
| C | Case Study: Analyzing Netflix's Content Delivery System. | CO3, CO4 |
| | **Unit 4: Security, Scalability & Performance Tuning** | |
| A | Analyzing performance bottlenecks, Scalability challenges | CO4, CO5 |
| B | Security vulnerabilities, Caching strategies, Failover mechanisms | CO4, CO5 |
| C | Case Study: Reverse Engineering Payment Systems like PayPal/Stripe. | CO4, CO5 |
| | **Unit 5: Practical System Redesign & Project** | |
| A | Redesigning an existing system to improve performance, scalability, or maintainability. | CO5, CO6 |
| B | Case Study: Optimizing the Uber System for Global Scalability. | CO5, CO6 |
| C | Reverse engineering and redesigning an existing software system of choice | CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | | ✓ | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | | | | |
| 8 | 3.B | | | ✓ | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | | | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | ✓ | ✓ | ✓ | | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | | | | | | | | | |
| CO5 | | | | ✓ | ✓ | ✓ | | | ✓ | | | | | | ✓ | | | |
| CO6 | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | | | | | ✓ | ✓ | | | |

**Legend:** ✓ = Strong / Dominant mapping.
Theory-oriented course: Cognitive domain is primary. Psychomotor domain is mainly associated with practical system analysis, redesign, and implementation activities. Affective domain reflects appreciation of scalable, secure, and maintainable software architectures.

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| **DD/MM/YY** | Fundamentals of System Design; Introduction to Reverse Engineering | UNIT-1 | 4 |
| **DD/MM/YY** | Role of System Decomposition in Software Architecture | | |

| | | | |
|---|---|---|---|
| **DD/MM/YY** | Design Documentation Analysis and Reverse Engineering Techniques | | |
| **DD/MM/YY** | UML Modeling; Case Study: Reverse Engineering a Monolithic Web Application | | |
| **DD/MM/YY** | Microservices vs. Monoliths; Load Balancing Concepts | UNIT-2 | 6 |
| **DD/MM/YY** | API Gateways and Service Communication Mechanisms | | |
| **DD/MM/YY** | Event-Driven Architectures and Message Queues | | |
| **DD/MM/YY** | Database Sharding and Distributed Data Management | | |
| **DD/MM/YY** | CAP Theorem and Eventual Consistency Concepts | | |
| **DD/MM/YY** | Case Study: Reverse Engineering Twitter's System Architecture | | |
| **DD/MM/YY** | MVC (Model-View-Controller) and Layered Architecture | UNIT-3 | 8 |
| **DD/MM/YY** | Observer Design Pattern and Event Handling | | |
| **DD/MM/YY** | Factory and Singleton Design Patterns | | |
| **DD/MM/YY** | CQRS (Command Query Responsibility Segregation) Architecture | | |
| **DD/MM/YY** | Dependency Injection and Loose Coupling Principles | | |
| **DD/MM/YY** | Architectural Styles in Large-Scale Systems | | |
| **DD/MM/YY** | Case Study: Analyzing Netflix's Content Delivery System | | |
| **DD/MM/YY** | Comparative Analysis of Design Patterns and Architectural Styles | | |
| **DD/MM/YY** | Performance Bottlenecks in Large-Scale Systems | UNIT-4 | 6 |
| **DD/MM/YY** | Scalability Challenges and Optimization Techniques | | |
| **DD/MM/YY** | Security Vulnerabilities in Distributed Systems | | |
| **DD/MM/YY** | Caching Strategies and Performance Enhancement | | |
| **DD/MM/YY** | Failover Mechanisms and High Availability Systems | | |
| **DD/MM/YY** | Case Study: Reverse Engineering Payment Systems like PayPal/Stripe | | |
| **DD/MM/YY** | Redesigning Existing Systems for Better Performance and Maintainability | UNIT-5 | 6 |
| **DD/MM/YY** | Improving System Scalability and Resource Utilization | | |
| **DD/MM/YY** | Case Study: Optimizing the Uber System for Global Scalability | | |
| **DD/MM/YY** | Reverse Engineering and Redesigning an Existing Software System | | |
| **DD/MM/YY** | Project Discussion, Evaluation and System Demonstration | | |
| **DD/MM/YY** | Final Review and Future Trends in System Architecture Design | | |

PART II

## THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | Conceptual Recall & Reverse Engineering Fundamentals | Recall fundamental concepts of system design, reverse engineering, system decomposition, UML modeling, and software architecture terminology; identify architectural components in existing systems | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| **TS2** | Architectural Understanding & System Interpretation | Explain microservices, monolithic systems, API gateways, event-driven architectures, CAP theorem, and database sharding; interpret architectural behavior in large-scale systems | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| **TS3** | Design Pattern Application & System Analysis | Apply architectural styles and design patterns such as MVC, Observer, Factory, Singleton, CQRS, and Dependency Injection in analyzing and redesigning software systems | CO3 \| L3–L4 | CA \| MTE Sec B \| ETE Sec B |
| **TS4** | Scalability, Security & Performance Evaluation | Analyze scalability challenges, performance bottlenecks, caching strategies, failover mechanisms, and security vulnerabilities; evaluate trade-offs in distributed architectures | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | System Redesign & Architectural Optimization | Evaluate redesign strategies for improving maintainability, scalability, reliability, and performance of existing systems; assess architectural improvements using real-world case studies | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | Practical Reverse Engineering & Software Redesign Project | Analyze and redesign an existing software system by applying reverse engineering techniques, architectural principles, and optimization strategies in project-based scenarios | CO6 \| L2–L6 | CA \| ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | Fundamentals of System Design & Reverse Engineering | Recall concepts of system design, reverse engineering, system decomposition, UML modeling, and design documentation analysis; identify components of existing software systems | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| **TS2** | Large-Scale System Architecture Understanding | Explain monolithic and microservices architectures, API gateways, load balancing, event-driven systems, CAP theorem, and database sharding concepts | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| **TS3** | Design Patterns & Architectural Application | Apply architectural styles and design patterns such as MVC, Layered Architecture, Observer, Factory, Singleton, CQRS, and Dependency Injection to software systems | CO3 \| L3–L4 | CA \| MTE Sec B \| ETE Sec B |
| **TS4** | Scalability & Performance Analysis | Analyze scalability challenges, performance bottlenecks, caching strategies, and failover mechanisms in distributed systems; evaluate optimization techniques | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | Security & System Evaluation | Evaluate security vulnerabilities, reliability mechanisms, and architectural trade-offs in large-scale systems such as payment platforms and distributed applications | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | Practical Reverse Engineering & System Redesign | Analyze and redesign an existing software system to improve scalability, maintainability, and performance using reverse engineering techniques and architectural principles | CO6 \| L3–L6 | CA \| Project Evaluation \| ETE Sec C |

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Architecture Analysis / Problem-based)** | 5 Assignments | 15 | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Technical Research Paper / Video Learning Report** | 1 Report + Presentation | 5 | CO2, CO3 | TS2, TS3 |
| **Real-World System Reverse Engineering Case Study** | 1 Report | 5 | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | **CO1–CO6** | **TS1–TS6** |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 concepts: Fundamentals of system design, reverse engineering, system decomposition, UML modeling | CO1 | TS1 | 5h SL | Report submission + conceptual understanding evaluation |
| **Assignment 2** | Large-scale system architectures: Microservices, monoliths, API gateways, CAP theorem, event-driven architecture | CO2 | TS2 | 5h SL | Architecture analysis and comparative study |
| **Assignment 3** | Design patterns and architectural styles: MVC, Observer, Factory, Singleton, CQRS, Dependency Injection | CO2, CO3 | TS2, TS3 | 5h SL | Pattern identification, implementation logic, and comparative analysis |
| **Assignment 4** | Scalability and performance analysis: Bottlenecks, caching strategies, failover mechanisms | CO3, CO4 | TS3, TS4 | 5h SL | Step-by-step system analysis and optimization recommendations |
| **Assignment 5** | Security vulnerabilities and system redesign for scalability and maintainability | CO4, CO5 | TS4, TS5 | 5h SL | System evaluation, redesign proposal, and performance justification |
| **Video Learning Report** | Technical video on distributed systems, reverse engineering, or scalable architectures (min 3 hrs); structured report + presentation | CO2, CO3 | TS2, TS3 | 9h SL | Report: learning outcomes, architecture insights, self-reflection. Presentation: 10 min |
| **Case Study Report** | Real-world case study (e.g., Twitter, Netflix, Uber, PayPal/Stripe architecture); reverse engineering and redesign analysis | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Technical depth, architecture analysis, scalability evaluation, comparative study, redesign quality |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | 10 | TS1 — Fundamentals of System Design & Reverse Engineering TS2 — Large-Scale System Architecture Understanding | CO1, CO2 | Short-answer questions: define reverse engineering concepts, explain system decomposition, compare monolithic and microservices architectures, describe API gateways, CAP theorem, UML modeling, and event-driven architectures |

| | | | | |
|---|---|---|---|---|
| **Section B** | 15 | TS3 — Design Pattern Application & System Analysis TS4 — Scalability & Performance Analysis | CO2, CO3, CO4 | Analytical and application-based questions: identify suitable design patterns, analyze architectural styles, evaluate scalability challenges, explain caching and failover mechanisms, compare distributed system approaches using case studies |
| **TOTAL** | **25** | **TS1–TS4** | **CO1–CO4** | Units 1–3 primarily assessed in MTE. Advanced evaluation and redesign-oriented CO5 and CO6 assessed mainly in ETE/project work. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1 — Conceptual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions (all units): definitions, OS type identification, process state diagrams, IPC mechanisms, synchronization concepts |
| **Section B** | **25** | TS3 — Algorithmic Application TS4 — Performance Evaluation TS5 — Memory System Analysis | **CO3, CO4, CO5** | Medium questions: scheduling algorithm numericals, deadlock handling, paging/segmentation calculations, page replacement algorithm traces, performance comparisons |
| **Section C** | **10** | TS5 — Memory System Analysis TS6 — File & Disk Management Evaluation | **CO5, CO6** | Long/evaluation questions: virtual memory analysis, thrashing, disk scheduling comparisons (FCFS/SSTF/SCAN/C-SCAN), file system design, Windows OS case study analysis |
| **TOTAL** | **50** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Understand fundamentals of system design, reverse engineering, UML modeling, and system decomposition | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| **CO2** | Explore large-scale system architectures including monoliths, microservices, API gateways, and event-driven systems | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | Apply design patterns and architectural styles in analyzing and improving software systems | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| CO4 | Analyze scalability challenges, performance bottlenecks, and optimization strategies in distributed systems | ✓ | ✓ | ✓ | TS4 | PO9, PO10, PO11 |
| CO5 | Evaluate security vulnerabilities, caching strategies, failover mechanisms, and system reliability | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| CO6 | Redesign and optimize existing software systems for scalability, maintainability, and performance | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineering | Problem | Design/Development of | Conduct Investigations | Engineering Tool Usage | The Engineer and The | Ethics | Individual and | Communication | Project Management | Life-Long Learning | Familiarity and practical | Understand, analyze and develop | Apply standard |
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 1 | 1 | - | 2 | 1 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | - | 2 | 2 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | - | 2 | 2 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 3 | 2 | 3 | 3 | 3 |
| CO6 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CSCR3105/ System Design | 2.83 | 2.83 | 2.83 | 3.00 | 2.83 | 2.67 | 1.83 | 1.83 | 2.33 | 2.33 | 2.00 | 3.00 | 3.00 | 2.83 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | H | H | H | | | | M | M | M | M | M | H | M | M |
| **CO2** | H | M | H | H | | | | M | M | M | M | M | M | H | M |
| **CO3** | H | H | H | H | | | | M | M | M | H | M | H | M | M |
| **CO4** | M | M | M | M | M | | | M | H | H | H | M | M | M | M |
| **CO5** | M | M | H | | | | | H | H | M | M | | H | | |
| **CO6** | H | M | | | | | | | M | H | | M | M | | |

**Legend:**
**H** = High / Primary Alignment
**M** = Medium / Secondary Alignment
Blank = No Direct Alignment

## 14. Self-Learning Activities (SL: 30 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | Architecture Analysis & Problem-Based Assignment Writing (5 assignments covering reverse engineering, system architecture, design patterns, scalability, and security analysis) | 5 Assignments × 3 hrs each Total = 15 hrs | CO1–CO4 TS1–TS4 | Evaluated based on assignment submission, architectural understanding, system analysis quality, comparison of approaches, and technical justification |
| 2 | Technical Video-Based Learning related to scalable systems, reverse engineering, microservices, distributed architectures, and design patterns | Video Viewing: 3 hrs Report Preparation: 3 hrs Presentation: 3 hrs Total = 9 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on learning outcomes; must include architecture insights, design concepts, scalability techniques, and personal reflections |
| 3 | Real-World Case Studies (e.g., Twitter architecture, Netflix CDN, Uber scalability, PayPal/Stripe systems) | Data Collection / Study: 4 hrs Report Preparation: 2 hrs Total = 6 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on technical depth, architecture evaluation, scalability analysis, fact finding, redesign suggestions, and analytical conclusions |
| | **TOTAL Self-Learning Hours** | **30 Hours** | **CO1–CO6** | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts | A1 — Receiving: Awareness and willingness to attend | P1 — Perception: Sensory cues guide motor activity |

| | | |
|---|---|---|
| L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**CSE 254 — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks

# COURSE PLAN

## Integrated Professional Communication and Intelligent Computing

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester IV | Batch 2026–2030*

*Lab-Only Course Plan — All 6 Lab COs (CO1–CO6) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I COURSE SYLLABUS** *Course Identification, Details, Outcomes, BTL Mapping & Lab Session Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |
| **Course Code:** | SKP2401 | **Course Type:** | Core |

## 2. Course Details

**LAB-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), Course Examination (CE), and End Semester Examination (ESE). No theory lecture component.**

| | | |
|---|---|---|
| **1** | **Course Code** | SKP2401 |
| **2** | **Course Title** | Integrated Professional Communication and Intelligent Computing |
| **3** | **Credits** | 3 |
| **4** | **Contact Hours (L-T-P-SL)** | 0-0-6-0 (Tutorial: 90 hrs) |
| **5** | **Course Status** | Core |
| **6** | **Course Objectives** | The objective of this course is to develop learners into confident, industry-ready professionals by strengthening their professional communication, presentation, public speaking, interview, and LSRW skills along with computational thinking, machine learning fundamentals, advanced data structures, and modern frontend development capabilities. The course aims to enhance verbal ability, critical thinking, quantitative aptitude, logical reasoning, problem-solving skills, and workplace readiness |

| | | |
|---|---|---|
| | | through structured activities, practical exercises, experiential learning, and industry-oriented software development practices. By the end of the course, learners will demonstrate improved communication competence, analytical ability, professional etiquette, and the capability to design scalable and effective technological solutions for academic, corporate, and real-world environments. |
| **7** | **Course Outcomes (COs)** | After successful completion of this course, the students will be able to:<br>**CO1 (Remember – BTL1): Communication & Computing Fundamentals**<br>Recall the fundamental concepts of professional communication, workplace readiness, machine learning, advanced data structures, and modern frontend development technologies.<br>**CO2 (Understand – BTL2): Business Communication & Technical Workflows**<br>Explain the principles of business communication, interpersonal effectiveness, machine learning workflows, data structure operations, JavaScript programming, and asynchronous processing techniques.<br>**CO3 (Apply – BTL3): Professional Interaction & Computational Problem Solving**<br>Apply communication strategies, interview and presentation skills, quantitative aptitude, logical reasoning, data structure techniques, API integration, and frontend development practices to solve real-world problems.<br>**CO4 (Analyze – BTL4): Critical Thinking, LSRW & System Analysis**<br>Analyze workplace scenarios, verbal communication, machine learning models, graph algorithms, and advanced computational structures using critical thinking and structured analytical approaches.<br>**CO5 (Evaluate – BTL5): Decision Making & Technology Evaluation**<br>Evaluate communication strategies, logical reasoning methods, machine learning algorithms, data structures, and frontend development approaches for effective and scalable solutions.<br>**CO6 (Create – BTL6): Industry-Oriented Communication & Application Development**<br>Design professional communication solutions and develop interactive, industry-oriented applications integrating modern frontend technologies, APIs, machine learning concepts, and problem-solving strategies. |
| **8** | **Course Description** | This course provides an interdisciplinary learning framework integrating professional communication, workplace readiness, machine learning fundamentals, advanced data structures, and modern JavaScript-based frontend development. The course focuses on enhancing business communication, presentation skills, interview readiness, LSRW proficiency, critical thinking, quantitative aptitude, logical reasoning, and professional etiquette alongside computational thinking, algorithmic problem-solving, machine learning workflows, API integration, and interactive web application development. Through practical activities, simulations, experiential learning, and project-based implementation using modern industry tools and technologies, students develop communication competence, analytical |

| | | |
|---|---|---|
| | | ability, technical proficiency, and industry-oriented problem-solving skills required for academic, corporate, and real-world environments. |
| **9** | **Teaching & Learning Scheme** | Lab Instructions (LI): 90 hrs \| Total: 90 hrs \| Credits: 3 |
| **10** | **Mode of Examination** | Lab Only. CA: 30% \| CE: 30% \| ESE: 40% \| Total: 100 marks |
| **11** | **Self Learning (SL: 0 hrs)** | - |
| **12** | **Textbook** | Lipschutz — Data Structures, Schaum's Outline Series, TMH<br>1. Business Communication Today – Bovee, Courtland L. & Thill, John V.A comprehensive resource covering professional communication, business interaction, presentations, workplace communication, and interpersonal effectiveness.<br>2. Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow – Aurélien Géron<br>Covers machine learning fundamentals, regression, classification, and practical implementation using modern ML frameworks.<br>3. Data Structures and Algorithms Made Easy – Narasimha Karumanchi<br>Provides strong conceptual and practical understanding of trees, heaps, hashing, graphs, and algorithmic problem solving.<br>4.JavaScript and JQuery: Interactive Front-End Web Development – Jon Duckett Focuses on JavaScript fundamentals, DOM manipulation, asynchronous programming, API integration, and interactive frontend development.<br>5.Quantitative Aptitude for Competitive Examinations & A Modern Approach to Verbal & Non-Verbal Reasoning – R.S. Aggarwal<br>Covers quantitative aptitude, logical reasoning, analytical thinking, verbal ability, and placement-oriented problem-solving techniques. |
| **13** | **References** | 1. *Communication Skills* – Sanjay Kumar & Pushp Lata<br>Widely used in Indian universities; covers LSRW skills, interpersonal communication, presentation techniques, and professional communication.<br>2. *Soft Skills* – Alex K.<br>Focuses on personality development, leadership communication, employability skills, workplace etiquette, and professional behavior.<br>3. *English Grammar in Use* – Raymond Murphy<br>Useful for grammar improvement, sentence correction, language accuracy, and verbal ability enhancement.<br>4. *Word Power Made Easy* – Norman Lewis<br>Highly effective for vocabulary building, speaking fluency, and verbal communication development.<br>5. *Cracking the Coding Interview & Placement Aptitude* – Various Authors<br>Useful for company-specific aptitude preparation, logical reasoning, and placement-oriented analytical thinking.<br>6. Online Resources:<br>• British Council Learning English – Grammar, listening, |

| | | |
|---|---|---|
| | | speaking, and workplace communication practice<br>• Toastmasters International – Public speaking and leadership communication frameworks<br>• EFSET & Speak and Improve Tools – LSRW assessment and speaking practice<br>• Overleaf Resume Tools – ATS-based resume building and formatting<br>• Newspaper editorials (*The Hindu* / *Indian Express*) for reading comprehension, vocabulary, and critical thinking practice<br>7. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning.<br>8. Kyle Simpson, You Don't Know JS Series.<br>9. Reema Thareja, Data Structures Using C.<br>10. David Flanagan, JavaScript: The Definitive Guide.<br>11. Ian Goodfellow, Deep Learning.<br>12. NPTEL – Machine Learning and Data Structures Courses.<br>13. MDN Web Docs – JavaScript and DOM.<br>14. LeetCode – Trees, BST, Heap, Graph and Hashing Problems.<br>15. Kaggle Learn – Machine Learning.<br>16. GeeksforGeeks – DSA and JavaScript.<br>17. JavaScript.info.<br>18. GitHub Learning Lab. |

## 3. Outline Syllabus — Lab Units with CO Mapping

*ℹ All CO mappings refer to Lab COs (CO1–CO6). This is a lab-only course; all assessment is via CA, CE, and ESE.*

| | Topic / Activity | CO Mapping |
|---|---|---|
| | **Unit 1:** Professional Communication, Computational Thinking & Programming Fundamentals ***(0-0-18-0 = 18 hrs)*** | |
| **A** | Introduction to PRIDE Model of Communication, Models of Communication, Professional & Business Communication | **CO1** |
| **B** | Introduction to STAR Model of Communication, Understanding KRA, KPI, CTP & CTQ, Workplace Communication Readiness | **CO1** |
| **C** | Professional Grooming, Styling, Dressing, Etiquette & Workplace Behaviour | **CO1** |
| **D** | Introduction to Machine Learning, Importance and Applications of Machine Learning, Types of Machine Learning including Supervised, Unsupervised and Reinforcement Learning **OR** Introduction to JavaScript, Role of JavaScript in Web Applications, Linking JavaScript Files, Browser Console and Debugging. | **CO1** |
| **E** | Machine Learning Workflow including Data Collection, Training, Testing and Prediction **OR** Variables, Data Types, Operators, Template Literals, Input/Output Operations and Conditional Statements. | **CO1** |

| | | |
|---|---|---|
| **F** | Tree Terminology, Binary Tree Properties, Perfect, Complete and Full Binary Trees | **CO2** |
| **G** | Tree Traversals including Inorder, Preorder, Postorder, Level Order Traversal and Iterative Traversals. | **CO2** |
| **H** | Height, Diameter, Lowest Common Ancestor, Path Sum Problems and Zigzag Traversals. | **CO2** |
| **I** | Serialization and Deserialization of Trees, Flatten Binary Tree and Binary Tree Camera Problems. | **CO2** |
| | **Unit 2:** Career Readiness, Machine Learning Applications & Advanced Programming Structures. ***(0-0-18-0 = 18 hrs)*** | |
| **A** | Interview Skills & PI Practice – Pre-Interview Preparation, Grooming & Stress Interviews | **CO2** |
| **B** | AI Driven Interview Tools (REMASTO Tools), Understanding Job Descriptions (JD), Understanding Job Offers, Compensation & Benefits | **CO2** |
| **C** | Hands-on Resume Building using Overleaf, ATS Optimization, Keywords, Mass Hiring, Head Hunting & Poaching | **CO3** |
| **D** | Introduction to Regression Problems and Prediction Techniques, Linear Regression Concepts, Working and Applications **OR** JavaScript Loops, Nested Loops, Break and Continue Statements. | **CO3** |
| **E** | Building Simple Prediction Models using Linear Regression **OR** Functions, Parameters, Arrow Functions, Closures, Scope and Execution Context. | **CO3** |
| **F** | Arrays and Array Methods including map(), filter(), reduce(), splice(), slice() and Spread Operator. | **CO4** |
| **G** | Binary Search Tree Properties, Insertion, Deletion and Search Operations.<br>BST Validation, Successor, Predecessor, Floor and Ceiling Operations. | **CO4** |
| **H** | AVL Tree Concepts, Rotation Operations and Height Balance Factor.<br>BST to Sorted DLL Conversion, Recover BST and Kth Smallest Element Problems. | **CO4** |
| | **Unit 3: Leadership Communication, Intelligent Systems & Interactive Programming Concepts. *(0-0-18-0 = 18 hrs)*** | |
| **A** | The Strategic Debate Matrix, Executive Panel Discussion, Corporate Crisis Communication Simulation | **CO3** |
| **B** | Situation-Based Speaking, Vocabulary Speaking Challenge, Thematic Appreciation Test (TAT) | **CO3** |
| **C** | Leadership Narration, Feedback Techniques using Sandwich Model, | **CO3** |

| | | |
|---|---|---|
| | MBTI Personality Assessment | |
| **D** | Introduction to Classification Problems and Binary Classification, Logistic Regression Algorithm, Sigmoid Function and Applications **OR** JavaScript Objects, Nested Objects, Object Methods and JSON Parsing. | **CO4** |
| **E** | Building Classification Models using Logistic Regression **OR** ES6 Features including Destructuring, Optional Chaining, Nullish Coalescing and Template Literals. | **CO4** |
| **F** | DOM Manipulation, Selecting Elements, Content Modification, Class Manipulation and Browser Inspection Tools. | **CO4** |
| **G** | Heap Properties, Min Heap and Max Heap, Array Representation and Parent–Child Relationships.<br>Heapify Operations, Insert and Extract Operations, Build Heap Complexity. | **CO5** |
| **H** | Heap Sort, K-Way Merge and Top-K Problems. | **CO5** |
| **I** | Priority Queue Applications, Fibonacci Heap Concepts and Median of Data Stream. | **CO5** |
| | **Unit 4:** Advanced Communication, Intelligent Computing & Asynchronous Problem Solving. ***(0-0-18-0 = 18 hrs)*** | |
| **A** | Advanced LSRW Practices, EFSET & Speak and Improve Tools, Reading Comprehension (Short & Long Passages) | **CO3** |
| **B** | Sentence Correction & Improvement, Paragraph Completion, Paragraph Jumbles, WriteX Activities | **CO3** |
| **C** | Vocabulary Development, Critical Thinking & Problem Solving, Workplace Writing & Communication Exercises | **CO4** |
| **D** | Decision Tree Algorithm, Working and Applications, K-Nearest Neighbors Algorithm and Distance Measurement Techniques **OR** DOM Traversal, Form Handling, Validation and Local Storage. | **CO4** |
| **E** | Building Classification Models using Decision Tree and KNN Algorithms **OR** Events, Event Listeners, Bubbling, Delegation and Timers. | **CO4** |
| **F** | Asynchronous JavaScript including Callbacks, Promises, Async/Await and Error Handling. | **CO5** |
| **G** | Hash Function Design, Collision Handling Techniques and Open Addressing.<br>Load Factor, Rehashing, HashMap vs HashSet and Amortized Analysis. | **CO5** |
| **H** | Frequency Counting, Two Sum Pattern and Subarray Sum Problems. Rolling Hash, Bloom Filter and Consistent Hashing Concepts. | **CO5** |
| | **Unit 5:** Analytical Reasoning, Intelligent Applications & Graph-Based Problem Solving. ***(0-0-18-0 = 18 hrs)*** | |

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|---|---|---|
| **A** | Number System – Remainder, Average & Weighted Average, AP & GP, Quadratic Equations | **CO4** |
| **B** | Direction & Sense, Coded Direction, Blood Relations, Coded Blood Relations, Order & Ranking | **CO4** |
| **C** | Number Puzzles, Mathematical Operations, Cubes & Dice, Syllogism (Either-Or, Possibility, Some & Not) | **CO5** |
| **D** | Probability-Based Machine Learning Algorithms, Naive Bayes Algorithm, Working and Applications **OR** Fetch API, HTTP Requests, JSON Handling and Error Management | **CO5** |
| **E** | Building Text and Category Classification Models using Naive Bayes **OR** JavaScript Modules, import/export, Classes, Constructors and Inheritance. | **CO5** |
| **F** | Interactive API-Based Project Development, Dynamic UI Interaction and Deployment Workflow. | **CO6** |
| **G** | Graph Types including Directed, Undirected and Weighted Graphs. Adjacency Matrix, Adjacency List, Degree, Path and Cycle Concepts. Breadth First Search, Multi-source BFS and Shortest Path Problems. | **CO6** |
| **H** | Depth First Search, Topological Sorting, Connected Components, Bipartite Graphs and Flood Fill Algorithms | **CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1A - Introduction to PRIDE Model of Communication, Models of Communication, Professional & Business Communication | ✔ | ✔ | | | | |
| 1 | 1B - Introduction to STAR Model of Communication, Understanding KRA, KPI, CTP & CTQ, Workplace Communication Readiness | | ✔ | ✔ | | | |
| 1 | 1C - Professional Grooming, Styling, Dressing, Etiquette & Workplace Behaviour | | ✔ | ✔ | ✔ | | |
| 1 | 1D - Introduction to Machine Learning, Importance and Applications of Machine Learning, Types of Machine Learning including Supervised, Unsupervised and Reinforcement Learning OR Introduction to JavaScript, Role of JavaScript in Web Applications, Linking JavaScript Files, Browser Console and Debugging. | ✔ | ✔ | ✔ | | | |
| 1 | 1E - Machine Learning Workflow including Data Collection, Training, Testing and Prediction OR Variables, Data Types, Operators, Template | | ✔ | ✔ | ✔ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Literals, Input/Output Operations and Conditional Statements. | | | | | | |
| 1 | 1F - Tree Terminology, Binary Tree Properties, Perfect, Complete and Full Binary Trees | ✔ | ✔ | ✔ | ✔ | | |
| 1 | 1G - Tree Traversals including Inorder, Preorder, Postorder, Level Order Traversal and Iterative Traversals. | | ✔ | ✔ | ✔ | | |
| 1 | 1H - Height, Diameter, Lowest Common Ancestor, Path Sum Problems and Zigzag Traversals. | | ✔ | ✔ | ✔ | ✔ | |
| 1 | 1I - Serialization and Deserialization of Trees, Flatten Binary Tree and Binary Tree Camera Problems. | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 2 | 2A - Interview Skills & PI Practice – Pre-Interview Preparation, Grooming & Stress Interviews | | ✔ | ✔ | ✔ | | |
| 2 | 2B - AI Driven Interview Tools (REMASTO Tools), Understanding Job Descriptions (JD), Understanding Job Offers, Compensation & Benefits | | ✔ | ✔ | ✔ | | |
| 2 | 2C - Hands-on Resume Building using Overleaf, ATS Optimization, Keywords, Mass Hiring, Head Hunting & Poaching | | ✔ | ✔ | ✔ | ✔ | |
| 2 | 2D - Introduction to Regression Problems and Prediction Techniques, Linear Regression Concepts, Working and Applications OR JavaScript Loops, Nested Loops, Break and Continue Statements. | ✔ | ✔ | ✔ | | | |
| 2 | 2E - Building Simple Prediction Models using Linear Regression OR Functions, Parameters, Arrow Functions, Closures, Scope and Execution Context. | | ✔ | ✔ | ✔ | | |
| 2 | 2F - Arrays and Array Methods including map(), filter(), reduce(), splice(), slice() and Spread Operator. | | ✔ | ✔ | ✔ | | |
| 2 | 2G - Binary Search Tree Properties, Insertion, Deletion and Search Operations. | ✔ | ✔ | ✔ | ✔ | ✔ | |
| 2 | 2H - BST Validation, Successor, Predecessor, Floor and Ceiling Operations. | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 3 | 3A - The Strategic Debate Matrix, Executive Panel Discussion, Corporate Crisis Communication Simulation | | ✔ | ✔ | ✔ | ✔ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 3B - Situation-Based Speaking, Vocabulary Speaking Challenge, Thematic Appreciation Test (TAT) | | ✔ | ✔ | ✔ | | |
| 3 | 3C - Leadership Narration, Feedback Techniques using Sandwich Model, MBTI Personality Assessment | | ✔ | ✔ | ✔ | ✔ | |
| 3 | 3D - Introduction to Classification Problems and Binary Classification, Logistic Regression Algorithm, Sigmoid Function and Applications OR JavaScript Objects, Nested Objects, Object Methods and JSON Parsing. | ✔ | ✔ | ✔ | ✔ | | |
| 3 | 3E - Building Classification Models using Logistic Regression OR ES6 Features including Destructuring, Optional Chaining, Nullish Coalescing and Template Literals. | | ✔ | ✔ | ✔ | | |
| 3 | 3F - DOM Manipulation, Selecting Elements, Content Modification, Class Manipulation and Browser Inspection Tools. | | ✔ | ✔ | ✔ | ✔ | |
| 3 | 3G - Heap Properties, Min Heap and Max Heap, Array Representation and Parent–Child Relationships. | ✔ | ✔ | ✔ | ✔ | | |
| 3 | 3H - Heapify Operations, Insert and Extract Operations, Build Heap Complexity. | | ✔ | ✔ | ✔ | ✔ | |
| 3 | 3I - Priority Queue Applications, Fibonacci Heap Concepts and Median of Data Stream. | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 4 | 4A - Advanced LSRW Practices, EFSET & Speak and Improve Tools, Reading Comprehension (Short & Long Passages) | | ✔ | ✔ | ✔ | ✔ | |
| 4 | 4B - Sentence Correction & Improvement, Paragraph Completion, Paragraph Jumbles, WriteX Activities | | ✔ | ✔ | ✔ | ✔ | |
| 4 | 4C - Vocabulary Development, Critical Thinking & Problem Solving, Workplace Writing & Communication Exercises | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 4 | 4D - Decision Tree Algorithm, Working and Applications, K-Nearest Neighbors Algorithm and Distance Measurement Techniques OR DOM Traversal, Form Handling, Validation and Local Storage. | ✔ | ✔ | ✔ | ✔ | | |
| 4 | 4E - Building Classification Models using Decision Tree and KNN Algorithms OR Events, Event Listeners, Bubbling, Delegation and Timers. | | ✔ | ✔ | ✔ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | 4F - Asynchronous JavaScript including Callbacks, Promises, Async/Await and Error Handling. | | ✔ | ✔ | ✔ | ✔ | |
| 4 | 4G - Hash Function Design, Collision Handling Techniques and Open Addressing. | ✔ | ✔ | ✔ | ✔ | | |
| 4 | 4H - Load Factor, Rehashing, HashMap vs HashSet and Amortized Analysis. | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 5 | 5A - Number System – Remainder, Average & Weighted Average, AP & GP, Quadratic Equations | | ✔ | ✔ | ✔ | ✔ | |
| 5 | 5B - Direction & Sense, Coded Direction, Blood Relations, Coded Blood Relations, Order & Ranking | | ✔ | ✔ | ✔ | ✔ | |
| 5 | 5C - Number Puzzles, Mathematical Operations, Cubes & Dice, Syllogism (Either-Or, Possibility, Some & Not) | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 5 | 5D - Probability-Based Machine Learning Algorithms, Naive Bayes Algorithm, Working and Applications OR Fetch API, HTTP Requests, JSON Handling and Error Management | ✔ | ✔ | ✔ | ✔ | | |
| 5 | 5E - Building Text and Category Classification Models using Naive Bayes OR JavaScript Modules, import/export, Classes, Constructors and Inheritance. | | ✔ | ✔ | ✔ | ✔ | |
| 5 | 5F - Interactive API-Based Project Development, Dynamic UI Interaction and Deployment Workflow. | | ✔ | ✔ | ✔ | ✔ | ✔ |
| 5 | 5G - Graph Types including Directed, Undirected and Weighted Graphs. | ✔ | ✔ | ✔ | ✔ | | |
| 5 | 5H - Adjacency Matrix, Adjacency List, Degree, Path and Cycle Concepts. | | ✔ | ✔ | ✔ | ✔ | ✔ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

*ℹ Only strong/dominant alignments are mapped. Lab COs span all three domains — Cognitive (L3–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of lab and project work.*

| | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **L1** | **L2** | **L3** | **L4** | **L5** | **L6** | **A1** | **A2** | **A3** | **A4** | **A5** | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** | **P7** |
| **CO1** | ✔ | ✔ | | | | | ✔ | ✔ | | | | ✔ | ✔ | | | | | |
| **CO2** | | ✔ | ✔ | | | | | ✔ | ✔ | | | ✔ | ✔ | ✔ | | | | |
| **CO3** | | | ✔ | ✔ | | | | ✔ | ✔ | ✔ | | | ✔ | ✔ | ✔ | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO4** | | | ✔ | ✔ | ✔ | | | ✔ | ✔ | ✔ | | | | ✔ | ✔ | ✔ | | |
| **CO5** | | | | ✔ | ✔ | | | ✔ | ✔ | ✔ | ✔ | | | | ✔ | ✔ | ✔ | |
| **CO6** | | | ✔ | ✔ | ✔ | ✔ | | ✔ | ✔ | ✔ | ✔ | | | | ✔ | ✔ | ✔ | ✔ |

*Legend: ✔ = Strong / Dominant mapping only.*

## 6. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs & Skill Dimensions Assessed |
|---|---|---|---|
| **Continuous Assessment (CA)** | 30% | **30** | CO1–CO6 through assignments, presentations, coding activities, quizzes, aptitude practice, communication tasks, lab exercises, project work, and classroom participation |
| **Course Examination (CE)** | 30% | **30** | CO1–CO4 through written examination, analytical problem solving, communication assessment, ML/DSA concepts, and programming-based questions |
| **End Semester Examination (ESE)** | 40% | **40** | CO1–CO6 through comprehensive theory, application-based problem solving, case studies, programming logic, communication analysis, and project-oriented questions |
| **TOTAL** | **100%** | **100** | All COs assessed across CA, MTE, and ETE components |

## 7. Continuous Assessment (CA) — 30 Marks

### 7.1 Per-Experiment CA Rubric (3.0 Marks each)

| Criterion | Marks | Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| Problem Understanding, Communication & Experimental Design | 0.75 | Problem understanding, communication clarity, workflow design, algorithm/flowchart preparation, tool/platform setup | 0.75: Clearly defined with proper design & communication \| 0.50: Partial understanding/design \| 0.25: Limited clarity \| 0: Missing | CO1–CO4 |
| Implementation, Programming & Technical Execution | 1.0 | Code correctness, ML/DSA/JavaScript implementation, logical | 1.00: Correct and successfully executed \| 0.50: Minor | CO1–CO5 |

| | | | | |
|---|---|---|---|---|
| | | execution, debugging, tool usage | logical/syntax issues \| 0: Not working/Incomplete | |
| Output Analysis, Problem Solving & Documentation | 0.75 | Result interpretation, analytical thinking, output validation, lab record maintenance, screenshots/output presentation | 0.75: Thorough analysis & documentation \| 0.50: Adequate analysis \| 0.25: Partial documentation \| 0: Absent | CO3–CO5 |
| Professional Behaviour, Teamwork & Ethical Practices | 0.50 | Professional conduct, communication etiquette, responsible coding practices, collaboration, originality, record integrity | 0.50: Consistent professionalism & ethics \| 0.25: Occasional compliance \| 0: Absent | CO5-CO6 |
| **Total** | **3.0** | Integrated communication, technical, analytical and professional skill development | | CO1–CO6 |

## 7.2 Best-N-of-15 Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| More than 12 | Best 10 | 30 Marks | Best 10 performance scores from practicals, coding tasks, communication activities, presentations, aptitude sessions, ML/DSA/JavaScript exercises, and project-based activities will be considered (3 Marks × 10 = 30). |
| 10–12 | Best 8–10 Evaluated Proportionally | Up to 30 Marks | Evaluation will be based on the number of activities conducted, maintaining proportional weightage and continuous assessment standards. |
| Less than 10 | All Conducted Activities Counted | Up to 30 Marks | Missed activities/practicals/presentations will be treated as zero unless officially approved. No compensatory activity shall normally be provided. |

# 8. Continuous Evaluation (CE) — 30 Marks

*i CE is a mid-point practical examination covering Units 1–3 (CO1–CO3). CO4, CO5, and CO6 are assessed in ESE only. CE maps to LS1–LS5.*

| Section | Marks | Skill Dimensions Covered | COs Assessed | Assessment Type & Guidelines |
|---|---|---|---|---|
| **Sec A** | 10 | Communication Skills, Tool Usage, Programming Fundamentals, Practical Execution | CO1, CO2 | Practical task involving communication activity, JavaScript/ML/DSA implementation, or aptitude/problem-solving exercise. Students must demonstrate proper tool/platform usage and successful execution/output. |
| **Sec B** | 10 | Analytical Thinking, Data Structures/ML Logic, Problem Solving, Output Interpretation | CO2, CO3,CO4 | Implementation-based task such as Trees, BST, Heap, Hashing, Graphs, ML workflow, API handling, or frontend interaction. Students must analyze logic, explain outputs, and justify solution approach. |
| **Sec C (Viva)** | 10 | Documentation, Presentation Skills, Professional Communication, Algorithmic Understanding | CO1–CO4 | Viva voce, resume/presentation review, lab/activity record verification, communication assessment, algorithm explanation, debugging discussion, output interpretation, and professional interaction evaluation. |
| **TOTAL** | **30** | Communication, Technical, Analytical & Professional Skills | CO1–CO4 | Units 1–3 based continuous practical evaluation through activities, coding exercises, presentations, discussions, and implementation tasks. |

## 9. End Semester Examination (ESE) — 40 Marks

*i ESE is comprehensive — all 5 units and all 6 COs. Full progression from LS2 (implementation) through LS8 (innovation). Minimum 16/40 required to pass.*

| Section | Marks | Skill Dimensions | COs Assessed | Assessment Type & Guidance |
|---|---|---|---|---|
| **Sec A** | 10 | Technical Implementation, Tool | CO1, CO2, CO3 | Practical implementation task involving Data Structures, Machine |

| | | | | |
|---|---|---|---|---|
| | | Usage, Communication & Practical Execution | | Learning workflow, JavaScript programming, frontend interaction, or communication-based activity. Students must execute correctly and demonstrate proper tool/platform usage with expected output/results. |
| **Sec B** | 20 | Algorithmic Thinking, Analytical Ability, Problem Solving, Output Interpretation | CO3, CO4, CO5 | Advanced implementation and analysis-based tasks such as Trees, BST, Heap, Hashing, Graph algorithms, ML classification/regression tasks, asynchronous JavaScript, API handling, or aptitude/problem-solving activities. Students must explain logic, analyze performance, interpret outputs, and justify solution/design approach. |
| **Sec C** | 10 | Professional Communication, Innovation, Documentation & Presentation Skills | CO5, CO6 | Viva voce, presentation, mini-project demonstration, resume/interview evaluation, debugging discussion, algorithm design, UI/project explanation, professional communication assessment, and innovation-oriented problem-solving tasks. |
| **TOTAL** | **40** | Communication, Technical, Analytical, Professional & Innovation Skills | CO1–CO6 | Comprehensive evaluation covering Units 1–5 through practical implementation, activities, viva, presentations, project demonstration, and analytical assessment. Minimum 16/40 required to pass. |

## 9.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (30) | CE (30) | ESE (40) | LS Dims | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Recall communication, ML, DSA and frontend fundamentals | ✓ | ✓ | ✓ | Communication Fundamentals, Tool Usage, Technical Understanding | PO1, PO5, PO9 |
| **CO2** | Explain business communication, ML | ✓ | ✓ | ✓ | Communication Skills, | PO1, PO2,PO9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | workflows and programming concepts | | | | Programming Logic, Analytical Understanding | |
| **CO3** | Apply communication strategies, DSA techniques, APIs and frontend practices | ✓ | ✓ | ✓ | Practical Implementation, Problem Solving, Technical Execution | PO1, PO2, PO3,PO5 |
| **CO4** | Analyze workplace scenarios, ML models and graph/data structure problems | ✓ | ✔ | ✓ | Analytical Thinking, Algorithmic Analysis, Critical Reasoning | PO1, PO2, PO4 |
| **CO5** | Evaluate communication methods, algorithms and development approaches | ✓ | — | ✓ | Evaluation Skills, Performance Analysis, Decision Making | PO1, PO2, PO8, PO10 |
| **CO6** | Design professional solutions and interactive industry-oriented applications | ✓ | — | ✓ | Innovation, Application Development, Professional Competency | PO3, PO5, PO10, PO11 |

⚠ *CO4 and CO5 are NOT assessed in CE (only Units 1–3 are covered at the course examination). They are assessed in CA (lab sessions) and ESE.*

**PART III COMBINED MAPPINGS & REFERENCE** *CO–PO Matrix, CO–PO Alignment, Bloom's Reference, Attendance & Pass/Fail*

## 10. CO–PO and CO–PSO Mapping Matrix

***i*** *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **2** | 1 | 1 | - | - | - | - | | 3 | 2 | 2 | **2** | **1** | **1** |
| **CO2** | 2 | **2** | 1 | - | 1 | - | 1 | 2 | 3 | 2 | 2 | 2 | 2 | **1** |
| **CO3** | **2** | **3** | 2 | 1 | 1 | - | 1 | 3 | 3 | 2 | 2 | 3 | **2** | 2 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO4** | **2** | **3** | 2 | 2 | 1 | 1 | 1 | **2** | 3 | 2 | 3 | **2** | 3 | **2** |
| **CO5** | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | **2** | 3 | 3 | 2 | 3 | **2** |
| **CO6** | **2** | **3** | 3 | 2 | 3 | 1 | 1 | 3 | 3 | 3 | **3** | 3 | **3** | **3** |
| **Avg** | **2.00** | **2.50** | **1.83** | **1.75** | **1.60** | **1.0** | **1** | **2.17** | **2.83** | **2.33** | **2.50** | **2.35** | **2.35** | **1.83** |

## 11. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | **M** | | | | | M | H | M | M | **M** | M | M |
| **CO2** | M | **M** | M | | M | | M | M | H | M | M | M | M | |
| **CO3** | H | **H** | **H** | M | M | | M | H | H | M | M | H | **M** | M |
| **CO4** | H | **H** | H | M | M | M | M | **M** | H | **M** | H | **M** | H | **M** |
| **CO5** | **H** | H | H | H | M | M | M | M | **M** | H | H | M | H | **M** |
| **CO6** | **M** | **H** | **H** | H | H | M | M | H | H | H | **H** | H | **H** | **H** |

*H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment*

## 12. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| **L1 — Remember:** Recall professional communication concepts, workplace terminology, ML fundamentals, DSA terminology, JavaScript syntax, aptitude concepts and frontend development basics. **L2 — Understand:** Explain communication models, ML workflows, DSA operations, frontend interaction concepts, API handling principles and analytical reasoning methods. **L3 — Apply:** Use communication strategies, coding techniques, ML methods, APIs, JavaScript concepts and problem-solving approaches in practical and workplace situations. **L4 — Analyze:** Analyze workplace | **A1 — Receiving:** Awareness of workplace communication, professional etiquette, technical learning tools and collaborative activities. **A2 — Responding:** Active participation in discussions, coding exercises, presentations, mock interviews, aptitude activities and teamwork tasks. **A3 — Valuing:** Demonstrating responsibility, collaboration, ethical coding practices, professional communication and workplace discipline **A4 — Organizing:** Integrating communication skills, leadership qualities, teamwork, technical practices and problem-solving approaches into | **P1 — Perception:** Identify communication tools, IDEs, APIs, browser tools, ML platforms, coding environments and technical resources. **P2 — Set:** Readiness for interviews, presentations, coding tasks, ML implementation, aptitude practice and frontend development activities. **P3 — Guided Response:** Perform communication activities, DSA implementation, ML exercises, JavaScript tasks and analytical problem-solving through guided practice. **P4 — Mechanism:** Independently execute coding, debugging, DOM manipulation, ML workflows, reasoning tasks |

| | | |
|---|---|---|
| scenarios, algorithms, graph problems, ML models, reasoning patterns, frontend behavior and communication effectiveness. **L5 — Evaluate:** Assess communication methods, algorithms, technical solutions, project implementations, reasoning approaches and professional practices. **L6 — Create:** Design professional communication solutions, interactive frontend applications, intelligent systems, ML-based projects and industry-oriented technical solutions. | structured workflows. **A5 — Characterizing:** Consistent display of professionalism, communication confidence, ethical conduct, technical competency and industry readiness. | and communication activities with accuracy. **P5 — Complex Overt Response:** Efficiently perform integrated technical activities including API integration, frontend interaction, ML model execution and project implementation. **P6 — Adaptation:** Modify communication styles, optimize algorithms, improve frontend behavior, adapt ML workflows and refine technical solutions for different scenarios. **P7 — Origination:** Create innovative applications, intelligent systems, professional communication solutions and industry-oriented software projects. |

*i OBE Compliance Statement: This is a lab-only course. All 6 COs span all three domains — Cognitive (L3–L6) as the primary domain, Psychomotor (P3–P6) for implementation and design skills, and Affective (A2–A4) for professional and collaborative conduct — reflecting the skill-based, hands-on nature of laboratory assessment.*

# 13. Attendance Policy & Pass/Fail Criteria

## 13.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| Practical / Activity Sessions | 75% Attendance | Communication activities, ML/DSA practicals, JavaScript/frontend sessions, aptitude activities, presentations and industry-oriented lab sessions | Students below the minimum attendance requirement may be debarred from Continuous Evaluation (CE) and End Semester Examination (ESE) as per institute norms |
| Continuous Assessment Activities | Completion of Assigned Activities | Coding exercises, communication tasks, presentations, mock interviews, ML/DSA assignments, frontend/API activities and aptitude practice | Incomplete or missing activities directly affect Continuous Assessment (CA) marks |
| Lab Record / Documentation | Regular Submission & Verification | Practical records, coding documentation, | Incomplete documentation may reduce CA/CE evaluation marks |

| | | | |
|---|---|---|---|
| | | presentation reports and project/activity submissions | |
| Professional Participation | Active Involvement | Team discussions, viva voce, collaborative activities, communication exercises and project demonstrations | Lack of participation may affect professionalism, communication and activity-based evaluation components |

*⚠ Lab attendance must meet 75% minimum. Missing SL activities (coding platform submissions) directly impacts CA marks and is not compensable by examination performance.*

## 13.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ESE Score** | ≥ 16 / 40 | **MANDATORY** | Minimum 40% marks in ESE are required. Failure to secure the minimum ESE marks may result in failure in the course irrespective of performance in CA and CE components. |
| **Overall Total (CA + CE + ESE)** | ≥ 40 / 100 | **Must pass overall** | Continuous Assessment (30) + Continuous Evaluation (30) + End Semester Examination (40) together constitute the total course assessment. Students must secure minimum overall passing marks as prescribed by institutional regulations. |
| Practical / Activity Participation | Satisfactory Completion | Mandatory for Course Completion | Students are expected to complete communication activities, coding exercises, ML/DSA practicals, JavaScript/frontend tasks, presentations and documentation requirements. |
| Professional & Academic Compliance | Mandatory | Required | Ethical practices, originality in submissions, professional conduct and timely completion of activities are compulsory as per institutional and course guidelines. |

**CSCR1505 — LAB-ONLY COURSE PLAN — MEASUREMENT ARCHITECTURE**

11 Programme Outcomes → 6 Lab COs (CO1–CO6) → 3 Assessment Instruments → 8 Lab Skill Dimensions (LS1–LS8)

CO1–CO3: Apply/Analyse → LS1–LS3, LS6 → CA + CE + ESE

CO4–CO5: Analyse/Evaluate → LS3–LS5, LS7 → CA + ESE

CO6: Create → LS7–LS8 → CA + ESE Sec C

**Marks: CA 30 + CE 30 + ESE 40 = Total 100**

# COURSE PLAN

## Machine Learning Operations (MLOps) & Agentic AI (CSAI2101)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester IV | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2027–28 |
| **Branch:** | CSE-AIML | **Semester:** | IV |
| **Course Code:** | CSAI2101 | **Course Type:** | Core - Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSAI2101** |
| 2 | **Course Title** | **Machine Learning Operations (MLOps) & Agentic AI** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs. Classroom + 45 hrs. Self Learning = 90 hrs. total) |

| | | |
|---|---|---|
| 5 | **Course Status** | **Core - Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | To introduce the principles and workflow of Machine Learning Operations including model deployment, monitoring, and lifecycle management.<br>To explore the concepts and techniques related to Agentic AI systems for autonomous decision-making and interaction.<br>To provide hands-on frameworks and best practices for scalable, reliable AI application development and management. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Understand the end-to-end MLOps lifecycle including data pipelines, model training, deployment, and monitoring.<br>CO2 (Apply – L2/L3): Implement CI/CD pipelines, automation, and version control for scalable ML model management.<br>CO3 (Analyze – L3): Analyze Agentic AI system architectures and core components for autonomous decision making and interaction.<br>CO4 (Design – L4/L5): Design scalable, efficient, and ethically responsible AI systems with considerations for performance optimization.<br>CO5 (Apply – L3/L4): Apply real-world MLOps tools and frameworks to develop robust and maintainable AI applications.<br>CO6 (Evaluate – L4/L5): Evaluate and troubleshoot deployed ML models through monitoring, retraining strategies, and lifecycle management. |
| 8 | **Course Description** | This course covers the essential concepts and practical frameworks of MLOps and Agentic AI, emphasizing continuous integration, deployment, and maintenance of machine learning models with autonomous agent capabilities. Students will learn techniques to ensure scalability, reliability, and ethical AI system governance in modern AI environments. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | • Mark Treveil, Alok Shukla, "Machine Learning Operations (MLOps): A Practical Guide to Continuous Delivery and Automation of ML," O'Reilly Media, 2020.<br>• Tarry Singh, "Agentic AI: Autonomous Agents and Architectural Principles," Springer, 2024.<br>• Emmanuel Ameisen, "Building Machine Learning Powered Applications: Going from Idea to Product," O'Reilly Media, 2020. |

| | | |
|---|---|---|
| 12 | **References** | 1. Gene Kim, Jez Humble, Patrick Debois, John Willis, "The DevOps Handbook," IT Revolution Press, 2016.<br>2. David Kopec, "Deep Reinforcement Learning Hands-On," Packt Publishing, 2019.<br>3. Andrew Ng, "Machine Learning Yearning," Online Resource.<br>4. MLflow Documentation (https://mlflow.org/docs/latest/index.html)<br>5. Kubernetes Documentation (https://kubernetes.io/docs/home/)<br>6. Docker Documentation (https://docs.docker.com/)<br>7. Kubeflow Documentation (https://www.kubeflow.org/docs/) |

## 3. Outline Syllabus with CO Mapping

*All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: INTRODUCTION TO ML OPS** | |
| **A** | ML Ops Overview: Concepts and significance in AI lifecycle | **CO1, CO2** |
| **B** | Data and Model Pipelines: Data collection, preprocessing, and model training workflows | **CO1, CO2** |
| **C** | ML Ops Tools: Introduction to Kubernetes, Docker, MLflow, and version control systems | **CO1, CO2** |
| | **Unit 2: AUTOMATION AND CONTINUOUS INTEGRATION/DEPLOYMENT** | |
| **A** | Automation Essentials: Scripting, scheduling, and workflow orchestration | **CO2, CO5** |
| **B** | CI/CD for ML Models: Setting up pipelines, testing, and validation | **CO2, CO5** |
| **C** | Model Registry and Versioning: Managing model versions and reproducibility | **CO2, CO5** |
| | **Unit 3: AGENTIC AI FUNDAMENTALS** | |
| **A** | Agentic AI Concepts: Autonomous agents, decision-making frameworks | **CO3** |
| **B** | Components of Agentic Systems: Sensors, actuators, and environment interaction | **CO3** |
| **C** | Agent Architectures: Reactive, deliberative, and hybrid models | **CO3** |

| | | |
|---|---|---|
| | **Unit 4: SCALABLE AI SYSTEM DESIGN** | |
| **A** | Scalability Challenges and Solutions: Distributed training, resource management | CO4, CO5 |
| **B** | Monitoring and Observability: Metrics, alerting, and fault tolerance | CO4, CO5 |
| **C** | Performance Optimization and Deployment Strategies | CO4, CO5 |
| | **Unit 5: ETHICS AND GOVERNANCE IN ML OPS AND AGENTIC AI** | |
| **A** | Ethical AI Principles: Fairness, transparency, bias mitigation | CO4, CO6 |
| **B** | Governance Frameworks: Compliance, audit trails, and accountability | CO4, CO6 |
| **C** | Case Studies and Future Trends in ML Ops and Autonomous AI Systems | CO4, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | ✓ | | | | |
| 7 | 3.A | | | ✓ | ✓ | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | 5.B | | | ✓ | ✓ | ✓ | |
| 15 | 5.C | | ✓ | ✓ | ✓ | | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | ✓ | | | | | ✓ | | | | |
| CO3 | | ✓ | ✓ | | | | ✓ | | | | | | | | | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | |
| CO5 | | | | ✓ | ✓ | | ✓ | ✓ | | | | | | ✓ | | | | |
| CO6 | | ✓ | | ✓ | | | | | | | ✓ | | | | | | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ *Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 11.*

| Date | Smart Contract Basics | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | ML Ops Overview: Concepts and Significance in AI Lifecycle | UNIT-1 | 9 |
| DD/MM/YY | History and Evolution of DevOps to MLOps | | |
| DD/MM/YY | Data Collection and Preprocessing for ML Pipelines | | |
| DD/MM/YY | Model Training Workflows and Pipeline Architecture | | |
| DD/MM/YY | Introduction to Kubernetes for ML Workloads | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Introduction to Docker and Containerization | | |
| DD/MM/YY | Introduction to MLflow: Experiment Tracking | | |
| DD/MM/YY | Version Control Systems for ML: Git and DVC | | |
| DD/MM/YY | End-to-End MLOps Lifecycle Overview and Case Discussion | | |
| DD/MM/YY | Automation Essentials: Scripting and Scheduling | UNIT-2 | 9 |
| DD/MM/YY | Workflow Orchestration with Apache Airflow | | |
| DD/MM/YY | CI/CD Concepts for Machine Learning Models | | |
| DD/MM/YY | Setting Up CI/CD Pipelines: Testing and Validation | | |
| DD/MM/YY | Pipeline Automation and Integration Strategies | | |
| DD/MM/YY | Model Registry: Concepts and Implementation | | |
| DD/MM/YY | Model Versioning and Reproducibility | | |
| DD/MM/YY | Managing Model Versions with MLflow Model Registry | | |
| DD/MM/YY | Continuous Delivery for ML: Best Practices and Challenges | | |
| DD/MM/YY | Agentic AI Concepts: Autonomous Agents and Definitions | UNIT-3 | 9 |
| DD/MM/YY | Decision-Making Frameworks in Autonomous Systems | | |
| DD/MM/YY | Components of Agentic Systems: Sensors and Actuators | | |
| DD/MM/YY | Environment Interaction and Perception Models | | |
| DD/MM/YY | Reactive Agent Architecture: Principles and Examples | | |
| DD/MM/YY | Deliberative Agent Architecture: Planning and Reasoning | | |
| DD/MM/YY | Hybrid Agent Architectures: BDI and Layered Models | | |
| DD/MM/YY | Multi-Agent Systems and Coordination Mechanisms | | |
| DD/MM/YY | Real-World Applications of Agentic AI Systems | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Scalability Challenges in AI System Deployments | UNIT-4 | 9 |
| DD/MM/YY | Distributed Training: Strategies and Frameworks | | |
| DD/MM/YY | Resource Management in Cloud and Kubernetes Clusters | | |
| DD/MM/YY | Monitoring and Observability: Metrics and KPIs | | |
| DD/MM/YY | Alerting Systems and Fault Tolerance Strategies | | |
| DD/MM/YY | Data and Model Drift Detection and Management | | |
| DD/MM/YY | Performance Optimization: Latency, Throughput, Cost | | |
| DD/MM/YY | Blue-Green, Canary, and Shadow Deployment Strategies | | |
| DD/MM/YY | Auto-scaling and Load Balancing for AI Services | | |
| DD/MM/YY | Ethical AI Principles: Fairness and Bias Mitigation | UNIT-5 | 9 |
| DD/MM/YY | Transparency, Explainability, and Interpretability in AI | | |
| DD/MM/YY | Governance Frameworks: Compliance and Accountability | | |
| DD/MM/YY | Audit Trails, Logging, and Regulatory Requirements | | |
| DD/MM/YY | Responsible AI Design Patterns | | |
| DD/MM/YY | Case Studies: MLOps Failures and Lessons Learned | | |
| DD/MM/YY | Case Studies: Agentic AI in Production Environments | | |
| DD/MM/YY | Future Trends: LLMOps and Foundation Model Deployment | | |
| DD/MM/YY | Discussion of Future Prospects and Course Review | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **MLOps Fundamentals & Conceptual Recall** | Recall fundamental concepts of MLOps lifecycle, data pipelines, model training, deployment terminology, and key tools such as Docker, Kubernetes, MLflow, and version control; identify appropriate MLOps components for given AI scenarios | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | **Automation & CI/CD Pipeline Understanding** | Explain automation principles, CI/CD pipeline concepts, workflow orchestration, model registry management, and versioning strategies for scalable ML model delivery and reproducibility | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | **Agentic AI Architecture & Application** | Apply Agentic AI concepts including autonomous agent architectures (reactive, deliberative, hybrid), decision-making frameworks, sensor-actuator models, and multi-agent coordination in real-world scenarios | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | **Scalable AI Design & Ethical Evaluation** | Analyze scalable AI system design patterns, distributed training, monitoring strategies, performance optimization, ethical AI principles, fairness, transparency, and bias mitigation; evaluate responsible AI governance approaches | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| TS5 | **MLOps Tools & Framework Proficiency** | Analyze real-world MLOps toolchains, deployment strategies (blue-green, canary, shadow), auto-scaling mechanisms, and hands-on application of frameworks for robust and maintainable AI application development | CO5 \| L3–L4 | ETE Sec B/C |

| | | | | |
|---|---|---|---|---|
| **TS6** | **Model Lifecycle Evaluation & Troubleshooting** | Analyze and evaluate deployed ML model performance through monitoring, drift detection, retraining strategies, governance frameworks, compliance audit trails, and future trends including LLMOps and foundation model deployment | CO6 \| L4–L5 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 MLOps Fundamentals & Conceptual Recall | TS2 Automation & CI/CD Pipeline Understanding | TS3 Agentic AI Architecture & Application | TS4 Scalable AI Design & Ethical Evaluation | TS5 MLOps Tools & Framework Proficiency | TS6 Model Lifecycle Evaluation & Troubleshooting |
|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | | | | |
| **CO2** | **M** | **H** | **M** | | | |
| **CO3** | | **M** | **H** | **M** | | |
| **CO4** | | | **M** | **H** | **M** | |
| **CO5** | | | | **M** | **H** | **M** |
| **CO6** | | **M** | | **M** | **M** | **H** |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 assignments | **10** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5,TS6 |

| | | | | |
|---|---|---|---|---|
| **Assessments 1–2 (Theory / Application-based)** | 2 Assessments (Assessment 1 (10 Marks) + Assessment 2 (5 Marks)) | **15** | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2 concepts: MLOps lifecycle, data pipelines, ML tools, automation, CI/CD, model versioning | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Report submission + conceptual evaluation |
| **Assignment 2** | Unit 3, 4 and Unit 5: Agentic AI architectures, scalable system design, monitoring, ethical AI principles, governance frameworks | CO1,CO2,CO3, CO4, CO5,CO6 | TS1,TS2,TS3,TS4,TS5,TS6 | 5h SL | Comparative analysis + conceptual explanation |

### 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2 concepts: MLOps lifecycle, data pipelines, automation, CI/CD pipelines, model registry and versioning | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Report submission + conceptual evaluation |
| **Assessment 2** | Unit 3 and Unit 4: Agentic AI fundamentals, agent architectures, scalability, monitoring, performance optimization, deployment strategies | CO1,CO2,CO3, CO4, CO5 | TS1,TS2,TS3,TS4,TS5 | 5h SL | Comparative analysis + conceptual explanation |

## 10. Mid Term Examination (MTE) - 15 Marks (Units 1–2)

*MTE covers Units 1–2 and CO1-CO6 are assessed in ETE. MTE maps to TS1–TS3.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — MLOps Fundamentals & Conceptual Recall TS2 — Automation & CI/CD Pipeline Understanding | CO1, CO2 | Short-answer: define MLOps lifecycle, explain data pipeline stages, describe CI/CD for ML, compare DevOps vs MLOps, identify containerization tools (Docker/Kubernetes), explain model versioning strategies |
| TS3 — Agentic AI Architecture & Application | CO3 | Application/theory-based questions: explain autonomous agent decision-making, describe reactive vs deliberative architectures, analyze components of agentic systems, evaluate hybrid agent models |
| TS1–TS3 | **CO1–CO3** | Units 1–2 only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

*ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 40/100 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — MLOps Fundamentals & Conceptual Recall TS2 — Automation & CI/CD Pipeline Understanding | **CO1, CO2** | Short questions (all units): definitions of MLOps concepts, pipeline stages, Docker/Kubernetes, CI/CD for ML, model registry, automation workflow terminology, versioning strategies |
| TS3 — Agentic AI Architecture & Application TS4 — Scalable AI Design & Ethical Evaluation TS5 — MLOps Tools & Framework Proficiency | **CO3, CO4, CO5** | Medium questions: autonomous agent architectures, decision-making frameworks, scalable deployment strategies, monitoring and observability, ethical AI principles, fairness metrics, MLOps toolchain application, performance optimization techniques |
| TS4 — Scalable AI Design & Ethical Evaluation TS5 — MLOps Tools & Framework Proficiency | **CO4, CO5** | Long/evaluation questions: analysis of distributed training strategies, comparison of deployment patterns, evaluation of governance frameworks, AI system case study analysis, comparative assessment of MLOps platforms |

| | | |
|---|---|---|
| TS6 — Model Lifecycle Evaluation & Troubleshooting | **CO6** | Long question based on Evaluate, Monitor and Troubleshoot deployed AI applications; model drift analysis, retraining strategies, LLMOps future trends. |
| TS1–TS6 (all) | **CO1–CO6** | Scaled from 100 mark to 60 marks. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Understand the end-to-end MLOps lifecycle including data pipelines, model training, deployment, and monitoring | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO5 |
| **CO2** | Implement CI/CD pipelines, automation, and version control for scalable ML model management | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO5 |
| **CO3** | Analyze Agentic AI system architectures and core components for autonomous decision making | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Design scalable, efficient, and ethically responsible AI systems with performance optimization | ✓ | — | ✓ | TS4 | PO6, PO7, PO9, PO10 |
| **CO5** | Apply real-world MLOps tools and frameworks to develop robust and maintainable AI applications | ✓ | — | ✓ | TS5 | PO1, PO2, PO5, PO8, PO11 |
| **CO6** | Evaluate and troubleshoot deployed ML models through monitoring, retraining, and lifecycle management | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 2 |
| CO6 | 2 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 3 |
| **Avg** | **2.83** | **2.50** | **2.50** | **2.50** | **2.66** | **1.66** | **1.30** | **1.33** | **1.67** | **1.83** | **1.67** | **2.67** | **2.17** | **2.33** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | M | | M | | M | | | | | | | | M | |
| CO 2 | M | H | | M | M | | | | | | | | M | M |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 3** | | M | H | H | M | H | | | | | | | M | |
| **CO 4** | M | | M | M | | | | H | H | | | | H | M |
| **CO 5** | H | M | H | | M | M | | | | | | | M | |
| **CO 6** | M | H | M | | M | | | | | | | | M | |
| **Avg** | 2.83 | 2.50 | 2.50 | 2.50 | 1.00 | 0.80 | 0.70 | 0.70 | 0.67 | 0.70 | 0.50 | 1 | 2.20 | 1.30 |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Assignment Writing (5 assignments, theory/application-based, one per unit focus area)** | 5 assignments × 4 hrs each Total = 20 hrs | CO1–CO4 TS1–TS4 | Evaluated based on assignment submission, conceptual understanding, pipeline application, tool usage analysis, comparative study of MLOps frameworks, and explanation of Agentic AI concepts |
| 2 | **Technical Video-Based Learning related to the subject (e.g., Ethereum, Solidity, DAO, decentralized applications, smart contract deployment)** | Video viewing: 4 hrs Report preparation: 4 hrs Presentation: 4 hrs Total = 12 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key MLOps workflow concepts, CI/CD pipeline stages, Agentic AI demonstrations, tool comparisons, and personal reflections |
| 3 | **Real-World Case Studies (e.g., Ethereum applications, DAO systems, crowdfunding platforms, DeFi applications, smart contract security incidents)** | Data collection/study: 5 hrs Report preparation: 8 hrs Total = 13 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, analytical conclusions, and comparative evaluation of MLOps and Agentic AI real-world implementations |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|

| | | |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

*Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | ≥ 40 / 100 | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**CBT302 - Smart Contracts Using Ethereum Summary**

*Theory-Only Course | 6 COs (CO1–CO6) | 2 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A

CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B

CO5–CO6: Evaluate/Create → TS5, TS6 → CA + ETE Sec B/C

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

| | | | |
|---|---|---|---|
| **School: SSCSE** | | | **Batch: 2026-2030** |
| **Program: B.Tech.** | | | **Current Academic Year: 2027-2028** |
| **Branch: CSE-AIML** | | | **Semester: IV** |
| 1 | Course Code | | **CSCR2601** |
| 2 | Course Title | | Project Based Learning (PBL) -2 (Research Methodology Based) |
| 3 | Credits | | 2 |
| 4 | Contact Hours (L-T-P) | | 0-0-4 |
| | Course Status | | Elective |
| 5 | Course Objective | | 1.To align student's skill and interests with a realistic problem or project<br>2.To understand the significance of problem and its scope<br>3.Students will make decisions within a framework |
| 6 | Course Outcomes | | Students will be able to:<br>CO1: Identify and formulate problem statements with systematic approach.<br>CO2: Develop teamwork and problem-solving skills, along with the ability to communicate effectively with others.<br>CO3: Design the problem solution as per the problem statement framed.<br>CO4: Explain the characteristics, architecture of database approach, describe the components of the project.<br>CO5: Fabricate and implement the solution by using different object oriented concepts like encapsulation, polymorphism etc.<br>CO6: Develop the glory of the need to engage in life-long learning. |
| 7 | Course Description | | In PBL-1, the students will learn how to define the problem for developing projects, identifying the skills required for developing the project based on given a set of specifications and all subjects of that Semester. |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | Problem Definition, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any. | CO1, CO2 |
| | **Unit 2** | Develop a work flow or block diagram for the proposed system / software. | CO2,CO3 |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 3** | Design algorithms for the proposed problem. | | | CO3 |
| | **Unit 4** | Implementation of work under the guidance of a faculty member and obtain the appropriate results. | | | CO3, CO4 |
| | **Unit 5** | Demonstrate and execute projects with the team. Validate and verify the project modules. | | | CO4, CO5, CO6 |
| | | The report should include Abstract, Hardware / Software Requirement, Problem Statement, Design/Algorithm, Implementation Detail. Validation Reports.<br>References if any.<br>The presentation, report, work done during the term supported by the documentation, forms the basis of assessment. | | | |
| | | | | | |
| | Mode of examination | Practical /Viva | | | |
| | Weight age Distribution | CA | CE(Viva) | ETE | |
| | | 30 | 30 | 40 | |

**CO and PO Mapping**

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | CO1: Identify and formulate problem statements with systematic approach. | PO1, PO2, PO4, PO9, PO10, PO11, PSO1,PSO2,PSO3 |
| 2. | CO2: Develop teamwork and problem-solving skills, along with the ability to communicate effectively with others. | PO1, PO2, PO4, PO7, PO9, PO10, PO11, PSO3 |
| 3. | CO3: Design the problem solution as per the problem statement framed. | PO1, PO2, PO5, PO9, PO10, PO11, PSO1,PSO2 |
| 4. | CO4: Explain the characteristics, architecture of database approach, describe the components of the project. | PO1, PO2, PO6, PO9, PO10, PO11, PSO2 |
| 5. | CO5: Fabricate and implement the solution by using different object oriented concepts like encapsulation, polymorphism etc. | PO1, PO2, PO3, PO4,PO5, PO6, PO7, PO8, PO9, PO10, PO11, PSO1,PSO2, PSO3 |
| 6. | CO6: Develop the glory of the need to engage in life-long learning. | PO1, PO2, PO4, PO9, PO10, PO11, PSO3 |

**PO and PSO mapping with level of strength for Course Name Project Based Learning -1 (Course Code CSP297)**

| Cos | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | - | 3 | - | - | - | - | 3 | 3 | 2 | 2 | 2 | 1 |
| CO2 | 3 | 2 | - | 3 | - | - | 2 | - | 3 | 3 | 2 | | | 1 |
| CO3 | 3 | 2 | - | - | 2 | - | - | - | 3 | 3 | 2 | 2 | 2 | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 3 | - | - | - | 2 | - | - | 3 | 3 | 2 | | 2 | |
| CO5 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | |
| CO6 | 3 | 3 | - | 3 | - | - | - | - | 3 | 3 | 2 | | | 1 |
| Avg PO attainted | 3 | 2.7 | 0.3 | 1.8 | 0.7 | 0.7 | 0.8 | 0.5 | 3 | 3 | 2 | 1 | 1.3 | 0.5 |

**Semester 5, Credits: 22**

| COURSE CODE | COURSE NAME |
|---|---|
| CSAI3301 | Cloud Computing & Databases |
| CSCR3311 | Design and Analysis of Algorithm |
| CSCR3110 | Data Mining & Warehousing |
| CS** | Program Elective-2 |
| SKP3501 | Skills & Informatics-3: Communication, Coding & Career Readiness Skills |
| CSCR3600 | Project Based Learning (PBL) -3 (Hackathon Based) |
| CCP3001 | Community Connect |
| CSCR3700 | Summer Internship-I |

# COURSE PLAN

## Cloud Computing and Databases (CSAI3301)

School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester IV | Batch 2026–2030

Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | AICTE 11-PO Framework | Full Skill Mapping

**PART I**

## COURSE SYLLABUS

Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | V |

## 2. Course Details

★ Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) assessed via MTE + ETE; Lab COs (CO7–CO10) assessed via Laboratory Assessment only. No cross-evaluation.

| | | |
|---|---|---|
| **1** | **Course Code** | CSAI3301 |
| **2** | **Course Title** | [object Object] |
| **3** | **Credits** | 3 (Theory: 2 + Lab: 1) |
| **4** | **Contact Hours (L-T-P-SL)** | 2-0-2-2 |
| **5** | **Course Status** | Minor Elective |

| | | |
|---|---|---|
| 6 | **Course Outcomes (COs)** | After successful completion of this course, the student will be able to:<br><br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Remember – L1): Define key concepts of cloud computing, service models, deployment models, and cloud architecture.<br>CO2 (Understand – L2): Explain virtualization, cloud infrastructure components, storage systems, and resource management techniques.<br>CO3 (Apply – L3): Use cloud tools, platforms, and serverless computing models to build basic cloud-based applications.<br>CO4 (Analyze – L4): Compare traditional databases with cloud-native databases and analyze the architecture and features of Amazon RDS.<br>CO5 (Evaluate – L5): Assess RDS performance, security, and scalability using monitoring, logging, and optimization strategies.<br>CO6 (Create – L6): Design and implement a scalable cloud-based solution integrating RDS for AI/ML workflows.<br><br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Implement cloud labs using professional tools (AWS, VirtualBox, CloudSim, Hadoop); configure environments; demonstrate operations; maintain lab records.<br>CO8 (Create – L5/L6): Design and develop real-world cloud solutions addressing societal problems; evaluate outcomes analytically with SDG alignment.<br>CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible cloud practices; perform skill self-assessment; reflect on lifelong professional growth.<br>CO10 (Apply – L3): Collaborate and communicate in team-oriented labs; plan, implement, and present cloud solutions; apply project management principles. |
| 7 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 30 hrs + Self Learning (SL) 30 hrs = 90 hrs |
| 8 | **Mode of Examination** | Lab (25 marks) + MTE (10 marks) + ETE (75 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 9 | **Self Learning (30 hrs)** | 1. AWS Free Tier hands-on: EC2, S3, RDS exercises.<br>2. NPTEL/SWAYAM: Cloud Computing course.<br>3. MOOC: AWS Cloud Practitioner Essentials (Coursera/edX). |
| 10 | **References** | **Textbooks:**<br>1. Rajkumar Buyya, Thamarai Selvi, Christian Vecchiola – Mastering Cloud Computing, McGraw Hill.<br>2. AWS Official Documentation – Amazon RDS Developer Guide.<br>3. Thomas Erl – Cloud Computing: Concepts, Technology & Architecture, Pearson.<br><br>**References:**<br>1. Ben Piper & David Clinton – AWS Certified Solutions Architect Study Guide, Wiley.<br>2. Michael J. Kavis – Architecting the Cloud, Wiley.<br>3. Chandrasekaran K. – Essentials of Cloud Computing, CRC Press. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).

| | Topic / Activity | CO Mapping |
|---|---|---|
| | Unit 1 **Foundations of Cloud Computing** | |

| | | |
|---|---|---|
| **A** | Evolution of Cloud Computing, Characteristics, Service Models: SaaS, PaaS, IaaS | CO1 |
| **B** | Deployment Models: Public, Private, Hybrid, Community; Cloud Architecture and Components | CO1 |
| **C** | Role of Cloud in AI/ML Workflows (High-level overview) | CO1 |
| **Tools Used** | AWS Free Tier, draw.io / Lucidchart, CloudSim, Reference diagrams | |
| **Activities** | Objective: To familiarize students with fundamental cloud computing concepts and service models. Explore real-world cloud architecture diagrams. Compare SaaS, PaaS, and IaaS with industry examples. Discuss deployment models using case studies. Illustrate how cloud resources support AI/ML workflows. | |
| | **Unit 2 Cloud Infrastructure & Storage** | |
| **A** | Virtualization Basics: Hypervisors, VM Creation; Scaling: Provisioning, Migration, Management | CO2 |
| **B** | Cloud Storage Types: Object, Block, File Storage; Distributed File Systems (GFS, HDFS) | CO2 |
| **C** | Elasticity and Auto Scaling; Monitoring Cloud Resources | CO2 |
| **Tools Used** | VirtualBox/VMware, AWS EC2, AWS S3, AWS CloudWatch, HDFS documentation | |
| **Activities** | Objective: To understand virtualization and cloud infrastructure. Create and configure a VM in VirtualBox. Explore AWS S3: buckets, versioning, object retrieval. Demonstrate cloud elasticity via Auto Scaling demo. Monitor cloud resource metrics using CloudWatch dashboards. | |
| | **Unit 3 Cloud Platforms & Tools** | |
| **A** | Platforms for Cloud Simulation and Development; Workflow Management in Cloud Applications | CO3 |
| **B** | MapReduce Programming Model; Serverless Computing Basics | |
| **C** | API-based Cloud Integration; AI/ML Services in Cloud | |
| **Tools Used** | CloudSim, CloudAnalyst, Hadoop (local mode), AWS Lambda, AWS API Gateway, Python | |
| **Activities** | Objective: To apply cloud platforms and tools for building cloud-based applications. Simulate cloud environment in CloudSim: configure datacenter, VMs, analyze execution time and cost. Write MapReduce Word Count using Hadoop local mode. Create a serverless function via AWS Lambda + API Gateway. Discuss AI/ML cloud services: AWS SageMaker, Google AutoML overview. | |
| | **Unit 4 Introduction to Cloud Databases & Amazon RDS** | |
| **A** | Basics of Databases: Relational vs. NoSQL; Traditional vs. Cloud-native Databases | CO4 |

| | | |
|---|---|---|
| **B** | Overview of Amazon RDS; Supported DB Engines: MySQL, PostgreSQL, MariaDB, Oracle, SQL Server; RDS Architecture | CO4 |
| **C** | Automated Backups, Snapshots & Point-in-Time Recovery; Parameter Groups, Option Groups, Instance Classes | CO4 |
| **Tools Used** | MySQL Workbench, pgAdmin, AWS RDS Free Tier, MongoDB Community Edition | |
| **Activities** | Objective: To compare database models and understand Amazon RDS. Perform CRUD on MySQL and MongoDB; compare data models. Create AWS RDS Free Tier instance (MySQL); configure connectivity; connect via MySQL Workbench. Enable automated backups; create manual snapshots; perform point-in-time recovery simulation. Explore RDS parameter groups and instance class options. | |
| | **Unit 5 RDS Management, Optimization & Integration with AI/ML Applications** | |
| **A** | RDS Monitoring, Logging & Basic Performance Tuning; Importance of RDS in AI/ML Pipelines | CO5, CO6 |
| **B** | Performance Optimization: Indexing, Query Optimization, Read Replicas for Scaling | CO5, CO6 |
| **C** | Backup, Disaster Recovery & Failover Strategies; Multi-AZ Deployment | CO5, CO6 |
| **Tools Used** | AWS CloudWatch, AWS RDS Console, MySQL Workbench, AWS S3 (snapshot export) | |
| **Activities** | Objective: To evaluate and optimize RDS performance and security. Monitor RDS with CloudWatch: CPU, storage, network; enhanced monitoring. Create indexes; run queries before/after; analyze performance improvement. Configure Read Replica; demonstrate read-only scaling. Enable Multi-AZ; simulate failover; export snapshot to S3; restore to new instance. Integrate RDS with a Python-based AI/ML application. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A – Cloud evolution, characteristics, service models | ✓ | ✓ | | | | |
| 2 | 1.B – Deployment models, cloud architecture | | ✓ | ✓ | | | |
| 3 | 1.C – Role of cloud in AI/ML workflows | | ✓ | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | 2.A – Virtualization, hypervisors, VM management | | ✓ | ✓ | | | |
| 5 | 2.B – Cloud storage types, distributed file systems | | ✓ | ✓ | | | |
| 6 | 2.C – Elasticity, auto scaling, monitoring | | | ✓ | ✓ | | |
| 7 | 3.A – Cloud platforms, workflow management | | ✓ | ✓ | | | |
| 8 | 3.B – MapReduce, serverless computing | | | ✓ | ✓ | | |
| 9 | 3.C – API-based integration, AI/ML cloud services | | | ✓ | ✓ | | |
| 10 | 4.A – Relational vs NoSQL, traditional vs cloud-native DB | | ✓ | | ✓ | | |
| 11 | 4.B – Amazon RDS architecture, supported engines | | ✓ | ✓ | | | |
| 12 | 4.C – Backups, snapshots, parameter groups | | | ✓ | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | 5.A – RDS monitoring, logging, performance tuning | | | ✓ | ✓ | ✓ | |
| 14 | 5.B – Indexing, query optimization, read replicas | | | ✓ | ✓ | ✓ | |
| 15 | 5.C – Backup, DR, failover, AI/ML integration | | | ✓ | | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

**i** Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | ✓ | | | | | |
| CO4 | | | | ✓ | | | | | | | | | | ✓ | | | | |
| CO5 | | | | | ✓ | | | | | | | | | | ✓ | | | |
| CO6 | | | | | | ✓ | | ✓ | | | | | | | ✓ | ✓ | | |
| CO7 | | | ✓ | | | | ✓ | | | | | | ✓ | ✓ | | | | |
| CO8 | | | | | ✓ | ✓ | | ✓ | | | | | | ✓ | ✓ | ✓ | | |
| CO9 | | | ✓ | | | | | | | ✓ | ✓ | | | | | | | |
| CO10 | | | ✓ | | | | ✓ | | | | ✓ | | ✓ | | | | | |

✓ = Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Evolution of cloud computing; characteristics; SaaS, PaaS, IaaS service models | Unit 1 | 6 |
| DD/MM/YY | Deployment models: Public, Private, Hybrid, Community | | |
| DD/MM/YY | Cloud architecture and components; role of cloud in AI/ML | | |
| DD/MM/YY | Virtualization basics: hypervisors, VM creation and configuration | Unit 2 | 6 |
| DD/MM/YY | VM scaling: provisioning, migration, management | | |
| DD/MM/YY | Cloud storage types: Object, Block, File; GFS and HDFS overview | | |
| DD/MM/YY | Elasticity, auto scaling; monitoring cloud resources using CloudWatch | | |
| DD/MM/YY | Cloud simulation platforms: CloudSim, CloudAnalyst | Unit 3 | 6 |
| DD/MM/YY | MapReduce programming model: concepts and Word Count example | | |
| DD/MM/YY | Serverless computing: AWS Lambda, event triggers, API Gateway | | |
| DD/MM/YY | API-based cloud integration; AI/ML services in cloud | | |
| DD/MM/YY | Workflow management in cloud applications | | |
| DD/MM/YY | Relational vs NoSQL databases: data model comparison | Unit 4 | 6 |
| DD/MM/YY | Traditional vs cloud-native databases | | |
| DD/MM/YY | Amazon RDS overview; supported DB engines: MySQL, PostgreSQL, MariaDB, Oracle, SQL Server | | |
| DD/MM/YY | RDS architecture: DB instance, VPC, subnet groups, security groups | | |
| DD/MM/YY | Automated backups, snapshots, point-in-time recovery | | |
| DD/MM/YY | Parameter groups, option groups, instance classes and storage | | |
| DD/MM/YY | RDS monitoring with CloudWatch: CPU, storage, network; enhanced monitoring | Unit 5 | 6 |
| DD/MM/YY | Performance tuning: indexing, query optimization strategies | | |
| DD/MM/YY | Read replicas for scaling; write vs read workload distribution | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | RDS security: IAM, VPC isolation, encryption at rest and in transit | | |
| DD/MM/YY | Backup and disaster recovery: Multi-AZ deployment, failover strategies | | |
| DD/MM/YY | RDS integration with AI/ML pipelines; case studies and best practices | | |
| DD/MM/YY | Revision: Unit 1 & 2 — cloud fundamentals, infrastructure | | |
| DD/MM/YY | Revision: Unit 3 & 4 — cloud tools, MapReduce, RDS architecture | | |
| DD/MM/YY | Revision: Unit 5 — RDS optimization, monitoring, DR | | |
| DD/MM/YY | Practice: cloud solution design (end-to-end scenario) | | |
| DD/MM/YY | Practice: RDS integration and optimization problem-solving | | |
| DD/MM/YY | Buffer / Guest lecture / Industry case study | | |

## 7. Lab Session Plan — List of Experiments

W1–W9: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W10–W12 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| **W1** | S-1.1 | Create a comparison chart of SaaS, PaaS, and IaaS using any cloud provider (AWS/Azure/GCP). Include examples, features, and use cases. Document in structured lab report. | CO7 | 3.0 |
| | S-1.2 | Using AWS Free Tier (or CloudSim), identify and illustrate cloud architecture components (compute, storage, networking). Prepare an interaction diagram. | CO7 | |
| **W2** | S-2.1 | Install and run VirtualBox/VMware; create a VM, configure CPU/RAM, demonstrate VM scaling and migration concepts. | CO7 | 3.0 |
| | S-2.2 | Demonstrate AWS S3 concepts (or MinIO locally): create a bucket, upload files, enable versioning, demonstrate object-level retrieval. | CO7 | |
| **W3** | S-3.1 | Simulate cloud elasticity using AWS EC2 Auto Scaling concept demo or CloudSim. Monitor performance using CloudWatch metrics. | CO7 | 3.0 |
| | S-3.2 | Build an AI/ML workflow diagram showing how cloud resources support model training and inference. Document architecture decisions. | CO7 | |
| **W4** | S-4.1 | Use CloudSim or CloudAnalyst to simulate a cloud environment: configure datacenter, VMs, analyze execution time and cost. | CO7 | 3.0 |
| | S-4.2 | Write a MapReduce Word Count or Log Count program using Hadoop local mode. Document execution steps and results. | CO7 | |

| | | | | |
|---|---|---|---|---|
| **W5** | S-5.1 | Create a serverless function using AWS Lambda (or Google Cloud Functions): write function in Python, trigger via API Gateway, test API integration. | CO7 | 3.0 |
| | S-5.2 | Compare Relational and NoSQL databases: install MySQL and MongoDB locally; perform CRUD operations on both; document differences. | CO7 | |
| **W6** | S-6.1 | Create an Amazon RDS instance (Free Tier): choose DB engine (MySQL), configure storage, instance class, and connectivity; connect via MySQL Workbench. | CO7 | 3.0 |
| | S-6.2 | Demonstrate RDS backup features: enable automated backups, create manual snapshots, perform point-in-time recovery simulation. | CO7 | |
| **W7** | S-7.1 | Monitor an RDS instance using CloudWatch: view CPU, storage, network metrics; enable enhanced monitoring; interpret error and slow query logs. | CO7 | 3.0 |
| | S-7.2 | Optimize database performance: create indexes; run queries before/after indexing; analyze performance improvement with screen captures. | CO7 | |
| **W8** | S-8.1 | Configure a Read Replica for an RDS instance; demonstrate read-only scaling; compare query execution against primary and replica. | CO7 | 3.0 |
| | S-8.2 | Create and test a disaster recovery plan: enable Multi-AZ deployment simulation; export backup snapshot to S3; demonstrate restore to a new DB instance. | CO7 | |
| **W9** | S-9.1 | End-to-end integration: connect a Python application to RDS; perform read/write operations; document the integration pipeline. | CO7 | 3.0 |
| | S-9.2 | Peer code review session: review a classmate's cloud configuration; identify improvements; document findings professionally. | CO7 | |
| **W10** | S-10.1 | Real-world cloud design: build an end-to-end solution integrating cloud storage, compute, and RDS for a societal use case (e.g., healthcare data, climate monitoring) with SDG context discussion. | CO8 | 3.0 |
| | S-10.2 | Design a cloud-native solution for an industry problem: document problem statement, architecture diagram, tool choices, and cost estimation. | CO8 | |
| **W11** | S-11.1 | Complex integration design: build a configurable, reusable cloud module integrating RDS. Document design decisions; reflect on code quality (CO9 reflection form submitted). | CO8/CO9 | 3.0 |
| | S-11.2 | Team-based project: role assignment (Cloud Architect, DBA, DevOps, Docs), peer review, collaborative cloud solution build. | CO8/CO10 | |
| **W12** | S-12.1 | Data security and ethics lab: implement RDS access control (IAM), encryption, and audit logging; ethical data handling discussion; skill self-assessment submitted. | CO8/CO9 | 3.0 |
| | S-12.2 | Final presentation: team presents end-to-end cloud solution — architecture, configuration walkthrough, results, SDG impact; group reflection and Q&A. | CO9/CO10 | |

**i Instructions**: Perform lab exercises; document aim, tools used, procedure, observations, and result. Lab record must be submitted before the next session.

PART II

# THEORY ASSESSMENT FRAMEWORK

Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

**THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Factual Recall & Conceptual Recognition** | Recall cloud terminology, service models, deployment types, RDS architecture; identify correct definitions | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| TS2 | **Conceptual Explanation & Logical Interpretation** | Explain cloud stages and tool roles; interpret infrastructure diagrams; predict outcome of cloud configuration | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| TS3 | **Procedural Application & Problem Solving** | Apply cloud tools, MapReduce, and serverless constructs; build and configure cloud-based applications | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| TS4 | **Analytical Reasoning & Comparative Analysis** | Analyze cloud database models; compare RDS vs NoSQL; trace RDS configurations; detect performance issues | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| TS5 | **Comparative Evaluation & Justification** | Compare RDS management strategies; evaluate monitoring approaches; justify performance optimization decisions | CO5 \| L5 | ETE Sec B/C |
| TS6 | **Synthesis & Holistic Design** | Design complete, scalable cloud-based solutions integrating RDS for AI/ML workflows; apply security and DR best practices | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

**9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)**

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | 4 | TS1 — Factual Recall TS2 — Conceptual Explanation | CO1, CO2 | Short-answer: definitions, output prediction, diagram identification |
| **Sec B** | 6 | TS3 — Procedural Application TS4 — Analytical Reasoning | CO3, CO4 | Problem solving; comparison analysis; configuration tracing |

| | | | | |
|---|---|---|---|---|
| **TOTAL** | **10** | **TS1–TS4** | **CO1–CO4** | Units 1–4 covered; CO5 and CO6 assessed only in ETE |

**9.2 End Term Examination (ETE) — 100 Marks (Scaled to 75) (CO1–CO6)**

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | 25 | TS1 — Factual Recall TS2 — Conceptual Explanation | CO1, CO2 | Short questions: definitions, architecture identification, concept MCQs (all units) |
| **Sec B** | 50 | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | CO3, CO4, CO5 | Medium questions: cloud configuration, RDS setup scenarios, performance comparison |
| **Sec C** | 25 | TS5 — Comparative Evaluation TS6 — Synthesis & Design | CO5, CO6 | Long/design questions: design scalable cloud-RDS solutions; justify choices; AI/ML integration |
| **TOTAL** | **100** | **TS1–TS6 (all)** | **CO1–CO6** | Scaled to 75 marks. Minimum 30/75 required to pass. |

**PART III**

# LABORATORY ASSESSMENT FRAMEWORK

Evaluation Scheme, CA Rubric & Lab Skill Dimensions for Lab COs (CO7–CO10)

## 10. Evaluation Scheme — Overview

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 25% | **25** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 75% | **75** | Theory COs only: CO1–CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | 1.0 | CA1 — Problem definition CA2 — Experimental design and tool | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |

| | | | | |
|---|---|---|---|---|
| | | setup CA7 — Solution plan / flowchart | | |
| **Code / Configuration Execution & Efficiency** | 1.0 | CA3 — Execution correctness; expected output CA4 — Efficiency and optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | 0.75 | CA5 — Output analysis and result interpretation CA6 — Documented outcome with verification CA8 — Lab record completeness; viva-voce | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | 0.25 | CO9 — Documentation ethics, responsible practice | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

**PART IV**

# COMBINED MAPPINGS & REFERENCE

CO–PO Matrix, Attendance & Pass/Fail Criteria

## 12. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.

| | Programme Outcomes (POs) | | | | | | | | | | | Programme Specific Outcomes (PSOs) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | – | 2 | 2 | 2 | 1 |
| **CO2** | 2 | 3 | 2 | 2 | 3 | 1 | – | 1 | 2 | – | 2 | 3 | 3 | 2 |
| **CO3** | 1 | 2 | 3 | 2 | 3 | 1 | – | 2 | 2 | 1 | 2 | 3 | 3 | 3 |
| **CO4** | 2 | 3 | 2 | 3 | 3 | 1 | – | 1 | 2 | 1 | 2 | 3 | 3 | 2 |
| **CO5** | 1 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| **CO6** | 1 | 2 | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO7** | 1 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 |
| **CO8** | 1 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 |
| **CO9** | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| **CO10** | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Avg** | **1.50** | **2.13** | **2.25** | **2.13** | **2.63** | **1.11** | **1.33** | **1.67** | **1.89** | **1.57** | **2.30** | **2.56** | **2.60** | **2.30** |

## 13. Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | 75% | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | 75% | All lab sessions | Debarred from Lab Assessment |

⚠ Both theory and practical attendance must independently meet 75%. Satisfying one does NOT compensate for a shortfall in the other.

## 14. Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 30 / 75** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 25 + MTE 10 + ETE 75 = 100; 40% overall minimum required |

**CLOUD COMPUTING AND DATABASES — INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions

Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO5, PO6, PO9 | 6 Theory Skill Dims (TS1–TS6)

Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims

**Marks: Lab 25 (Experiments) + MTE 10 + ETE 75 = Total 100**

Sharda University — SSCSE | Theory COs (CO1–CO6): MTE+ETE | Lab COs (CO7–CO10): Lab only | AICTE 11-PO

# COURSE PLAN

## Design and Analysis of Algorithms *(CSCR3311)*

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester V | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | V |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR3311 |
| 2 | **Course Title** | **Design and Analysis of Algorithms** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-2 |
| 5 | **Course Status** | Major Course |
| 6 | **Course Objective** | Objective of this course is to |

| | | |
|---|---|---|
| | | 1. Reinforce basic design concepts (e.g., pseudocode, specifications, top-down design)<br>2. Knowledge of algorithm design strategies<br>3. Familiarity with an assortment of important algorithms.<br>Enable students to analyze time and space complexity |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>**CO1** (**Analyze-L1):** The asymptotic performance of algorithms<br>**CO2** (Understand – L2): The dynamic-programming and Greedy paradigm and explain when an algorithmic design situation calls for it.<br>**CO3** (Apply – L3): A familiarity with major algorithms and data structures<br>**CO4** (Analyze – L4): Important algorithmic design paradigms and methods of analysis<br>**CO5** (Evaluate – L5): NP-complete problems and develop algorithms to solve the problems.<br>**CO6** (Create – L6): Appropriate algorithm design techniques for solving problems.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Implement C programs using professional tools (gcc, Linux CLI, debuggers); configure experimental setups; demonstrate system operation; maintain structured lab records.<br>CO8 (Create – L5/L6): Design and develop modular C applications addressing real-world problems with societal awareness; propose solutions with planning considerations; evaluate outcomes analytically.<br>CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible practices; perform skill self-assessment; reflect on learning to cultivate lifelong professional growth.<br>CO10 (Apply – L3): Collaborate and communicate effectively in team-oriented lab activities; plan, implement, and present programming solutions; apply project management principles. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 60 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | 1. Reading topics yourself from books/notes<br>2. Practicing algorithm problems<br>3. Understanding proofs and complexity analysis<br>4. Coding algorithms<br>5. Solving numerical/examples<br>6. Watching lectures/tutorials |
| 11 | **References** | 1.Cormen et al., “Introduction of Computer Algorithms”, Prentice Hall India<br>2.Sahni et al., “Fundamentals of Computer Algorithms”, Galgotia Publications.<br>3.Hopcroft A, The Design And Analysis Computer Algorithms, Addison Wesley |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction (4-0-10-6 = 20 hrs)** | |
| **A** | Introduction : Algorithms, Analyzing algorithms, Complexity of algorithms, Growth of functions, Performance measurements | CO1, CO2, CO3 |

| | | |
|---|---|---|
| **B** | Asymptotic Notations and their properties – Mathematical analysis for Recursive and Non-recursive algorithms, Recurrences relations, Master Method | |
| **C** | Divide-and-conquer: Analysis and Structure of divide-and-conquer algorithms, Divide-and-conquer examples-Quick sort, Merge sort,<br>Sorting in Linear Time counting sort, Heap Sort | |
| **Tools Used** | Turbo C Environment, Whiteboards, sticky notes, gcc compiler, Virtual Labs | |
| **Activities** | Objective: Practical based on Searching and sorting<br>1. WAP to demonstrate the concept of Linear and Binary Search<br>2. WAP to implement Merge sort<br>3 WAP to implement Quick Sort | |
| **Unit 2** | **Greedy Method (6-0-12-6 = 24 hrs)** | |
| **A** | Overview of the Greedy paradigm, Analysis and example: task scheduling, | CO3, CO4 |
| **B** | Fractional Knapsack problem, Single source shortest paths problem: Dijkastra's Algorithm, Bellman-ford Algorithm, | |
| **C** | Overview and analysis of Backtracking & Branch and Bound: N-Queens problem and Sum of subsets | |
| **Tools Used** | Turbo C Environment, Whiteboards, sticky notes, gcc compiler, Virtual Labs | |
| **Activities** | Objective: To apply Practical based on Dynamic Programming<br>1. WAP to implement Matrix Chain Multiplication problem<br>2. WAP to demonstrate the concept of Longest Common Subsequence(LCS)<br>3. WAP to demonstrate concept of 0 – 1 Knapsack Problem | |
| **Unit 3** | **Dynamic Programming (8-0-16-6 = 30 hrs)** | |
| **A** | Overview, Difference between dynamic programming and divide and conquer, All pair shortest path problems: Floyd-Warshall Algorithm | CO2, CO3, CO4, CO5, CO6 |
| **B** | Applications and analysis: Matrix Chain Multiplication, | |
| **C** | Applications and analysis: Longest Common sub-sequence, 0/1 Knapsack Problem | |
| **Tools Used** | Turbo C Environment, Competitive coding platforms (Leetcode, Hackerrank, etc.), Virtual Labs, whiteboards, online compilers, GitHub. | |
| **Activities** | **Objective:** To understand the concept of Practical based on Greedy Programming | |

| | | |
|---|---|---|
| | 1. WAP to demonstrate concept of Minimum Spanning Tree(Prim's Algorithm)<br>2. WAP to demonstrate concept of Fractional Knapsack Problem<br>3. WAP to implement single source shortest problem using Dijkstra's Algorithm | |
| **Unit 4** | **Advanced Data Structures (6-0-12-6 = 24 hrs)** | |
| **A** | Red-Black Trees - Definition, Applications, Insertion and deletion of elements in RB-Tree | CO3, CO4, CO5 |
| **B** | B-Trees - Definitions, Applications, Insertion and Deletion in B-Trees | |
| **C** | Data Structure for Disjoint Sets – Definition, Binomial Heaps, Fibonacci Heaps. | |
| **Tools Used** | C Environment, Competitive coding platforms (Leetcode, Hackerrank, etc.), Virtual Labs, whiteboards, online compilers, GitHub. | |
| **Activities** | **Objective:** To understand **Practical based on Advance concepts**<br>WAP to demonstrate concept of Red Black Tree insertion and Deletion | |
| **Unit 5** | **Selected Topics (6-0-10-6 = 22 hrs)** | |
| **A** | Introduction to NP Complete and NP Hard Problems, Examples, Amortized Analysis | CO2, CO3, CO4, CO5, CO6 |
| **B** | Approximation Algorithms – Travelling Sales Person Problem and Vertex Cover Problem, Randomized Algorithms, Randomized Quick Sort Algorithm | |
| **C** | String Matching Algorithms – Naive String Matching Algorithm, Rabin Karp Algorithm. | |
| **Tools Used** | C environment, Competitive coding platforms (Leetcode, Hackerrank, etc.), Virtual Labs, whiteboards, online compilers, GitHub. | |
| **Activities** | **Objective:** To understand Practical based on String Matching<br>1. WAP to demonstrate the concept of Naïve String matching algorithm.<br>2. WAP to demonstrate the concept of Robin Karp Algorithm. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | | ✓ | | | |
| 5 | 2.B | | | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | | | ✓ | ✓ | | ✓ |
| 8 | 3.B | | ✓ | ✓ | | ✓ | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | | | |
| 13 | 5.A | | ✓ | ✓ | | ✓ | ✓ |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | | ✓ | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | | | | | | | | | ✓ | | |
| CO6 | | | | | | ✓ | | | ✓ | | | | | | | ✓ | ✓ | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | |
| CO8 | | | | | ✓ | ✓ | | | ✓ | | | | | | ✓ | ✓ | ✓ | |
| CO9 | | | ✓ | | | | | | | ✓ | ✓ | | | | | | | |
| CO10 | | | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 40 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction : Algorithms, Analyzing algorithms, | Unit 1 | 9 |
| DD/MM/YY | Complexity of algorithms, Growth of functions, Performance measurements | | |
| DD/MM/YY | Properties of Asymptotic Notations | | |
| DD/MM/YY | Mathematical analysis for Recursive algorithms | | |
| DD/MM/YY | Recurrences relations, Master Method | | |
| DD/MM/YY | Divide-and-conquer: Analysis and Structure of divide-and-conquer algorithms | | |
| DD/MM/YY | Divide-and-conquer examples-Quick sort, Merge sort, | | |
| DD/MM/YY | Sorting in Linear Time counting sort, Heap Sort | | |
| DD/MM/YY | Revision Unit 1 | | |
| DD/MM/YY | Overview of the Greedy paradigm, Analysis and example: task scheduling, | Unit 2 | 6 |
| | Fractional Knapsack problem | | |
| DD/MM/YY | Single source shortest paths problem: Dijkastra's Algorithm | | |
| DD/MM/YY | Bellman-ford Algorithm | | |
| DD/MM/YY | Overview and analysis of Backtracking & Branch and Bound: N-Queens problem and Sum of subsets | | |
| DD/MM/YY | Revision Unit 2 | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Overview of dynamic programming and divide and conquer | Unit 3 | 8 |
| DD/MM/YY | Difference between dynamic programming and divide and conquer | | |
| DD/MM/YY | All pair shortest path problems: Floyd-Warshall Algorithm | | |
| DD/MM/YY | Applications and analysis of dynamic programming | | |
| DD/MM/YY | Matrix Chain Multiplication | | |
| DD/MM/YY | Longest Common sub-sequence | | |
| DD/MM/YY | 0/1 Knapsack Problem | | |
| DD/MM/YY | Revision Unit 3 | | |
| DD/MM/YY | Red-Black Trees - Definition | Unit 4 | 8 |
| DD/MM/YY | Red-Black Trees -Applications | | |
| DD/MM/YY | B-Trees - Definitions, Applications | | |
| DD/MM/YY | Insertion and Deletion in B-Trees | | |
| DD/MM/YY | Data Structure for Disjoint Sets – Definition | | |
| DD/MM/YY | Binomial Heaps | | |
| DD/MM/YY | Fibonacci Heaps | | |
| DD/MM/YY | Revision Unit 4 | | |
| DD/MM/YY | Introduction to NP Complete Problems, Examples | Unit 5 | 9 |
| DD/MM/YY | Amortized Analysis | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Approximation Algorithms – Travelling Sales Person Problem | | |
| DD/MM/YY | Vertex Cover Problem, Randomized Algorithms | | |
| DD/MM/YY | Randomized Quick Sort Algorithm | | |
| DD/MM/YY | String Matching Algorithms | | |
| DD/MM/YY | Naive String Matching Algorithm | | |
| DD/MM/YY | Rabin Karp Algorithm | | |
| DD/MM/YY | Revision Unit 5 | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Write a program to search an element in the array using Binary search determine the time required to search the element | CO7 | 3.0 |
| | S-1.2 | Write a program to search an element in the array using Binary search determine the time required to search the element | CO7 | |
| W2 | S-2.1 | Write a program to sort given set of numbers in ascending/descending order using Quick Sort. | CO7 | 3.0 |
| | S-2.2 | Write a program to sort given set of numbers in ascending/descending order using Merge Sort and determine the time required to sort the elements. | CO7 | |
| W3 | S-3.1 | Write a program to sort given set of numbers in ascending/descending order using Counting Sort | CO7 | 3.0 |
| | S-3.2 | Write a program to sort given set of numbers in ascending/descending order using Bucket Sort. | CO7 | |

| | | | | |
|---|---|---|---|---|
| W4 | S-4.1 | Write a program to sort given set of numbers in ascending/descending order using Radix Sort. | CO7 | 3.0 |
| | S-4.2 | Write a program to sort given set of numbers in ascending/descending order using Radix Sort. | CO7 | |
| W5 | S-5.1 | Write a program to implement Longest Common Subsequences (LCS). | CO7 | 3.0 |
| | S-5.2 | Write a program to implement Longest Common Subsequences (LCS). | CO7 | |
| W6 | S-6.1 | Write a program to implement Matrix chain multiplication | CO7 | 3.0 |
| | S-6.2 | Write a program to implement Matrix chain multiplication | CO7 | |
| W7 | S-7.1 | Write a program to implement 0/1 Knapsack problem Using greedy approach. | CO7 | 3.0 |
| | S-7.2 | Write a program to implement 0/1 Knapsack problem Using greedy approach. | CO7 | |
| W8 | S-8.1 | Write a program to implement fractional Knapsack problem Using greedy approach. | CO7 | 3.0 |
| | S-8.2 | Write a program to implement fractional Knapsack problem Using greedy approach. | CO7 | |
| W9 | S-9.1 | From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm. | CO7 | 3.0 |
| | S-9.2 | Write a program to implement Sum of Subset problem. | CO7 | |
| W10 | S-10.1 | WAP to demonstrate concept of Red Black Tree insertion and Deletion. | CO7 | 3.0 |
| | S-10.2 | Implement All-Pairs Shortest Paths Problem using Floyd's algorithm. | CO7 | |
| | S-11.1 | Write a program to implement Naïve string matching problem. | CO7 | |

| | | | | |
|---|---|---|---|---|
| W11 | | | | 3.0 |
| | S-11.2 | Write a program to implement Naïve string matching problem. | CO7 | |
| W12 | S-12.1 | Write a program to implement RabinKarp Algorithm problem. | CO7 | 3.0 |
| | S-12.2 | Write a program to implement RabinKarp Algorithm problem. | CO7 | |
| W13 | S-13.1 | Present and analyse 5 different implementations of greedy dominating set algorithm. | CO8 | 3.0 |
| | S-13.2 | Design a novel algorithm that can schedule 2 salesmen in a network. Hint: The two-server problem is concerned with the movement of two servers to request points in a metric space. Consider an offline version of the problem in a graph in which the requests may be served in any order. A family of approximations algorithms can be developed for this NP complete problem. | CO8 | |
| W14 | S-14.1 | Given the input n>=2,Design and write an algorithmto implement n-ary search. | CO8/CO9 | 3.0 |
| | S-14.2 | Implement the N-queen Problem using graphical view. | CO8/CO10 | |
| W15 | S-15.1 | Merge & sort files — ethical data handling; skill self-assessment form submitted | CO8/CO9 | 3.0 |
| | S-15.2 | Create and implement a complete graphical environment for performing Matrix Chain Multiplication. | CO9/CO10 | |

ℹ *Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Factual Recall & Conceptual Recognition | Recall of definitions, algorithm terminology, asymptotic notation concepts, and basic recognition of algorithmic structures | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| TS2 | Conceptual Explanation & Logical Interpretation | Ability to explain algorithm paradigms, interpret concepts, and justify appropriate algorithm selection | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| TS3 | Procedural Application & Problem Solving | Application of algorithms and data structures to solve computational problems step-by-step | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| TS4 | Analytical Reasoning & Program Tracing | Analysis of algorithm behavior, tracing execution flow, recurrence solving, and complexity analysis | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| TS5 | Comparative Evaluation & Algorithmic Justification | Evaluation and comparison of algorithms based on efficiency, correctness, and suitability for NP and optimization problems | CO5 \| L5 | ETE Sec B/C |
| TS6 | Synthesis & Holistic Design | Design and development of complete algorithmic solutions using appropriate paradigms and optimization strategies | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | 4 | TS1 — Factual Recall TS2 — Conceptual Explanation | CO1, CO2 | Short-Answer Questions, Definitions, Algorithm Terminology, Output Prediction, Conceptual Explanation |
| Sec B | 6 | TS3 — Procedural Application TS4 — Analytical Reasoning | CO3, CO4 | Algorithm Writing, Program Tracing, Dry Run, Complexity Analysis, Debugging, Numerical Problem Solving |
| TOTAL | 10 | TS1–TS4 | CO1–CO4 | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | 25 | TS1 — Factual Recall TS2 — Conceptual Explanation | CO1, CO2 | Definitions, Conceptual Questions, Short Notes, Algorithm Identification, Theoretical Explanation |

| | | | | |
|---|---|---|---|---|
| **Sec B** | **50** | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Algorithm Design, Program Tracing, Complexity Analysis, Comparative Analysis, Numerical Problems, Case-Based Questions |
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long Descriptive Questions, Design-Based Problems, Optimization Problems, NP-Complete Problem Solving, Algorithm Development |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |

| | | | | |
|---|---|---|---|---|
| | | P9 — Statistical/comparative analysis; technical report | | |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define experiment problem; identify measurable attributes, parameters, success criteria | CO7, CO8 |
| CA2 | **Experimental Design & Tool Setup** | Plan experiment; configure development environment (gcc, IDE, Linux CLI, debugger) | CO7 |
| CA3 | **Code Implementation & Execution** | Write correct code; compile and execute to produce expected output | CO7 |
| CA4 | **Computational Efficiency & Optimization** | Evaluate time/space complexity; identify bottlenecks; propose optimizations | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Analyse output critically; explain deviations; draw evidence-based inferences | CO8 |
| CA6 | **Documented Outcome with Verification** | Record final outcome formally; verify against the problem statement | CO7, CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Produce algorithm/flowchart/pseudocode before coding; justify design choices | CO7, CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records; demonstrate conceptual understanding orally | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | **SDG Alignment & Social Relevance** | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | **Problem Scoping & Requirements** | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | **Communication & Testing Strategy** | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | **Innovative Solution Proposal** | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |

| | | | |
|---|---|---|---|
| P5 | **Professional Toolchain** | Select and justify development tools; configure professional project environment | CO7 \| PO5 |
| P6 | **End-to-End Implementation** | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |
| P7 | **System Commissioning & Testing** | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | **Measurable Impact & Outcome** | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | **Critical Analysis & Reporting** | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | **Professional Presentation & Teamwork** | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | **Financial Feasibility & Planning** | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | **Individual Skill Growth Mapping** | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | **Professional Attitude, Ethics & Responsibility** | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

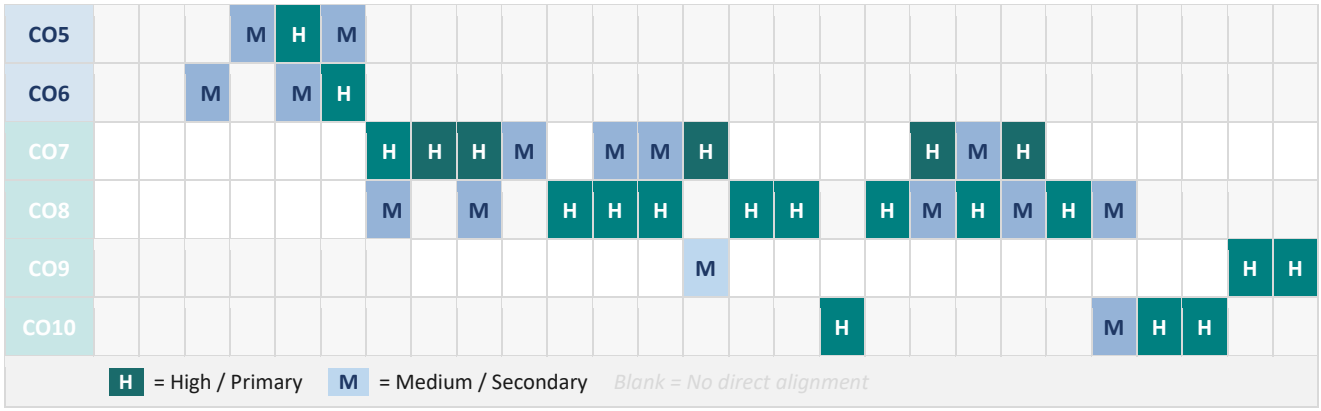
## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |




PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 1 | 2 | - | -- | -- | - | 2 | - | - | 3 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 2 | - | -- | -- | - | 3 | - | - | 2 | 3 | 2 |
| CO3 | 2 | 1 | 2 | - | - | -- | -- | - | 1 | - | - | 3 | 2 | - |
| CO4 | 1 | 2 | 2 | 3 | - | -- | -- | - | 2 | - | - | 2 | 2 | 2 |
| CO5 | 3 | 3 | 1 | 3 | - | - | - | - | 3 | - | - | 2 | 1 | 3 |
| CO6 | 2 | 2 | 3 | 2 | 2 | - | - | -- | 2 | - | - | 3 | 2 | - |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| Avg | 2.50 | 2.14 | 2.33 | 1.75 | 2.33 | 1.80 | 3.00 | 2.50 | 1.50 | 2.00 | 2.13 | 2.22 | 2.30 | 2.38 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |
| CO2 | H | M | | | | | | | M | | |
| CO3 | M | H | M | | M | M | | | M | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | | M | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in computational thinking and structured programming; aligned with lifelong learning (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant programming and professional tool skills (CO7) directly applicable to employment in technology sectors. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables development of efficient software solutions; fosters innovation through real-world application design (CO6, CO8) and team-based projects (CO10). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance |

| | | |
|---|---|---|
| L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A5 — Characterizing: Internalized value system | P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Data Mining and Warehousing (CSCR3110)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I**

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | V |
| **Course Code:** | CSCR3110 | **Course Type:** | Core |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR3110 |
| 2 | **Course Title** | **Data Mining & Warehousing** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 |
| 5 | **Course Status** | Core |

| | | |
|---|---|---|
| 6 | **Course Objective** | To introduce the fundamental concepts of data warehousing and data mining, and develop analytical and problem-solving skills through data preprocessing, visualization, mining techniques, ethical data handling, practical laboratory exercises, and collaborative project-based learning. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br><br>CO1 (Remember – L1): Recall and explain the fundamental concepts of data warehousing, multidimensional data models, OLTP, OLAP, and data mining terminology.<br>CO2 (Understand – L2): Explain data warehouse architectures, warehousing processes, distributed storage concepts, and data preprocessing techniques used in data mining applications.<br>CO3 (Apply – L3): Apply data preprocessing, transformation, dimensionality reduction, and visualization techniques for preparing and analyzing datasets.<br>CO4 (Analyze – L4): Analyze and implement suitable data mining algorithms such as classification, clustering, frequent pattern mining, and OLAP operations for complex datasets.<br>CO5 (Evaluate – L5): Evaluate different data warehousing architectures, mining techniques, visualization tools, and analytical approaches for enterprise and real-world applications.<br>CO6 (Create – L6): Design and develop data-driven solutions using data warehousing, mining algorithms, visualization techniques, and modern analytical tools to address societal, scientific, and industrial challenges. |
| 8 | **Course Description** | This course provides a comprehensive understanding of data warehousing and data mining concepts, including OLTP/OLAP systems, multidimensional data models, preprocessing techniques, data visualization, classification, clustering, and pattern mining. It enables students to analyze large datasets, evaluate analytical approaches and warehousing architectures, and design intelligent data-driven solutions for real-world industrial, scientific, and societal applications using modern data analytics tools. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | Han, J., Kamber, M., & Pei, J. (2011). *Data mining: Concepts and techniques* (3rd ed.). Morgan Kaufmann. |
| 12 | **References** | Han, J., Kamber, M., & Pei, J. (2011). *Data mining: Concepts and techniques* (3rd ed.). Morgan Kaufmann.<br>Dunham, M. H. (2006). *Data mining: Introductory and advanced topics*. Pearson Education.<br>Pudi, V., & Radhakrishnan, P. (2009). *Data mining*. Oxford University Press. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

*All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction to Data Warehousing** | |
| **A** | Data Warehousing: Overview, Definition, Data Warehousing Components, Building a Data Warehouse, Warehouse Database | CO1, CO2, CO3 |
| **B** | Mapping the Data Warehouse to a Multiprocessor Architecture, Difference between Database System and Data Warehouse | |

| | | |
|---|---|---|
| C | Multi-Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept | |
| **Unit 2** | **Data Warehouse Process and Technology** | |
| A | Data Warehouse Process, Extraction–Transformation–Loading (ETL), Data Cleaning, Data Integration, Metadata Management | CO2, CO3, CO4, CO5 |
| B | Data Warehouse Architecture, Distributed Data Warehousing, Virtual Warehouse, Data Mart Concepts | |
| C | OLAP Technology, MOLAP vs ROLAP, OLAP Operations (Roll-up, Drill-down, Slice, Dice, Pivot) | |
| **Unit 3** | **Data Preprocessing and Data Visualization** | |
| A | Data Preprocessing: Data Cleaning, Data Integration, Data Transformation, Data Reduction, Data Discretization, Normalization Techniques | CO3, CO4, CO5 |
| B | Data Visualization and Analytical Reporting: Visualization Techniques, Statistical Summarization, Correlation Analysis, Dashboards, Graphical Representation of Data | |
| C | Data Reduction and Feature Engineering: Dimensionality Reduction, Attribute Selection, Sampling Techniques, Feature Extraction, Principal Component Analysis (PCA) | |
| **Unit 4** | **Data Mining Techniques and Algorithms** | |
| A | Classification and Prediction Techniques: Decision Trees, Bayesian Classification, Rule-Based Classification, Prediction Methods, Model Evaluation Techniques | CO4, CO5, CO6 |
| B | Clustering and Association Rule Mining: K-Means Clustering, Hierarchical Clustering, Frequent Pattern Mining, Apriori Algorithm, Association Rule Generation | |
| C | Advanced Data Mining Applications and Web Mining: Text Mining, Web Mining, Spatial and Temporal Data Mining, Mining Applications in Business Intelligence and Healthcare | |
| **Unit 5** | **Advanced Data Warehouse Design and Modelling** | |
| A | Advanced Dimensional Modeling: Slowly Changing Dimensions (Type 1, Type 2, Type 3), Junk Dimensions, Large Dimensions | CO4, CO5, CO6 |
| B | Hierarchy and Schema Modeling: Descriptive Attributes, Cross-Dimensional Attributes, Shared Hierarchies, Incomplete Hierarchies, Recursive Hierarchies | |
| C | Aggregation and Warehouse Optimization: Additive, Semi-Additive and Non-Additive Measures, Aggregation Techniques, Convergence, Query Optimization in Data Warehousing | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | ✓ | | |
| 4 | 2.A | | ✓ | ✓ | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | 2.B | | ✓ | ✓ | ✓ | | |
| 6 | 2.C | | | ✓ | ✓ | ✓ | |
| 7 | 3.A | | ✓ | ✓ | ✓ | | |
| 8 | 3.B | | ✓ | ✓ | ✓ | ✓ | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | | ✓ | ✓ | ✓ | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | ✓ |
| 12 | 4.C | | ✓ | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | ✓ | ✓ | |
| 14 | 5.B | | ✓ | ✓ | ✓ | ✓ | |
| 15 | 5.C | | | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | | | | |
| CO5 | | | | | ✓ | | | | ✓ | | | | | | | | | |
| CO6 | | | | | | ✓ | | | ✓ | | | | | | | | | |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Affective (A3) for CO5 and CO6 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Data Warehousing: Overview, Definition, | Unit 1 | 9 |
| DD/MM/YY | Need and Characteristics | | |
| DD/MM/YY | Data Warehousing Components and Building a Data Warehouse | | |
| DD/MM/YY | Warehouse Database | | |
| DD/MM/YY | Metadata Concepts Mapping the Data Warehouse to a Multiprocessor Architecture | | |
| DD/MM/YY | Difference between Database System and Data Warehouse | | |
| DD/MM/YY | Multi-Dimensional Data Model | | |
| DD/MM/YY | Data Cubes, Star, Snowflake | | |
| DD/MM/YY | Fact Constellation Schemas | | |
| DD/MM/YY | Data Warehouse Process and ETL Concepts | Unit 2 | 9 |
| DD/MM/YY | Data Extraction and Data Cleaning Techniques | | |
| DD/MM/YY | Data Integration and Data Transformation | | |
| DD/MM/YY | Metadata Management and Warehouse Administration | | |
| DD/MM/YY | Data Warehouse Architecture and Distributed Data Warehousing | | |
| DD/MM/YY | Virtual Warehouse and Data Mart Concepts | | |
| DD/MM/YY | OLAP Technology: MOLAP, ROLAP and HOLAP | | |
| DD/MM/YY | OLAP Operations: Roll-up, Drill-down, Slice, Dice | | |
| DD/MM/YY | Pivoting and Multidimensional Analytical Processing | | |
| DD/MM/YY | Data Preprocessing: Data Cleaning and Integration | Unit 3 | 10 |
| DD/MM/YY | Data Transformation and Data Reduction Techniques | | |
| DD/MM/YY | Data Discretization and Normalization Methods | | |
| DD/MM/YY | Data Visualization Techniques | | |
| DD/MM/YY | Statistical Summarization and Correlation Analysis | | |
| DD/MM/YY | Dashboards and Graphical Representation of Data | | |
| DD/MM/YY | Feature Engineering and Attribute Selection | | |
| DD/MM/YY | Sampling Techniques and Feature Extraction | | |
| DD/MM/YY | Principal Component Analysis (PCA) | | |
| DD/MM/YY | Dimensionality Reduction and Visualization Tools | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Classification Techniques: Decision Trees | Unit 4 | 10 |
| DD/MM/YY | Bayesian Classification Techniques | | |
| DD/MM/YY | Rule-Based Classification and Prediction Methods | | |
| DD/MM/YY | Model Evaluation Techniques | | |
| DD/MM/YY | Clustering Techniques: K-Means Clustering | | |
| DD/MM/YY | Hierarchical Clustering Techniques | | |
| DD/MM/YY | Frequent Pattern Mining Concepts | | |
| DD/MM/YY | Apriori Algorithm and Association Rule Generation | | |
| DD/MM/YY | Text Mining and Web Mining | | |
| DD/MM/YY | Spatial and Temporal Data Mining Applications | | |
| DD/MM/YY | Slowly Changing Dimensions: Type 1, Type 2 and Type 3 | Unit 5 | 7 |
| DD/MM/YY | Junk Dimensions and Large Dimensions, Advanced Dimensional Modeling Concepts | | |
| DD/MM/YY | Descriptive Attributes and Cross-Dimensional Attributes | | |
| DD/MM/YY | Shared Hierarchies and Incomplete Hierarchies | | |
| DD/MM/YY | Recursive Hierarchies and Schema Modeling | | |
| DD/MM/YY | Aggregation Techniques: Additive Measures, Semi-Additive and Non-Additive Measures | | |
| DD/MM/YY | Convergence and Query Optimization in Data Warehousing, Warehouse Performance Optimization and Enterprise Case Studies | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L6) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **TS1** | **Factual Recall & Conceptual Recognition** | Recall definitions, terminology, architectures, OLTP/OLAP concepts, multidimensional models, ETL concepts, and data mining terminology | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| **TS2** | **Conceptual Explanation & Analytical Understanding** | Explain data warehouse processes, OLAP operations, preprocessing methods, warehouse architectures, and mining workflows; interpret analytical models and visualization outputs | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| **TS3** | **Procedural Application & Dataset Handling** | Apply preprocessing, ETL, dimensionality reduction, visualization, and mining techniques on datasets using appropriate analytical tools | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| **TS4** | **Analytical Reasoning & Mining Analysis** | Analyze classification, clustering, OLAP operations, association rules, and warehouse schema behavior; evaluate mining results and analytical outputs | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| **TS5** | **Comparative Evaluation & Decision Support** | Compare data warehouse architectures, mining algorithms, preprocessing techniques, and visualization methods based on performance, scalability, accuracy, and interpretability | CO5 \| L5 | ETE Sec B/C |
| **TS6** | **Design, Integration & Solution Development** | Design and develop integrated data warehousing and data mining solutions using preprocessing, analytical modeling, visualization, and optimization techniques for real-world applications | CO6 \| L6 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Factual Recall & Conceptual Recognition | TS2 Conceptual Explanation & Analytical Understanding | TS3 Procedural Application & Dataset Handling | TS4 Analytical Reasoning & Mining Analysis | TS5 Comparative Evaluation & Decision Support | TS6 Design, Integration & Solution Development |
|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | | | | |
| **CO2** | **M** | **H** | **M** | | | |
| **CO3** | | **M** | **H** | **M** | | |
| **CO4** | | | **M** | **H** | **M** | |
| **CO5** | | | | **M** | **H** | **M** |
| **CO6** | | **M** | | **M** | **M** | **H** |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

## 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 assignments | **10** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5,TS6 |
| **Assessments 1–2 (Theory / Application-based)** | **2 Assessments (Assessment 1 (10 Marks) + Assessment 2 (5 Marks))** | **15** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5,TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

## 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2 concepts: Introduction to Data Warehousing , Data Warehouse Process and Technology | CO1, CO2,CO3, CO4,CO5 | TS1,TS2,TS3,TS4,TS5 | 5h SL | Report submission + conceptual evaluation |
| **Assignment 2** | Unit 3, 4 and Unit 5 : Data Preprocessing and Data Visualization, Data Mining Techniques and Algorithms, Advanced Data Warehouse Design and Modelling | CO1,CO2,CO3, CO4, CO5,CO6 | TS1,TS2,TS3,TS4,TS5,TS6 | 5h SL | Comparative analysis + conceptual explanation |

## 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2 concepts: Introduction to Data Warehousing , Data Warehouse Process and Technology | CO1, CO2,CO3, CO4,CO5 | TS1,TS2,TS3,TS4,TS5 | 5h SL | Report submission + conceptual evaluation |
| **Assessment 2** | Unit 3 AND Unit 4 : Data Preprocessing and Data Visualization, Data Mining Techniques and Algorithms | CO1,CO2,CO3, CO4, CO5,CO6 | TS1,TS2,TS3,TS4,TS5,TS6 | 5h SL | Comparative analysis + conceptual explanation |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–2)

ℹ *MTE covers Units 1–2 (CO1, CO2, CO3,CO4,CO5) and CO1-CO6 are assessed in ETE only. MTE maps to TS1–TS5.*

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | 10 | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short-answer questions: definitions, conceptual understanding, architecture identification, OLAP/ETL concepts, terminology, analytical interpretation |
| **Sec B** | 15 | TS3 — Procedural Application TS4 — Analytical Reasoning TS5- Comparative Evaluation & Decision Support | **CO3, CO4,CO5** | Problem-solving and analytical questions based on preprocessing, OLAP operations, dimensional modeling, classification, clustering, association analysis, and data interpretation |
| **TOTAL** | 25 | TS1–TS4 | **CO1–CO5** | Units 1–2 primarily covered; higher-order evaluation and design-oriented . CO1-CO6 assessed mainly in ETE |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | 20 | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short-answer and conceptual questions: definitions, terminology, OLTP vs OLAP, ETL concepts, multidimensional models, OLAP operations, preprocessing concepts, architecture-based MCQs and analytical interpretation |
| **Sec B** | 25 | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Medium-answer analytical questions based on ETL workflows, preprocessing techniques, dimensional modeling, OLAP operations, classification, clustering, association rule mining, visualization, mining performance evaluation, and comparative analysis of algorithms and warehouse architectures |
| **Sec C** | 15 | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long-answer/design-oriented questions involving warehouse schema design, mining workflow development, analytical solution design, enterprise case |

| | | | | |
|---|---|---|---|---|
| | | | | studies, optimization strategies, algorithm selection with justification, and integrated real-world applications |
| **TOTAL** | 60 | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 24/60 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Recall and explain the fundamental concepts of data warehousing, multidimensional data models, OLTP, OLAP, and data mining terminology. | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| **CO2** | Explain data warehouse architectures, warehousing processes, distributed storage concepts, and data preprocessing techniques used in data mining applications. | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| **CO3** | Apply data preprocessing, transformation, dimensionality reduction, and visualization techniques for preparing and analyzing datasets. | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Analyze and implement suitable data mining algorithms such as classification, clustering, frequent pattern mining, and OLAP operations for complex datasets. | ✓ | ✓ | ✓ | TS4 | PO9, PO10, PO11 |
| **CO5** | Evaluate different data warehousing architectures, mining techniques, visualization tools, and analytical approaches for enterprise and real-world applications. | ✓ | ✓ | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Design and develop data-driven solutions using data warehousing, mining algorithms, visualization techniques, and modern analytical tools to address societal, scientific, and industrial challenges. | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO6 is NOT assessed in MTE (only Units 1-2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | – | – | – | – | – | – | – | – | - | 2 | 1 | – |
| CO2 | 3 | 2 | – | 1 | – | – | – | – | - | – | 1 | 2 | 2 | – |
| CO3 | 2 | 3 | 2 | 2 | 3 | - | – | – | 1 | – | 1 | 2 | 3 | 2 |
| CO4 | 2 | 3 | 2 | 3 | 2 | – | – | – | – | – | 1 | 2 | 3 | 2 |
| CO5 | 2 | 3 | 2 | 3 | 2 | 1 | – | – | – | – | 2 | 2 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 3 |
| Avg | 2.33 | 2.33 | 2.25 | 2.2 | 2.5 | 2 | 1 | 1 | 1 | 1 | 1.40 | 2.0 | 2.50 | 2.25 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | | | | | | | | | | |
| CO2 | H | M | | | | | | | | | |
| CO3 | M | H | M | M | H | | | | | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | M | H | M | | | | | | M |
| CO6 | M | M | H | M | H | H | | | | M | M |
| CO7 | | | M | | H | | | | | | |
| CO8 | | M | H | M | H | M | | | | | |
| CO9 | | | | | | M | H | | | | H |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO10 | | | | | M | | | H | H | M | |

H = High / Primary M = Medium / Secondary *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Numerical / Analytical Assignment Writing based on Data Warehousing and Data Mining concepts (5 assignments covering ETL, OLAP operations, preprocessing, dimensional modeling, classification, clustering, and association rule mining)** | 5 assignments × 4 hrs each **Total = 20 hrs** | CO1–CO4 TS1–TS4 | Evaluated based on correctness of analytical solutions, preprocessing steps, algorithm implementation logic, OLAP analysis, comparative performance evaluation, and interpretation of results |
| 2 | **Technical Video-Based Learning related to Data Warehousing and Data Mining (e.g., ETL workflows, OLAP cube operations, Decision Trees, Clustering, Data Visualization, PCA, Apriori Algorithm)** | Video viewing: 4 hrs Report preparation: 4 hrs Presentation: 4 hrs **Total = 12 hrs** | CO2, CO3 TS2, TS3 | Evaluation based on report quality, conceptual understanding, analytical interpretation, explanation of mining techniques, workflow understanding, and presentation effectiveness |
| 3 | **Real-World Case Studies on Enterprise Data Warehousing and Data Mining Applications (e.g., Healthcare Analytics, Business Intelligence Systems, Recommendation Systems, Fraud Detection, Web Mining, Smart City Analytics)** | Data collection / study: 5 hrs Report preparation: 7hrs **Total = 13 hrs** | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on technical depth, analytical reasoning, architecture/algorithm comparison, real-world applicability, data-driven conclusions, and solution design approach |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines shall be communicated at the beginning of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts | A1 — Receiving: Awareness and willingness to attend | P1 — Perception: Sensory cues guide motor activity |

| | | |
|---|---|---|
| L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5).*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

## Data Mining and warehousing

### MEASUREMENT ARCHITECTURE SUMMARY

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

# COURSE Plan
# Artificial Intelligence for IoT (CSAI3302)

**PART I**

Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Shadra School of Computing Sciences & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Acad. Year:** | 2028–29 |
| **Branch:** | CSE - AIML | **Semester:** | V |
| **Department:** | Department of Computer Science & Engineering | | |

## 2. Course Details

Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) assessed via MTE + ETE; Lab COs (CO7–CO10) assessed via Laboratory Assessment only. No cross-evaluation between tiers.

| | | |
|---|---|---|
| 1 | **Course Code** | CSAI3302 |
| 2 | **Course Title** | Artificial Intelligence for IoT |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-2-2 |
| 5 | **Course Status** | Elective |
| 6 | **Course Objective** | To equip students with the principles and practice of Artificial Intelligence for Internet of Things (IoT) systems — integrating ML paradigms, smart city applications, and TensorFlow/Keras-based development through structured theory and hands-on laboratory work. |
| 7 | **Teaching & Learning** | Classroom Instructions (CI): 30 hrs \| Lab Instructions (LI): 30 hrs \| Self Learning (SL): 30 hrs = 90 hrs total |
| 8 | **Mode of Examination** | Lab Assessment (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab Assessment only. Strict separation — no cross-evaluation. |
| 9 | **Self Learning (SL: 30 hrs)** | 1. Kaggle IoT datasets — minimum 3 end-to-end ML notebooks. 2. NPTEL: Introduction to Machine Learning (IIT Madras) — selected modules. 3. TensorFlow developer documentation exercises. 4. Case study report on one smart city AI deployment. |

| | | |
|---|---|---|
| 10 | **References** | Textbook: Hands-On Artificial Intelligence for IoT — Amita Kapoor, Packt Publishing. Reference: Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow (3rd Ed.) — Aurélien Géron, O'Reilly. Reference: Deep Learning with Python — François Chollet, Manning. |

## 3. Course Outcomes (COs)

**After successful completion of this course, the student will be able to:**

**THEORY COs (CO1–CO6) — Assessed via MTE + ETE**

| CO | Bloom's Level | Outcome Statement |
|---|---|---|
| CO1 | L2 – Understand | Explain the principles of IoT, AI infusion, and data-driven pipelines including IoT reference models, platforms, big data integration, and CRISP-DM methodology. |
| CO2 | L3 – Apply | Apply supervised machine learning paradigms — linear regression, logistic regression, and support vector machines — to IoT sensor data for prediction and classification tasks. |
| CO3 | L3 – Apply | Implement probabilistic and tree-based ML models (Naïve Bayes, Decision Trees, Ensemble Learning) to construct intelligent IoT applications using scikit-learn. |
| CO4 | L4 – Analyze | Analyze and improve ML model performance through feature scaling, regularization, cross-validation, and evaluation of the No Free Lunch theorem. |
| CO5 | L5 – Evaluate | Evaluate AI-driven smart city IoT applications — traffic management, parking, waste management, policing, and governance — assessing societal impact and system design trade-offs. |
| CO6 | L6 – Create | Design and develop end-to-end AI-IoT solutions using TensorFlow and Keras, integrating multiple ML techniques to solve real-world smart city and IoT domain problems. |

**LAB COs (CO7–CO10) — Assessed via Laboratory Assessment only**

| CO | Bloom's Level | Outcome Statement |
|---|---|---|
| CO7 | L3 – Apply | Configure AI-IoT development environments (TensorFlow, Keras, scikit-learn) and implement ML experiments using professional tools, maintaining structured lab records and documentation. |
| CO8 | L3 – Apply | Collaborate and communicate effectively in team-oriented lab activities; plan, implement, and present AI-IoT solutions applying project management and peer-review principles. |
| CO9 | L3/L4 – Apply / Analyze | Demonstrate professional, ethical, and responsible data science practices; perform skill self-assessment and critically reflect on learning to cultivate lifelong growth in AI-IoT domains. |
| CO10 | L5/L6 – Evaluate / Create | Design and develop modular ML-IoT applications addressing real-world problems; analyse experimental outcomes, propose data-driven solutions, and evaluate results critically against SDG-aligned goals. |

## 4. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).

| Sub | | Topic / Activity | CO Mapping |
|---|---|---|---|
| **Unit 1: Principles and Foundations of IoT and AI** | | | |
| | **A** | IoT Reference Model, IoT platforms, IoT verticals | **CO1** |
| | **B** | Big data and IoT, Infusion of AI — data science in IoT | **CO1** |
| | **C** | Cross-industry standard process for data mining (CRISP-DM), AI and IoT platforms | **CO1** |
| **Unit 2: Machine Learning for IoT — I** | | | |
| | **A** | ML and IoT, Learning paradigms; Prediction using Linear Regression | **CO2, CO6** |
| | **B** | Logistic Regression for classification; Cross-entropy loss function | **CO2, CO6** |
| | **C** | Classification using Support Vector Machines; Maximum margin hyperplane; Kernel trick | **CO2, CO6** |
| **Unit 3: Machine Learning for IoT — II** | | | |
| | **A** | Naïve Bayes classifier; Gaussian Naïve Bayes for IoT data | **CO3, CO6** |
| | **B** | Decision Trees: Decision trees in scikit-learn; Decision trees in action | **CO3, CO6** |
| | **C** | Ensemble Learning: Voting classifier, Bagging and pasting, Random Forests | **CO3, CO6** |
| **Unit 4: Improving the Model** | | | |
| | **A** | Feature scaling to resolve uneven data scale; StandardScaler, MinMaxScaler | **CO4, CO6** |
| | **B** | Overfitting: Regularization (L1, L2); Cross-validation strategies | **CO4, CO6** |
| | **C** | No Free Lunch theorem; Model selection and evaluation frameworks | **CO4, CO6** |
| **Unit 5: AI for Smart Cities IoT** | | | |
| | **A** | Need of smart cities; Components of a smart city; Data pipelines in smart city AI | **CO5, CO6** |
| | **B** | Smart traffic management, Smart parking, Smart waste management systems | **CO5, CO6** |
| | **C** | Smart policing, Smart lighting, Smart governance; Ethical considerations | **CO5, CO6** |

## 5. Topic-wise Bloom's Taxonomy Level Mapping — Theory

| Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|
| **1.A** | ✓ | ✓ | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.B | | ✓ | ✓ | | | |
| 1.C | | ✓ | ✓ | | | |
| 2.A | | | ✓ | | | |
| 2.B | | | ✓ | ✓ | | |
| 2.C | | | ✓ | ✓ | | |
| 3.A | | | ✓ | ✓ | | |
| 3.B | | | ✓ | | ✓ | |
| 3.C | | | ✓ | ✓ | | |
| 4.A | | | ✓ | ✓ | | |
| 4.B | | | ✓ | ✓ | ✓ | |
| 4.C | | ✓ | ✓ | | | |
| 5.A | | ✓ | ✓ | | ✓ | ✓ |
| 5.B | | | ✓ | ✓ | | |
| 5.C | | | ✓ | ✓ | ✓ | ✓ |

## 6. CO vs Bloom's Taxonomy — All Three Domains (10 COs)

★ Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.

| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | | | | | | | | | ✓ | | |
| CO6 | | | | | | ✓ | | | ✓ | | | | | | | ✓ | ✓ | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO8 | | | ✓ | | | | | ✓ | | | | | | ✓ | | | | |
| CO9 | | | ✓ | ✓ | | | | | | ✓ | ✓ | | | | | | | |
| CO10 | | | | | ✓ | ✓ | | | ✓ | | | | | | ✓ | ✓ | ✓ | |

## 7. Lecture Plan Outline — Theory (30 Lectures)

| Unit | Hrs | Topics to be Covered | Planned Date | Actual Date |
|---|---|---|---|---|
| Unit 1 | 6 | IoT architecture overview: Reference model, verticals, and platforms | | |
| | | Big data pipelines in IoT; role of AI/data science in IoT ecosystems | | |
| | | CRISP-DM: phases and application to IoT problem solving | | |
| | | AI platforms (Google Cloud IoT, AWS IoT Greengrass, Azure IoT) | | |
| | | IoT platform selection criteria; hands-on demo: MQTT, Node-RED | | |
| | | Unit 1 synthesis: industry case studies and Socratic recap | | |
| Unit 2 | 6 | ML paradigms: supervised, unsupervised, reinforcement — IoT use cases | | |
| | | Linear Regression: derivation, cost function, gradient descent | | |
| | | Linear Regression: scikit-learn implementation on power consumption data | | |
| | | Logistic Regression: sigmoid, cross-entropy; binary IoT classification | | |
| | | SVM: maximal margin classifier, kernel trick (RBF, polynomial) | | |
| | | SVM: scikit-learn; comparison of classifiers on IoT dataset | | |
| Unit 3 | 6 | Naïve Bayes: Bayes' theorem; Gaussian NB; IoT sensor fault detection | | |
| | | Decision Trees: CART algorithm; Gini impurity; scikit-learn DecisionTreeClassifier | | |
| | | Decision Trees in action: pruning, depth control, feature importance | | |
| | | Ensemble Learning: Voting classifiers (hard vs soft voting) | | |
| | | Bagging and pasting; Random Forests; feature importance in IoT | | |
| | | Boosting: AdaBoost, Gradient Boosting overview | | |
| Unit 4 | 6 | Feature scaling: StandardScaler, MinMaxScaler, RobustScaler — when to use each | | |

| | | | | |
|---|---|---|---|---|
| | | Overfitting: bias-variance trade-off; visualisation with learning curves | | |
| | | Regularization: Ridge (L2) and Lasso (L1); ElasticNet | | |
| | | Cross-validation: K-Fold, Stratified K-Fold; pipeline in scikit-learn | | |
| | | No Free Lunch theorem: implications for IoT ML model selection | | |
| | | Unit 4 synthesis: model selection workflow and evaluation metrics | | |
| **Unit 5** | **6** | Smart cities: need, components, data ecosystems and AI integration | | |
| | | Smart traffic management: congestion prediction, signal optimization | | |
| | | Smart parking and smart waste management: ML-driven systems | | |
| | | Smart policing: crime pattern analysis (ethical issues and data bias) | | |
| | | Smart lighting and governance: sensor fusion and predictive control | | |
| | | Unit 5 synthesis: ethical AI in smart cities; societal impact evaluation | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.

THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Conceptual Understanding & Principles** | Recall IoT architectures, AI platforms, CRISP-DM, and fundamental ML definitions; identify correct terminology and frameworks | CO1 \| L2 | MTE \| ETE |
| TS2 | **Procedural Application & Algorithm Use** | Apply regression, logistic regression, and SVM using scikit-learn; write code snippets; implement ML pipelines for IoT data | CO2 \| L3 | MTE \| ETE |
| TS3 | **Implementation of ML Models** | Construct and configure Naïve Bayes, Decision Trees, and Ensemble models; explain model selection rationale for IoT scenarios | CO3 \| L3 | MTE \| ETE |
| TS4 | **Analytical Reasoning & Model Improvement** | Trace and explain feature scaling, regularization, and cross-validation; diagnose overfitting and propose mitigation strategies | CO4 \| L4 | MTE \| ETE |
| TS5 | **Evaluation of Smart City AI Systems** | Compare smart city AI approaches; evaluate societal impact; justify AI design choices for traffic, waste, governance applications | CO5 \| L5 | ETE |
| TS6 | **Synthesis & Holistic System Design** | Design end-to-end AI-IoT solutions using TensorFlow/Keras; integrate multiple ML techniques for complex real-world specifications | CO6 \| L6 | ETE |

## 9. CO × Theory Skill Dimension Mapping (10 COs × 6 Dimensions)

Theory COs (CO1–CO6) are fully mapped to TS dimensions. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.

| CO | TS1 Conceptual | TS2 Procedural | TS3 Implementation | TS4 Analytical | TS5 Evaluation | TS6 Synthesis |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | | M | | M | H |
| CO7 | | | | | | |
| CO8 | | | | | | |
| CO9 | | | | | | |
| CO10 | | | | | | |

## 10. Theory Assessment Structure — MTE and ETE

### 10.1 Mid Semester Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | 4 | TS1 — Conceptual Understanding TS2 — Procedural Application | CO1, CO2 | Short-answer: IoT/AI definitions, ML algorithm identification, output prediction from code snippets |
| Sec B | 6 | TS3 — Implementation TS4 — Analytical Reasoning | CO3, CO4 | Program writing: implement ML model; trace execution of feature scaling or cross-validation code |
| TOTAL | 10 | TS1–TS4 | CO1–CO4 | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 10.2 End Semester Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | 25 | TS1 — Conceptual Understanding TS2 — Procedural Application | CO1, CO2 | Short questions: IoT/AI definitions, ML algorithm identification, syntax, output tracing (all units) |
| Sec B | 50 | TS3 — Implementation TS4 — Analytical Reasoning TS5 — Evaluation | CO3, CO4, CO5 | Medium questions: ML model implementation, debugging, algorithm comparison, smart city system evaluation |
| Sec C | 25 | TS5 — Evaluation TS6 — Synthesis & Design | CO5, CO6 | Long/design questions: design AI-IoT pipeline with TensorFlow/Keras; justify design choices; complete smart city application |
| TOTAL | 100 | TS1–TS6 (all) | CO1–CO6 | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

Lab Experiment Plan, Evaluation Scheme, CA Rubric, Mini Project Rubric

## 11. Lab Experiment Plan — AI for IoT (15 Sessions × 2 Experiments = 30 Experiments)

★ W1–W10: All experiments develop CO7 skills (professional tool setup, implementation, documentation). W11–W12 (teal rows): CO10 (design/real-world mini project start). W13: Revision. W14: Model Test / Practice Exam. W15: CO8 & CO9 (project presentation, ethics, reflection). Theory knowledge is applied but NOT re-evaluated in lab.

| Week | Session | Experiment / Activity | Lab CO |
|---|---|---|---|
| W1 | S-1.1 | Installing TensorFlow, Keras, scikit-learn; configuring Jupyter Notebook/Colab environment — professional tool setup | CO7 |
| W1 | S-1.2 | Downloading and exploring IoT datasets (UCI Power Consumption, Air Quality); dataset inspection with pandas | CO7 |
| W2 | S-2.1 | Electrical power output prediction using Linear Regression (scikit-learn); visualise regression line and MSE | CO7 |
| W2 | S-2.2 | Wine quality classification using Logistic Regression; confusion matrix, precision, recall, F1-score | CO7 |
| W3 | S-3.1 | Classifying wine dataset using Support Vector Machines (linear and RBF kernels); parameter tuning | CO7 |
| W3 | S-3.2 | Gaussian Naïve Bayes for IoT sensor fault classification; probability calibration; comparison with SVM | CO7 |
| W4 | S-4.1 | Decision Tree classifier on IoT data; visualise tree; tune max_depth and min_samples_split | CO7 |
| W4 | S-4.2 | Ensemble Learning: Voting classifier (hard/soft); Bagging and Random Forest; feature importance plots | CO7 |
| W5 | S-5.1 | Feature scaling: StandardScaler vs MinMaxScaler; demonstrate effect on KNN and SVM performance | CO7 |
| W5 | S-5.2 | Regularization: Ridge (L2) and Lasso (L1) regression; K-Fold cross-validation; learning curves | CO7 |
| W6 | S-6.1 | Hyperparameter tuning: GridSearchCV and RandomizedSearchCV on Random Forest; compare results | CO7 |
| W6 | S-6.2 | End-to-end scikit-learn Pipeline: preprocessing → model → evaluation; IoT dataset walk-through | CO7 |
| W7 | S-7.1 | TensorFlow basics: tensors, computational graphs, Eager Execution; Keras Sequential API introduction | CO7 |
| W7 | S-7.2 | Build and train a Dense Neural Network on IoT energy data; monitor training/validation loss curves | CO7 |
| W8 | S-8.1 | CNN for IoT time-series classification: build, compile, fit; compare with MLP baseline | CO7 |

| | | | |
|---|---|---|---|
| W8 | S-8.2 | LSTM for sequential IoT sensor data; demonstrate vanishing gradient mitigation | CO7 |
| W9 | S-9.1 | Smart city case study — traffic data: load, clean, feature engineer, apply RandomForest/NN classifier | CO7 |
| W9 | S-9.2 | Smart city crime detection: PyCaret / scikit-learn pipeline; ethical data handling discussion | CO7 |
| W10 | S-10.1 | Model deployment simulation: Flask REST API serving a trained ML model for IoT inference | CO7 |
| W10 | S-10.2 | Model persistence (joblib, Keras .h5); retrain cycle simulation; drift detection overview | CO7 |
| W11 | S-11.1 | Mini Project — Phase 1: SDG-aligned problem scoping; define IoT problem; map to SDG; propose ML approach | CO10 |
| W11 | S-11.2 | Mini Project — Phase 2: Data collection & preprocessing; clean, impute, engineer features; design documentation | CO10 |
| W12 | S-12.1 | Mini Project — Phase 3: Model development; select and justify ML/DL architecture; train, validate, document | CO10 |
| W12 | S-12.2 | Mini Project — Phase 4: Impact assessment; evaluate model vs success criteria; statistical analysis; technical report | CO10 |
| W13 | — | **REVISION WEEK — Comprehensive review of all lab experiments (W1–W10); doubt-clearing sessions; viva preparation; lab record completion and submission deadline** | — |
| W14 | — | **MODEL TEST / PRACTICE EXAM — Simulated lab practical examination: one unseen IoT dataset; apply ML pipeline (preprocessing → model → evaluation); individual performance under exam conditions** | — |
| W15 | S-15.1 | **Project Presentation & Viva-Voce: live demo, jury evaluation, peer assessment; CO8 ethics & reflection form submission; skill self-assessment form** | CO8, CO9 |
| W15 | S-15.2 | **Group Reflection & Course Feedback: skill growth mapping (pre/post); post-project debrief; course-level continuous improvement input** | CO9 |

## 12. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | **40%** | **40** | Lab COs only: CO7 (CA experiments W1–W10), CO8 (teamwork/presentation), CO9 (ethics/reflection), CO10 (Mini Project design) |
| **Mid Semester Examination (MTE)** | **10%** | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| **End Semester Examination (ETE)** | **50%** | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-evaluation between tiers |

## 13. Per-Experiment CA Rubric (3.0 Marks each)

LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: objectives, metrics, success criteria CA2 — Tool setup and configuration (Colab, Jupyter, TF) CA7 — Algorithm/model selection plan | 1.0: Well-defined with design plan \| 0.5: Partial \| 0: Missing | **CO7, CO8** |
| **Code Implementation & Correctness** | **1.0** | CA3 — Implementation correctness; output matches expected CA4 — Efficiency: model complexity, training time, optimisation | 1.0: Correct & optimised \| 0.5: Correct but not optimised \| 0: Fails to execute | **CO7** |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis; metrics interpretation (accuracy, F1, MSE) CA6 — Documented outcome with verification CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | **CO10, CO9** |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible use of datasets PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | **CO9** |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

## 14. Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance of AI-IoT application P2 — Problem scope and stakeholder requirements P4 — Innovative ML solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | **CO10 / PO3, PO6** |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource allocation P11 — Cloud/compute cost estimation; feasibility analysis | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | **CO8 / PO10** |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain: TF, Keras, scikit-learn, Flask/FastAPI P6 — Complete AI-IoT project build and integration P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | **CO7, CO10 / PO3, PO5** |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals (accuracy, latency, SDG impact) P9 — | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | **CO10, CO8 / PO6** |

| | | | | |
|---|---|---|---|---|
| | | Statistical/comparative analysis; structured technical report | | |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy P10 — Professional presentation quality and delivery; team dynamics | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | **CO8 / PO8, PO9** |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project) P13 — Professional attitudes, ethical data use, responsible AI conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | **CO9 / PO7, PO11** |
| **Total** | **10** | All 13 Project skill dimensions covered; all 4 Lab COs (CO7–CO10) | | |

PART IV

# CO–PO ALIGNMENT & REFERENCE MATRICES

CO–PO Matrix, H/M Indicators, SDG Mapping, Attendance & Pass/Fail

## 15. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define experiment problem; identify measurable attributes (accuracy, MSE, F1), parameters, success criteria | CO7, CO10 |
| CA2 | **Experimental Design & Tool Setup** | Plan experiment; configure AI-IoT development environment (TensorFlow, Keras, Jupyter, Colab, scikit-learn) | CO7 |
| CA3 | **Code Implementation & Execution** | Write correct ML/DL code; compile and execute to produce expected output | CO7 |
| CA4 | **Computational Efficiency & Optimisation** | Evaluate training time, model complexity; identify bottlenecks; propose optimisations | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Analyse metrics (accuracy, loss curves, confusion matrix); explain deviations; draw evidence-based inferences | CO10 |
| CA6 | **Documented Outcome with Verification** | Record final outcome formally; verify model output against problem statement | CO7, CO10 |
| CA7 | **Algorithmic Design & Model Selection Plan** | Document ML/DL architecture choice before coding; justify selection criteria | CO7, CO10 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records (aim, code, output, inference); demonstrate understanding orally | CO7, CO9 |

## 16. CO–PO and CO–PSO Mapping Matrix (All 10 COs — Freshly Calculated)

Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only. Integrated course yields broader PO coverage than individual theory/lab courses.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | - | - | - | - | 1 | - | - | - | 1 | 2 | 1 | - |
| CO2 | 3 | 2 | 1 | - | 2 | - | - | - | 1 | - | 1 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 1 | 3 | - | - | - | 1 | - | 1 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 3 | 2 | - | - | - | 1 | - | 1 | 2 | 2 | 2 |
| CO5 | 2 | 3 | 3 | 2 | 2 | 3 | 1 | - | 1 | - | 2 | 2 | 3 | 2 |
| CO6 | 3 | 2 | 3 | 2 | 3 | 2 | - | 1 | 1 | 1 | 2 | 3 | 3 | 3 |
| CO7 | - | - | 1 | - | 3 | 1 | - | - | - | - | - | 2 | 3 | 3 |
| CO8 | - | - | - | - | - | 1 | - | 3 | 3 | 2 | 1 | 1 | 2 | 2 |
| CO9 | - | - | - | - | - | - | 3 | - | - | - | 3 | - | 1 | 2 |
| CO10 | - | 1 | 3 | 2 | 2 | 3 | - | - | - | - | - | 2 | 3 | 3 |
| Avg | 2.7 | 2.0 | 2.1 | 2.0 | 2.4 | 2.0 | 1.7 | 2.0 | 1.3 | 1.5 | 1.5 | 2.1 | 2.2 | 2.2 |

## 17. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know | PO2 Analysis | PO3 Design | PO4 Invest. | PO5 Tools | PO6 Society | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | M | | | | |
| CO2 | H | M | M | | M | | | | M | | M |
| CO3 | H | M | M | M | H | | | | M | | M |
| CO4 | M | H | M | H | M | | | | | | M |
| CO5 | M | H | H | M | M | H | M | | M | | M |
| CO6 | H | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |
| CO8 | | | | | | M | | H | H | M | M |
| CO9 | | | | | | | H | | | | H |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO10 | | M | H | M | M | H | | | | | |

## 18. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 — High | Develops AI-IoT competencies aligned with future STEM careers; fosters lifelong learning mindset (CO1, CO9). |
| SDG 9 | Industry, Innovation & Infrastructure | 3 — High | Enables intelligent IoT infrastructure design; drives innovation through ML-powered smart city applications (CO3, CO5, CO6, CO8). |
| SDG 11 | Sustainable Cities & Communities | 3 — High | Smart traffic, waste, parking, and governance AI systems directly support sustainable urban environments (CO5, CO8, CO10). |
| SDG 13 | Climate Action | 2 — Moderate | Energy prediction and smart city optimisation models contribute to climate-aware infrastructure (CO2, CO5). |
| SDG 16 | Peace, Justice & Strong Institutions | 2 — Moderate | Smart policing applications raise discussions on ethical AI, responsible data use, and institutional accountability (CO5, CO9). |
| SDG 12 | Responsible Consumption | 2 — Moderate | Promotes efficient, optimised model design; encourages ethical data handling and responsible use of computational resources (CO9, CO7). |

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| Theory Classes | 70% | All lecture sessions | Debarred from ETE |
| Practical / Lab | 70% | All lab sessions | Debarred from ETE |
| Combined (Theory + Lab) | 75% | Combined sessions | Debarred from ETE |

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| ETE Score (scaled) | ≥ 20 / 50 | MANDATORY | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| Overall Total | ≥ 40 / 100 | Must pass overall | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**AI FOR IOT INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO5, PO6, PO9, PO11 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

Sharda University — SSCSE | Theory COs (CO1–CO6): MTE + ETE | Lab COs (CO7–CO10): Lab only | AICTE 11-PO | NBA / NAAC OBE Compliant

# COURSE PLAN

## Big Data Analytics (CSDS3103)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VII | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | V |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSDS3103 |
| 2 | **Course Title** | Big Data Analytics |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-2-2 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | Students should be able to learn about analytics techniques to handle the big data through Hadoop framework. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>**CO1** (Remember – L1): Define the fundamental concepts of Big Data analysis.<br>**CO2** (Understand – L2): Demonstrate and explain appropriate techniques and tools to solve actual Big Data problems (derive value from vast data sets).<br>**CO3** (Apply – L3): Develop the distributed and parallel computing and its application for big data analysis.<br>**CO4** (Analyze – L4): Analyze how to deal with huge amount of data and propose scalable solutions. |

| | | |
|---|---|---|
| | | **CO5** (Evaluate – L5): Evaluate statistical packages and deriving intelligence from unstructured information.<br>**CO6** (Create – L6): Compile and contrast among different big data analytics tools and how they can help solving Industry challenges.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>**CO7** (Apply – L3): Implement Big Data programs using professional tools (Hadoop, Spark, Cloudera/Hortonworks, Linux CLI, debuggers); configure cluster setups; demonstrate operations; maintain structured lab records.<br>**CO8** (Create – L5/L6): Design and develop modular Big Data applications addressing real-world problems with societal impact; propose scalable solutions with planning; evaluate outcomes analytically.<br>**CO9** (Apply – L2/L3): Demonstrate professional, ethical, and responsible practices in Big Data handling (privacy, bias mitigation); perform skill self-assessment; reflect on learning for lifelong growth.<br>**CO10** (Apply – L3): Collaborate and communicate effectively in team-oriented lab activities; plan, implement, and present Big Data solutions; apply project management principles. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) + Lab Instructions (LI) + Self Learning (SL) L: 30 hrs \| T: 0 hrs \| P: 30 hrs \| SL: 30 hrs \| Total: 90 hrs \| Credits: 3 |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self-Learning (SL: 30 hrs)** | 1. Coding Problems on HackerRank/LeetCode/Kaggle — 15 problems minimum on data processing, MapReduce, Spark SQL, and analytics (e.g., word count, joins, aggregations).<br>2. Virtual Labs (NPTEL/SWAYAM): Big Data experiments on Hadoop, Spark, and HDFS.<br>3. MOOC course on Big Data Analytics/Hadoop/Spark (SWAYAM/Coursera/edX). |
| 11 | **References** | **Textbook:** Bill Franks, "Taming the big data tidal wave: finding opportunities in huge data streams with advanced analytics", John Wiley & Sons, 2012<br>Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012<br>Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer 2007<br>Jiwaei Han, Micheline Kamber, "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction to Big Data (4-0-4-4 = 12hrs)** | |
| **A** | Introduction to Big Data, challenges of conventional systems | **CO1, CO2** |
| **B** | Evolution of analytic scalability | |
| **C** | Modern data analytic tools | |
| **Tools Used** | Apache Hadoop, Apache Spark, Apache Kafka, Apache Flume | |
| **Activities** | **Objective:** | |

| | | |
|---|---|---|
| | To enable students to understand Big Data fundamentals, limitations of traditional systems, and the need for scalable analytics platforms.<br>• Discussion on characteristics of Big Data (5Vs) with real-world examples<br>• Demonstration of large dataset handling using Apache Hadoop vs traditional systems<br>• Case study: Failure of conventional databases in handling large-scale data<br>• Demo: Data ingestion using Apache Kafka or Apache Flume<br>• Comparative analysis: Apache Spark vs traditional processing | |
| **Unit 2** | **Modelling techniques (6-0-6-6 = 18hrs)** | |
| **A** | Mining frequent item sets, Apriori algorithm, Handling large data sets in main memory | CO3, CO4 |
| **B** | Clustering techniques, clustering for parallelism | |
| **C** | Classification and Prediction: Decision Tree induction, developing models using Decision Tree Algorithms | |
| **Tools Used** | Apache Mahout, Spark MLlib, Weka | |
| **Activities** | **Objective:**<br>To enable students to understand and apply scalable data mining and machine learning techniques on large datasets.<br>• Demonstration of Apriori algorithm using Weka<br>• Clustering demo (K-means) using Spark MLlib<br>• Decision Tree model building using Apache Mahout<br>• Visualization of classification results and model accuracy<br>• Discussion on scalability challenges in ML | |
| **Unit 3** | **Frameworks (6-0-6-6 = 18hrs)** | |
| **A** | Overview of Hadoop, Hadoop Distributed File System, HDFS design and architecture | CO2, CO3, CO4, CO5, CO6 |
| **B** | Hadoop Map reduce Framework, HBASE | |
| **C** | Interacting HDFS using HIVE, sample programs in HIVE-PIG | |
| **Tools Used** | Apache Hadoop, HDFS, MapReduce, Apache Hive, Apache Pig, Apache HBase | |
| **Activities** | **Objective:**<br>To provide hands-on understanding of Hadoop ecosystem, distributed storage, and processing frameworks.<br>• Installation/demo of Apache Hadoop (pseudo-distributed mode)<br>• Demonstration of file operations in HDFS<br>• Execution of basic MapReduce programs (Word Count)<br>• Query execution using Apache Hive<br>• Script demonstration using Apache Pig | |
| **Unit 4** | **Data Analysis and mining data streams (5-0-5-5 = 15hrs)** | |
| **A** | Regression modelling, Rule Induction | CO3, CO4, CO5 |
| **B** | Fuzzy decision trees and neural networks | |
| **C** | Introduction to streams concepts, Real time analytics platform, case studies | |
| **Tools Used** | Apache Spark Streaming, Apache Flink, Apache Storm, TensorFlow | |

| | | |
|---|---|---|
| **Activities** | **Objective:**<br>To enable students to perform real-time data analytics and apply advanced models on streaming data.<br>• Regression modelling demo using large datasets<br>• Real-time stream processing demo using Apache Spark Streaming<br>• Demonstration of data pipelines using Apache Flink<br>• Case study: Real-time analytics (stock market / social media)<br>• Introduction to neural networks using TensorFlow | |
| **Unit 5** | **Visualization (9-0-9-9 = 27hrs)** | |
| **A** | Visual data analysis techniques, Interaction techniques | CO2, CO3, CO4, CO5, CO6 |
| **B** | Analytics using statistical packages, association intelligence from unstructured information | |
| **C** | Text analytics, industry challenges and application of analytics | |
| **Tools Used** | Tableau, Power BI, Apache Superset, NLTK | |
| **Activities** | **Objective:**<br>To enable students to analyze, interpret, and visualize large datasets using modern visualization and text analytics tools.<br>• Dashboard creation using Tableau or Power BI<br>• Visualization of big datasets using Apache Superset<br>• Text analytics demo using NLTK<br>• Case study: Visualization in business intelligence. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | | | | | |
| 2 | 1.B | | ✓ | | | | |
| 3 | 1.C | | ✓ | | | | |
| 4 | 2.A | | | ✓ | | | |
| 5 | 2.B | | | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | | | | ✓ | | |
| 8 | 3.B | | ✓ | | | ✓ | |
| 9 | 3.C | | | | ✓ | | |
| 10 | 4.A | | | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | | | |
| 13 | 5.A | | ✓ | ✓ | | ✓ | ✓ |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | | ✓ | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | |
| CO1 | ✓ | | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | ✓ | | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | ✓ | | | | |
| CO5 | | | | | ✓ | | | | | | | | | | | ✓ | | | |
| CO6 | | | | | | ✓ | | | ✓ | | | | | | | ✓ | ✓ | | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | | |
| CO8 | | | | | ✓ | ✓ | | | ✓ | | | | | | ✓ | ✓ | ✓ | | |
| CO9 | | | ✓ | | | | | | | ✓ | ✓ | | | | | | | | |
| CO10 | | | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | | |

*Legend: ✓= Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Big Data | **UNIT-1** | **4** |
| DD/MM/YY | Challenges of Conventional Systems | | |
| DD/MM/YY | Evolution of Analytic Scalability | | |
| DD/MM/YY | Modern Data Analytic Tools | | |
| DD/MM/YY | Mining Frequent Item Sets, Apriori Algorithm | | |
| | Handling Large Data Sets in Main Memory | **UNIT-2** | **6** |
| DD/MM/YY | Clustering Techniques, Clustering for Parallelism | | |
| DD/MM/YY | Classification & Prediction | | |
| DD/MM/YY | Decision Tree Induction | | |
| DD/MM/YY | Model Development using Decision Trees | | |
| DD/MM/YY | Overview of Hadoop | | |
| DD/MM/YY | HDFS Design & Architecture | **UNIT-3** | **6** |
| DD/MM/YY | Hadoop MapReduce Framework | | |
| DD/MM/YY | HBase | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Hive (HDFS Interaction) | | |
| DD/MM/YY | Pig (Sample Programs) | | |
| DD/MM/YY | Regression Modelling | | |
| DD/MM/YY | Rule Induction | | |
| DD/MM/YY | Fuzzy Decision Trees | | |
| DD/MM/YY | Neural Networks | **UNIT-4** | **5** |
| DD/MM/YY | Stream Concepts | | |
| DD/MM/YY | Real-Time Analytics Platforms | | |
| DD/MM/YY | Case Studies (Streaming/Data Analysis) | | |
| DD/MM/YY | Visual Data Analysis Techniques | | |
| DD/MM/YY | Interaction Techniques | | |
| DD/MM/YY | Analytics using Statistical Packages | **UNIT-5** | **9** |
| DD/MM/YY | Association from Unstructured Data | | |
| DD/MM/YY | Text Analytics | | |
| DD/MM/YY | Applications of Analytics | | |
| DD/MM/YY | Visualization Project / Case Solution | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| **W1** | S-1.1 | i. Setting up Big Data Environment<br>(a) Install and configure Apache Hadoop<br>(b) Run basic Linux commands for file/directory handling<br>(c) Start Hadoop services | **CO7** | 3.0 |
| | S-1.2 | ii. Hadoop Basics<br>(a) Explore Hadoop ecosystem<br>(b) Execute basic Hadoop commands<br>(c) Check cluster status | **CO7** | |
| **W2** | S-2.1 | i. HDFS Operations<br>(a) Create directories in HDFS<br>(b) Upload and download files<br>(c) Analyze file blocks and replication | **CO7** | 3.0 |
| | S-2.2 | i. Advanced HDFS Commands<br>(a) File permissions and access control<br>(b) Monitoring HDFS status<br>(c) File system management | **CO7** | |
| **W3** | S-3.1 | i. Implement Word Count using MapReduce | **CO7** | 3.0 |
| | S-3.2 | i. Develop custom MapReduce program (log analysis/sorting) | **CO7** | |

| | | | | |
|---|---|---|---|---|
| **W4** | S-4.1 | i. Introduction to Hive<br>(a) Create database and tables<br>(b) Load datasets into Hive | **CO7** | 3.0 |
| | S-4.2 | i. Hive Queries<br>(a) SELECT, WHERE, GROUP BY<br>(b) Aggregation operations | **CO7** | |
| **W5** | S-5.1 | i. Advanced Hive<br>(a) Joins and subqueries<br>(b) Partitioning and bucketing | **CO7** | 3.0 |
| | S-5.2 | i. Introduction to Pig<br>(a) Write basic Pig scripts<br>(b) Perform data transformations | **CO7** | |
| **W6** | S-6.1 | i. Pig Latin Programming<br>(a) Filtering, grouping, joining datasets | **CO7** | 3.0 |
| | S-6.2 | i. Case Study using Hive/Pig for data analysis | **CO7** | |
| **W7** | S-7.1 | i. Introduction to Spark<br>(a) Run Spark shell<br>(b) Perform basic RDD operations | **CO7** | 3.0 |
| | S-7.2 | i. Spark Transformations and Actions<br>(a) Implement Word Count using Spark | **CO7** | |
| **W8** | S-8.1 | i. Spark DataFrames<br>(a) Create and manipulate DataFrames | **CO7** | 3.0 |
| | S-8.2 | i. Spark SQL<br>(a) Query structured datasets | **CO7** | |
| **W9** | S-9.1 | i. Clustering using Spark MLlib (K-Means) | **CO7** | 3.0 |
| | S-9.2 | i. Classification using Decision Trees | **CO7** | |
| **W10** | S-10.1 | i. Frequent Itemset Mining (Apriori Algorithm using Weka) | **CO7** | 3.0 |
| | S-10.2 | i. Model Evaluation (Accuracy, Precision, Recall) | **CO7** | |
| **W11** | S-11.1 | i. Introduction to Streaming (Spark Streaming) | **CO7** | 3.0 |
| | S-11.2 | i. Simulate real-time data streaming | **CO7** | |
| **W12** | S-12.1 | i. Streaming Analytics<br>(a) Window operations | **CO7** | 3.0 |
| | S-12.2 | i. Case Study: Real-time analytics pipeline | **CO7** | |
| **W13** | S-13.1 | i. Visualization using Tableau / Power BI<br>(a) Import dataset<br>(b) Create charts | **CO8** | 3.0 |
| | S-13.2 | i. Dashboard creation and storytelling | **CO8** | |
| **W14** | S-14.1 | i. Text Analytics<br>(a) Perform basic NLP tasks | **CO8/CO9** | 3.0 |
| | S-14.2 | i. Analysis of unstructured data (reviews/tweets) | **CO8/CO10** | |
| **W15** | S-15.1 | i. Mini Project: Big Data Pipeline<br>(a) Data ingestion → processing → visualization | **CO8/CO9** | 3.0 |
| | S-15.2 | i. Setting up Big Data Environment<br>(a) Install and configure Apache Hadoop | **CO9/CO10** | |

| | | | | |
|---|---|---|---|---|
| | | (b) Run basic Linux commands for file/directory handling<br>(c) Start Hadoop services | | |

ℹ *Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8.Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Factual Recall & Conceptual Recognition** | Recall keywords, Big Data core concepts, definitions, and architectural components. | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| **TS2** | **Conceptual Explanation & Logical Interpretation** | Explain the inner workings of scalable analytics platforms; interpret data pipelines and processing flows. | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| **TS3** | **Procedural Application & Problem Solving** | Apply framework constructs and APIs to execute basic data ingestion, queries, and machine learning scripts. | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| **TS4** | **Analytical Reasoning & Program Tracing** | Trace execution of distributed tasks, detect bottlenecks, and analyze algorithmic behavior on large datasets. | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| **TS5** | **Comparative Evaluation & Algorithmic Justification** | Compare different big data approaches; evaluate time/space trade-offs; justify tool choices with performance evidence. | CO5 \| L5 | ETE Sec B/C |
| **TS6** | **Synthesis & Holistic Design** | Design comprehensive, well-structured, modular end-to-end Big Data streaming or processing pipelines for complex industrial specifications. | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short-answer: definitions, output prediction, syntax identification |

| | | | | |
|---|---|---|---|---|
| **Sec B** | **6** | TS3 — Procedural Application TS4 — Analytical Reasoning | **CO3, CO4** | Program writing; program tracing — detect errors and trace execution |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **25** | TS1 — Factual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions: definitions, syntax, output tracing, concept MCQs (all units) |
| **Sec B** | **50** | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | **CO3, CO4, CO5** | Medium questions: program writing, debugging, algorithm comparison, complexity analysis |
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long/design questions: design modular solutions, justify choices, complete application |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |

| | | | | |
|---|---|---|---|---|
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define experiment problem; identify measurable attributes, parameters, success criteria | CO7, CO8 |
| CA2 | **Experimental Design & Tool Setup** | Plan experiment; configure development environment (gcc, IDE, Linux CLI, debugger) | CO7 |
| CA3 | **Code Implementation & Execution** | Write correct code; compile and execute to produce expected output | CO7 |
| CA4 | **Computational Efficiency & Optimization** | Evaluate time/space complexity; identify bottlenecks; propose optimizations | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Analyse output critically; explain deviations; draw evidence-based inferences | CO8 |
| CA6 | **Documented Outcome with Verification** | Record final outcome formally; verify against the problem statement | CO7, CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Produce algorithm/flowchart/pseudocode before coding; justify design choices | CO7, CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records; demonstrate conceptual understanding orally | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | **SDG Alignment & Social Relevance** | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | **Problem Scoping & Requirements** | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | **Communication & Testing Strategy** | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | **Innovative Solution Proposal** | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | **Professional Toolchain** | Select and justify development tools; configure professional project environment | CO7 \| PO5 |
| P6 | **End-to-End Implementation** | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |

| | | | |
|---|---|---|---|
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

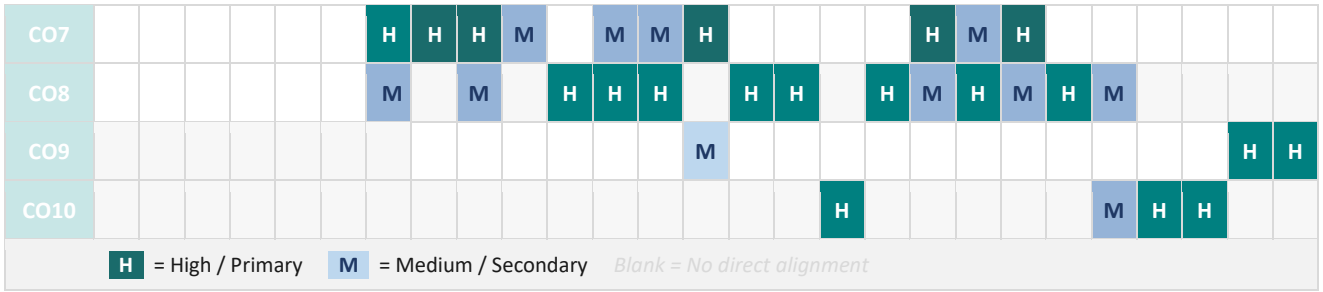
## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | M | | M | H | | | | | | | | | | | | | | | | | | | | | |




PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15.CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | – | – | – | – | – | – | – | – | 1 | 2 | 1 | – |
| CO2 | 3 | 2 | – | – | – | – | – | – | 1 | – | 2 | 2 | 2 | – |
| CO3 | 3 | 3 | 2 | – | 2 | 2 | – | – | 1 | – | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 2 | – | 2 | 1 | 1 | 3 | 3 | 3 | 3 |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| Avg | 2.50 | 2.14 | 2.33 | 1.75 | 2.33 | 1.80 | 3.00 | 2.50 | 1.50 | 2.00 | 2.13 | 2.22 | 2.30 | 2.38 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |
| CO2 | H | M | | | | | | | M | | |
| CO3 | M | H | M | | M | M | | | M | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | | M | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in computational thinking and structured programming; aligned with lifelong learning (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant programming and professional tool skills (CO7) directly applicable to employment in technology sectors. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables development of efficient software solutions; fosters innovation through real-world application design (CO6, CO8) and team-based projects (CO10). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Digital Forensics (CSCF2300)

Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML| Semester IV | Batch 2023–2027

Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment

PART I

## COURSE SYLLABUS

Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | V |
| **Course Code:** | CSCF2300 | **Course Type:** | Core - Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCF2300 |
| 2 | **Course Title** | Digital Forensics |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs. Classroom + 45 hrs. Self Learning = 90 hrs. total) |
| 5 | **Course Status** | Core - Theory Only (No Laboratory Component) |
| 6 | **Course Objectives** | Provide students with practice in applying digital forensics techniques and enhance their skills regarding practical applications. To develop competence in forensic tools, methodologies, legal and ethical frameworks, and digital investigation best practices. |

| S.No | Attribute | Details |
|---|---|---|
| 7 | **Course Outcomes (COs)** | After successful completion of this course, students will be able to: CO1 (Apply – L1/L2/L3): Demonstrate the principles of Digital Forensics and how resultant evidence can be applied within legal cases. CO2 (Understand – L2): Illustrate competence in recovering files, network forensics, and password cracking. CO3 (Apply – L3): Evaluate the effectiveness of available digital forensics tools and use them to optimise the efficiency and quality of digital forensics investigations. CO4 (Analyse – L4): Apply foundational grounding in computer networks, operating systems, file systems, hardware, and mobile devices to digital investigations and protection of computer network resources from unauthorised activity. CO5 (Evaluate – L5): Access and critically evaluate relevant technical and legal information and emerging industry trends. CO6 (Create/Adapt – L6): Adapt the results of a computer, network, and/or data forensic analysis effectively to technical and lay audiences verbally, in writing, and in presentations. |
| 8 | **Course Description** | This course introduces students to the fundamentals of Digital Forensics. Students apply appropriate skills and knowledge in solving computer forensics problems, from evidence acquisition to legal reporting. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks |
| 11 | **Textbook** | Anthony Reyes, Jack Wiles — Cybercrime and Digital Forensics, Syngress, Elsevier, 2007. John Sammons — The Basics of Digital Forensics, Elsevier, 2012. |
| 12 | **References** | Linda Volonins, Reynalds Anzaldua — Computer Forensics for Dummies, Wiley, 2008. NIST Special Publication 800-86: Guide to Integrating Forensic Techniques into Incident Response. EC-Council — Computer Forensics: Investigating Network Intrusions (CHFI), Cengage. IEEE Transactions on Information Forensics and Security (Journal). |

## 3. Outline Syllabus with CO Mapping

ℹ All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: INTRODUCTION TO COMPUTER FORENSICS (9-0-0-9)** | |
| A | History of Forensics – Computer Forensic Flaws and Risks | CO1 |
| B | Rules of Computer Forensics – Legal Issues – Digital Forensic Principles | CO1, CO2 |
| C | Digital Environments – Digital Forensic Methodologies | CO1, CO2, CO4 |
| | **Unit 2: AN OVERVIEW OF DIGITAL FORENSICS INVESTIGATION (9-0-0-9)** | |
| A | Live Forensics and Investigation – Digital Evidence | CO1, CO2 |
| B | Seizure Methodology – Factors Limiting Wholesale Seizure of Hardware – Demystifying Cybercrime | CO1, CO2 |
| C | Explosion of Networking – Explosion of Wireless Networks – Interpersonal Communication | CO1, CO2, CO5, CO6 |
| | **Unit 3: DATA FORENSICS (9-0-0-9)** | |

| | Topic | CO Mapping |
|---|---|---|
| A | Recovering Deleted Files and Deleted Partitions – Deleted File Recovery Tools | CO1, CO2, CO3 |
| B | Deleted Partition Recovery Tools – Data Acquisition and Duplication | CO1, CO2, CO3 |
| C | Data Acquisition Tools – Hardware Tools – Backing Up and Duplicating Data | CO1, CO2, CO3 |
| | **Unit 4: ROUTER FORENSICS AND NETWORK FORENSICS (9-0-0-9)** | |
| A | Overview of Routers – Hacking Routers – Investigating Routers | CO2, CO3, CO4 |
| B | Investigating Wireless Attacks – Basics of Wireless – Wireless Penetration Testing | CO3, CO4 |
| C | Direct Connections to Wireless Access Point – Wireless Connect to a Wireless Access Point | CO2, CO4, CO5 |
| | **Unit 5: E-MAIL FORENSICS AND STEGANOGRAPHY (9-0-0-9)** | |
| A | Forensics Acquisition – Processing Local Mail Archives | CO2, CO5 |
| B | Processing Server-Level Archives – Classification of Steganography | CO3, CO5, CO6 |
| C | Categories of Steganography in Forensics – Types of Password Cracking | CO4, CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A – History of Forensics, Flaws & Risks | ✓ | ✓ | | | | |
| 2 | 1.B – Rules, Legal Issues, Principles | ✓ | ✓ | | | | |
| 3 | 1.C – Digital Environments & Methodologies | ✓ | ✓ | ✓ | | | |
| 4 | 2.A – Live Forensics & Digital Evidence | | ✓ | ✓ | | | |
| 5 | 2.B – Seizure Methodology & Cybercrime | | ✓ | ✓ | | | |
| 6 | 2.C – Networking, Wireless, Communication | | ✓ | ✓ | | ✓ | ✓ |
| 7 | 3.A – Deleted File Recovery & Tools | | ✓ | ✓ | ✓ | | |

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 8 | 3.B – Partition Recovery & Data Acquisition | | ✓ | ✓ | ✓ | | |
| 9 | 3.C – Data Acquisition Tools & Duplication | | ✓ | ✓ | ✓ | | |
| 10 | 4.A – Router Overview & Investigation | | | ✓ | ✓ | | |
| 11 | 4.B – Wireless Attacks & Penetration Testing | | | ✓ | ✓ | ✓ | |
| 12 | 4.C – Wireless Access Point Connections | | ✓ | ✓ | ✓ | | |
| 13 | 5.A – Forensics Acquisition & Local Mail | | ✓ | | | ✓ | |
| 14 | 5.B – Server Archives & Steganography | | | ✓ | | ✓ | ✓ |
| 15 | 5.C – Steganography Categories & Password Cracking | | | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for forensic tool tracing in CO3. Affective domain appears at A3 (Valuing) for CO4 and CO5.

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | ✓ | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | |

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO4 | | | | ✓ | ✓ | | | | ✓ | | | | | | | | | |
| CO5 | | | | ✓ | ✓ | | | ✓ | | | | | | | | | | |
| CO6 | | ✓ | | ✓ | | | | | | | ✓ | | | | | | | |

Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) for CO3 (digital tool tracing). Affective (A3) for CO4 and CO5 (valuing forensic evidence integrity).

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ Total classroom contact: 45 hours across 5 units (9 lectures each). Self-Learning activities (45 hrs) are structured separately in Section 14.

| Date | Topics to be Covered | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | History of Forensics – Computer Forensic Flaws and Risks | UNIT-1 | 9 |
| DD/MM/YY | Rules of Computer Forensics | | |
| DD/MM/YY | Legal Issues in Digital Forensics | | |
| DD/MM/YY | Digital Forensic Principles | | |
| DD/MM/YY | Digital Environments in Forensic Investigations | | |
| DD/MM/YY | Digital Forensic Methodologies – I | | |
| DD/MM/YY | Digital Forensic Methodologies – II; Case study discussion | | |
| DD/MM/YY | Tools overview and documentation standards | | |
| DD/MM/YY | Unit 1 revision and Q&A | | |
| DD/MM/YY | Live Forensics and Investigation | UNIT-2 | 9 |
| DD/MM/YY | Digital Evidence – types and handling | | |
| DD/MM/YY | Seizure Methodology – principles and challenges | | |
| DD/MM/YY | Factors limiting wholesale seizure of hardware | | |
| DD/MM/YY | Demystifying computer/cyber crime | | |
| DD/MM/YY | Explosion of networking and digital footprints | | |
| DD/MM/YY | Wireless network explosion and forensic implications | | |
| DD/MM/YY | Interpersonal communication forensics | | |

| Date | Topics to be Covered | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Unit 2 revision; chain of custody documentation | | |
| DD/MM/YY | Recovering deleted files and deleted partitions | UNIT-3 | 9 |
| DD/MM/YY | Deleted file recovery tools – overview | | |
| DD/MM/YY | Deleted partition recovery tools | | |
| DD/MM/YY | Data acquisition concepts and legal considerations | | |
| DD/MM/YY | Data duplication: dd, dcfldd, FTK Imager | | |
| DD/MM/YY | Hardware-based data acquisition tools | | |
| DD/MM/YY | Software-based acquisition tools and write blockers | | |
| DD/MM/YY | Backing up and duplicating data; hash verification | | |
| DD/MM/YY | Unit 3 revision; imaging workflow discussion | | |
| DD/MM/YY | Overview of Routers and Router Architecture | UNIT-4 | 9 |
| DD/MM/YY | Hacking Routers – attack vectors | | |
| DD/MM/YY | Investigating Routers – log analysis | | |
| DD/MM/YY | Investigating Wireless Attacks | | |
| DD/MM/YY | Basics of wireless networking | | |
| DD/MM/YY | Wireless Penetration Testing – tools and methodology | | |
| DD/MM/YY | Direct Connections to Wireless Access Points | | |
| DD/MM/YY | Wireless forensics – packet capture and analysis | | |
| DD/MM/YY | Unit 4 revision; network forensics case discussion | | |
| DD/MM/YY | Forensics Acquisition of email data | UNIT-5 | 9 |
| DD/MM/YY | Processing local mail archives | | |
| DD/MM/YY | Processing server-level email archives | | |
| DD/MM/YY | Introduction to steganography – classification | | |
| DD/MM/YY | Categories of steganography in forensic context | | |
| DD/MM/YY | Steganography detection tools and methods | | |
| DD/MM/YY | Types of password cracking – dictionary, brute force, rainbow | | |
| DD/MM/YY | Password cracking tools – Hashcat, John the Ripper | | |
| DD/MM/YY | Unit 5 revision; capstone forensic case study | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

ℹ Six Theory Skill Dimensions — one per Bloom's progression (L1–L6) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Digital Forensics Fundamentals & Conceptual Recall** | Recall forensic principles, legal frameworks, evidence handling, investigation lifecycle, and digital forensic terminology; identify appropriate forensic methodology for given scenarios | CO1 \| L1–L3 | CA \| MTE \| ETE |
| TS2 | **Forensic Investigation & Evidence Interpretation** | Explain live forensics, digital evidence types, seizure methodologies, wireless/network investigation scenarios; interpret evidence acquisition workflows | CO2 \| L2 | CA \| MTE \| ETE |
| TS3 | **Data Recovery & Forensic Tool Application** | Apply data recovery tools (FTK Imager, Autopsy, dd, HashCalc) to recover deleted files and partitions; demonstrate data acquisition and integrity verification | CO3 \| L3 | CA \| MTE \| ETE |
| TS4 | **Network & Router Forensics Analysis** | Analyse network forensic scenarios including router investigation, wireless attacks, penetration testing; evaluate tools (Wireshark, Nmap, Ettercap) for forensic effectiveness | CO4 \| L4–L5 | CA \| ETE |
| TS5 | **E-mail & Steganography Forensics Evaluation** | Analyse email forensic acquisition, server-level archives, steganography techniques, and password cracking approaches; evaluate tools and their forensic applicability | CO5 \| L4–L5 | CA \| ETE |
| TS6 | **Forensic Reporting & Communication Synthesis** | Adapt forensic investigation results to technical and non-technical audiences; design comprehensive forensic reports; evaluate legal and ethical dimensions of forensic findings | CO6 \| L2–L6 | CA \| ETE |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.

| CO | TS1 Digital Forensics Fundamentals | TS2 Forensic Investigation | TS3 Data Recovery & Tools | TS4 Network Forensics | TS5 E-mail & Steganography | TS6 Reporting & Communication |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | M | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 9. Continuous Assessment (CA) — 25 Marks

ℹ CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.

### 9.1 CA Component Breakdown

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 assignments | **10** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5, TS6 |
| **Assessments 1–2 (Theory / Application-based)** | Assessment 1 (10 Marks) + Assessment 2 (5 Marks) | **15** | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2 concepts: Forensic principles, legal issues, evidence handling, seizure methodology, live forensics | CO1, CO2, CO3 | TS1, TS2, TS3 | 5h SL | Report submission + conceptual evaluation |
| **Assignment 2** | Unit 3, 4 and Unit 5: Data recovery tools, network forensics, email forensics, steganography, password cracking comparison | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5, TS6 | 5h SL | Comparative analysis + tool evaluation |

### 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2 concepts: Forensic principles, legal issues, digital environments, live forensics, seizure methodology | CO1, CO2, CO3 | TS1, TS2, TS3 | 5h SL | Short-answer + scenario-based evaluation |
| **Assessment 2** | Unit 3 and Unit 4: Data recovery tools, network forensics, router investigation, wireless attacks and forensic tool comparison | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 | 5h SL | Comparative analysis + tool evaluation |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–2)

ℹ MTE covers Units 1–2. CO4, CO5, CO6 are assessed in CA and ETE only. MTE maps to TS1–TS3.

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Digital Forensics Fundamentals & Conceptual Recall TS2 — Forensic Investigation & Evidence Interpretation | **CO1, CO2** | Short-answer: define forensic principles, explain evidence types, describe seizure methodology, compare forensic methodologies, identify investigation lifecycle stages |
| TS3 — Data Recovery & Forensic Tool Application | **CO3** | Application/theory-based: explain data acquisition process, describe deleted file recovery tools, discuss hash verification, outline imaging steps with write blockers |
| TS1–TS3 | **CO1–CO3** | Units 1–2 only. CO4, CO5, CO6 assessed only in ETE. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (synthesis). Minimum 40/100 overall required to pass.

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Digital Forensics Fundamentals & Conceptual Recall TS2 — Forensic Investigation & Evidence Interpretation | **CO1, CO2** | Short questions (all units): definitions, forensic principles, evidence types, seizure rules, methodology comparison, cybercrime terminology, investigation lifecycle |
| TS3 — Data Recovery & Forensic Tool Application TS4 — Network & Router Forensics Analysis TS5 — E-mail & Steganography Forensics Evaluation | **CO3, CO4, CO5** | Medium questions: data acquisition process, tool comparison (FTK vs Autopsy), router log analysis, wireless attack investigation, email header analysis, steganography detection, password cracking methods |

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS4 — Network & Router Forensics Analysis TS5 — E-mail & Steganography Forensics Evaluation | CO4, CO5 | Long/evaluation questions: case-based router forensics, wireless network forensics analysis, comprehensive email investigation, steganography and password cracking evaluation, comparative tool analysis |
| TS6 — Forensic Reporting & Communication Synthesis | CO6 | Long question: design a forensic investigation report for a given scenario; adapt findings for lay and technical audience; justify tool selection and legal/ethical considerations |
| TS1–TS6 (all) | CO1–CO6 | Scaled from 100 marks to 60 marks. Minimum 40/100 overall required to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Demonstrate Digital Forensics principles and legal evidence application | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO5, PO8, PO12 |
| CO2 | Illustrate competence in file recovery, network forensics, password cracking | ✓ | ✓ | ✓ | TS2 | PO1, PO2, PO3 |
| CO3 | Evaluate digital forensics tools and optimise investigation efficiency | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO5, PO9 |
| CO4 | Apply computer networks/OS/file systems/hardware grounding to digital investigations | ✓ | — | ✓ | TS4 | PO1, PO2, PO4, PO5, PO6 |
| CO5 | Access and critically evaluate technical/legal information and industry trends | ✓ | — | ✓ | TS5 | PO1, PO2, PO3, PO8, PO9 |
| CO6 | Adapt forensic analysis results to technical and lay audiences | ✓ | — | ✓ | TS6 | PO1, PO2, PO4, PO6, PO7, PO10, PO11 |

⚠ CO5 and CO6 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.

PART III

## COMBINED MAPPINGS & REFERENCE

CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail

## 12. CO–PO and CO–PSO Mapping Matrix

ℹ Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | – | – | 2 | – | – | 3 | – | – | – | – | – | 3 |
| CO2 | 3 | 3 | 2 | – | – | – | – | – | – | – | – | – | – | 3 |
| CO3 | 3 | 3 | 2 | – | 2 | – | – | – | 2 | – | – | 3 | – | – |
| CO4 | 3 | 3 | – | 3 | 2 | 3 | – | 2 | – | – | – | – | 3 | – |
| CO5 | 3 | 2 | 3 | – | – | – | – | 3 | 3 | – | – | – | 3 | – |
| CO6 | 3 | 3 | – | 3 | 3 | 3 | 3 | – | – | 3 | 3 | 3 | – | – |
| Avg | 2.83 | 2.83 | 2.33 | 3.00 | 2.25 | 3.00 | 3.00 | 2.67 | 2.50 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | H | | | M | | | H | | | | | | H |
| CO2 | H | H | M | | | | | | | | | | | H |
| CO3 | H | H | M | | M | | | | M | | | H | | |
| CO4 | H | H | | H | M | H | | M | | | | | H | |
| CO5 | H | M | H | | | | | H | H | | | | H | |
| CO6 | H | H | | H | H | H | H | | | H | H | H | | |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | Assignment Writing (2 assignments — Unit 1–2 focus and Unit 3–5 focus; theory/application-based, forensic case analysis) | 2 assignments × 5 hrs each Total = 10 hrs | CO1–CO6 TS1–TS6 | Assignment submission, conceptual understanding, forensic tool application, comparative analysis |
| 2 | Technical Video-Based Learning (e.g., digital forensics tools, FTK Imager walkthrough, Wireshark network forensics, steganography detection, Autopsy tutorial) | Video viewing: 5 hrs Report preparation: 5 hrs Presentation: 5 hrs Total = 15 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning; must capture key forensic tool features, methodology, and personal reflections |
| 3 | Real-World Case Studies (e.g., cybercrime investigation case, digital evidence in court, corporate data breach forensics, network intrusion analysis, email forensics case) | Data collection/study: 5 hrs Report preparation: 10 hrs Presentation: 5 hrs Total = 20 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated on technical depth, evidence chain analysis, legal/ethical discussion, comparative tool evaluation, and professional report quality |
| **TOTAL Self-Learning Hours: 45 hours \| CO1–CO6 \| All activities are compulsory. Submission deadlines communicated at the start of the semester.** | | | | |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L6). Psychomotor domain (P3) appears for CO3 (digital tool tracing as mental procedure). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of forensic evidence integrity and professional standards.

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL activities directly impact CA score |

ℹ Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**CSCR2201 — Digital Forensics Summary**

Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)

CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A

CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B

CO5–CO6: Evaluate / Create → TS5, TS6 → CA + ETE Sec B/C

**CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks**

# COURSE PLAN

## Introduction to Natural Language Processing (CSAI3001)

*Sharda School of Computing Science & Engineering (SSCSE) | **B. Tech CSE-AIML** | Semester VII | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Shadra School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | V |
| **Course Code:** | CSAI4200 | **Course Type:** | Core — Theory Only |

## 2. Course Details

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSAI3001** |
| 2 | **Course Title** | **Introduction to Natural Language Processing** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-2 (Theory: 45 hrs Classroom + 45 hrs Self Learning = 90 hrs total) |

| | | |
|---|---|---|
| 5 | **Course Status** | **Specialization Elective — Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | 1. Introduce the fundamentals of Natural Language Processing and Computational Linguistics.<br>2. Enable students to apply NLP algorithms and programming techniques for processing natural language text.<br>3. Develop understanding of morphology, syntax, semantics, discourse, and pragmatics in NLP systems.<br>4. Familiarize learners with lexical resources, text corpora, and machine learning approaches for NLP tasks.<br>**5.** Develop the ability to design NLP-based applications for real-world business and AI environments. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1: (Understand – L1/L2): Define computational linguistics concepts, NLP fundamentals, ambiguity, and language processing techniques.<br>CO2: (Explore – L2/L3): Explain text corpora, lexical resources, and language understanding techniques used in NLP systems.<br>CO3: (Apply – L3): Apply NLP programming concepts, regular expressions, lexical resources, and Python libraries for raw text processing.<br>CO4: (Analyze – L4): Analyze tagging methods, classification techniques, and information extraction approaches from textual data.<br>CO5: (Analyze – L4/L5): Analyze sentence structures, semantic interpretation, logic representations, and deep learning sequence models in NLP.<br>CO6: (Create – L5/L6): Design NLP-based intelligent applications and manage linguistic resources for different business environments. |
| 8 | **Course Description** | This course introduces the concepts and techniques of Natural Language Processing (NLP) and Computational Linguistics. It covers language modeling, lexical resources, text corpora, tagging, text classification, information extraction, sentence analysis, semantics, and modern NLP approaches using machine learning and deep learning techniques. Students will explore linguistic as well as statistical approaches for designing intelligent language processing systems. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1. Jurafsky, D. & Martin, J.H. — Speech and Language Processing, Pearson.<br>2. Ruslan Mitkov — The Oxford Handbook of Computational Linguistics, Oxford University Press. |
| 12 | **References** | 1. Charu C. Aggarwal & Cheng Xiang Zhai — Mining Text Data, Springer.<br>2. Hopcroft, J.E. & Ullman, J.D. — Introduction to Automata, Theory and Languages, Addison-Wesley. |

## 3. Outline Syllabus with CO Mapping

ℹ All *CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Introduction and Computational Linguistics** | |
| A | What is Natural Language Processing, Hands-on Demonstrations, Ambiguity and Uncertainty in Language, Turing Test | CO1 |
| B | Computing with Language Texts and Words Implementation of NLTK, Searching Text, Counting Vocabulary, A Closer Look at Python Texts as Lists of Words, Computing with Language Simple Statistics, Frequency Distributions, Fine-grained Selection of Words, Collocations and Bigrams, | CO1 |
| C | Making Decisions and Taking Control, Conditionals, Operating on Every Element, Nested Code Blocks, Looping with Conditions | CO1 |
| | **Unit 2: Accessing Text Corpora and Lexical Resources** | |
| A | Automatic Natural Language Understanding, Word Sense Disambiguation, Pronoun Resolution, Generating Language Output, Machine Translation, Spoken Dialog Systems, Textual Entailment, Limitations of NLP | CO2 |
| B | Accessing Text Corpora, Gutenberg Corpus, Web and Chat Text, Brown Corpus, Reuters Corpus, Inaugural Address Corpus, Annotated Text Corpora, Corpora in Other Languages | CO2 |
| C | Text Corpus Structure, loading your own Corpus, Conditional Frequency Distributions, Conditions and Events, Counting Words by Genre, Plotting and Tabulating Distributions, Generating Text with Language Models | CO2 |
| | **Unit 3: Processing Raw Text** | |
| A | Lexical Resources, Word list Corpora, A Pronouncing Dictionary, Comparative Wordlists, Shoebox and Toolbox Lexicons, WordNet, Senses and Synonyms, The WordNet Hierarchy, Lexical Relations, Semantic Similarity | CO3 |
| B | Accessing Text from the Web and from Disk, Strings Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting from Lists to Strings | CO3 |
| C | NLP Programming Sequences, Style, Functions for text processing, Program Development & Algorithm Design using, Python Libraries | CO3 |
| | **Unit 4: Tagging & Information Extraction** | |
| A | Categorizing and Tagging Words Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, Determine the Category of a Word. | CO4 |
| B | Text classification Supervised Classification, Examples of Supervised Classification, Evaluation, Text Classification using Scikit-learn (SVM, Logistic Regression) Classifiers, Maximum Entropy Classifiers, Modeling Linguistic Patterns | CO4 |

| | | |
|---|---|---|
| C | I Extracting Information from Text Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction | CO4 |
| | **Unit 5: Analysis of Sentences** | |
| A | Analyzing Sentence Structure Grammatical Dilemmas, Use of Syntax, Sequence Models: RNNs and LSTMs for sentence classification, Dependencies and Dependency Grammar, Grammar Development | CO5 |
| B | Analyzing the Meaning of Sentences Natural Language Understanding, Propositional Logic, First-Order Logic, The Semantics of English Sentences, Discourse Semantics, Overview of sentence classification and semantic similarity using pre-trained transformer models. | CO5. CO6 |
| C | Managing Linguistic Data Corpus Structure, The Life Cycle of a Corpus, Acquiring Data, Working with XML, Working with Toolbox Data, Describing Language Resources Using OLAC Metadata | CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | ✓ | ✓ | | | | |
| 6 | 2.C | | ✓ | ✓ | ✓ | | |
| 7 | 3.A | | ✓ | ✓ | ✓ | | |
| 8 | 3.B | | ✓ | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | ✓ | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | ✓ | | |
| 14 | 5.B | | ✓ | ✓ | ✓ | ✓ | |
| 15 | 5.C | | ✓ | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ Cognitive domain is primary for this theory-oriented AI elective. Psychomotor mapping is limited to Guided Response (P3) and Mechanism (P4) through NLP programming activities. Affective mapping appears at A3 for ethical and responsible AI-based NLP application development.

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | | | | | | ✓ | ✓ | | | |
| CO4 | | | ✓ | ✓ | ✓ | | | | ✓ | | | | | ✓ | ✓ | | | |
| CO5 | | | ✓ | ✓ | ✓ | | | | ✓ | | | | | ✓ | ✓ | | | |
| CO6 | | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary.* Psychomotor mapping is limited to Guided Response (P3) and Mechanism (P4) through NLP programming activities. Affective mapping appears at A3 for ethical and responsible AI-based NLP application development.

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ **Total** *classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to NLP and Computational Linguistics | UNIT-1 | 7 |
| DD/MM/YY | Ambiguity and Uncertainty in Language | | |
| DD/MM/YY | Turing Test and NLP Demonstrations | | |
| DD/MM/YY | NLTK Installation and Text Processing Basics | | |
| DD/MM/YY | Vocabulary Analysis and Frequency Distribution | | |
| DD/MM/YY | Fine-grained Selection of Words, Collocations and Bigrams | | |
| DD/MM/YY | Decision Making, Nested Code Blocks, Conditions and Looping | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Word Sense Disambiguation | UNIT-2 | 9 |
| DD/MM/YY | Pronoun Resolution and Machine Translation | | |
| DD/MM/YY | Spoken Dialogue Systems and Textual Entailment, Limitations of NLP | | |
| DD/MM/YY | Introduction to Text Corpora | | |
| DD/MM/YY | Brown, Reuters and Gutenberg Corpus | | |
| DD/MM/YY | Web and Chat Text Processing, Inaugural Address Corpus | | |
| DD/MM/YY | Annotated Corpora and Multilingual Corpora | | |
| DD/MM/YY | Conditional Frequency Distribution, Conditions and Events, Counting Words by Genre, Plotting and Tabulating Distributions, | | |
| DD/MM/YY | Language Models and Text Generation | | |
| DD/MM/YY | Lexical Resources and WordNet | UNIT-3 | 8 |
| DD/MM/YY | Semantic Similarity and Lexical Relations, Pronouncing Dictionary and Lexicons | | |
| DD/MM/YY | Accessing Text from the Web and from Disk, Strings Text Processing at the Lowest Level, | | |
| DD/MM/YY | Unicode and Text Processing | | |
| DD/MM/YY | Regular Expressions and Pattern Matching | | |
| DD/MM/YY | Tokenization and Text Segmentation | | |
| DD/MM/YY | Text Normalization and String Formatting | | |
| DD/MM/YY | NLP Programming Functions and Libraries | | |
| DD/MM/YY | Categorizing and Tagging Words Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, | UNIT-4 | 9 |
| DD/MM/YY | N-Gram Tagging Techniques | | |
| DD/MM/YY | Transformation-Based Tagging, Determine the Category of a Word | | |
| DD/MM/YY | Text classification Supervised Classification, Examples of Supervised Classification | | |
| DD/MM/YY | Decision Trees, Naive Bayes Classifiers, and Maximum Entropy Classifiers | | |
| DD/MM/YY | Evaluation Metrics for Classification | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Information Extraction and Chunking, Developing and Evaluating Chunkers | | |
| DD/MM/YY | Recursion in Linguistic Structure, Named Entity Recognition | | |
| DD/MM/YY | Relation Extraction Techniques | | |
| DD/MM/YY | Analyzing Sentence Structure Grammatical Dilemmas, Use of Syntax, | UNIT-5 | 12 |
| DD/MM/YY | Sequence Models: RNNs and LSTMs for sentence classification | | |
| DD/MM/YY | Context-Free Grammar and Parsing Techniques | | |
| DD/MM/YY | Dependencies and Dependency Grammar, Grammar Development | | |
| DD/MM/YY | Natural Language Understanding | | |
| DD/MM/YY | Propositional Logic and First-Order Logic | | |
| DD/MM/YY | Semantics of English Sentences and Discourse Semantics | | |
| DD/MM/YY | Overview of sentence classification and semantic similarity using pre-trained transformer models. | | |
| DD/MM/YY | Corpus Lifecycle and Linguistic Data Management | | |
| DD/MM/YY | XML and Toolbox Data Processing | | |
| DD/MM/YY | OLAC Metadata and Language Resources | | |
| DD/MM/YY | NLP Applications and Industry Case Studies | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ Six *Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Conceptual Understanding of NLP | Recall and explain NLP fundamentals, ambiguity, computational linguistics concepts, and language models | CO1 | CA, MTE Sec A, ETE Sec A |
| TS2 | Corpus & Lexical Resource Interpretation | Explain corpora, lexical resources, language understanding, and NLP applications | CO2 | CA, MTE Sec A, ETE Sec A |
| TS3 | NLP Programming & Text Processing | Apply regular expressions, tokenization, lexical resources, and Python libraries for NLP tasks | CO3 | CA, MTE Sec B, ETE Sec B |
| TS4 | NLP Model Analysis & Information Extraction | Analyze tagging methods, classification algorithms, and information extraction systems | CO4 | CA, MTE Sec B, ETE Sec B |
| TS5 | Semantic & Sentence Analysis | Analyze semantics, logic, grammar structures, and sequence models | CO5 | ETE Sec B/C |
| TS6 | NLP Application Design & Resource Management | Design NLP applications and evaluate linguistic resource management systems | CO6 | CA, ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ **Each** *CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | **TS1** Conceptual Understanding of NLP | **TS2** Corpus & Lexical Resource Interpretation | **TS3** NLP Programming & Text Processing | **TS4** NLP Model Analysis & Information Extraction | **TS5** Semantic & Sentence Analysis | **TS6** NLP Application Design & Resource Management |
|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | | | | |
| **CO2** | **M** | **H** | **M** | | | |
| **CO3** | | **M** | **H** | **M** | | |
| **CO4** | | | **M** | **H** | **M** | |
| **CO5** | | | **M** | **M** | **H** | **M** |
| **CO6** | | | | **M** | **M** | **H** |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ **CA** *is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 |
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO5, CO6 | TS5, TS6 |
| **Mini NLP Case Study (Report)** | 1 Report | **5** | CO5, CO6 | TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | NLP basics, ambiguity, NLTK operations | CO1 | TS1 | 5h SL | Correctness and conceptual understanding |
| **Assignment 2** | Text corpora and lexical resources | CO2 | TS2 | 5h SL | Corpus exploration and analysis |
| **Assignment 3** | Regular expressions, tokenization, WordNet | CO3 | TS3 | 5h SL | Program implementation and output validation |
| **Assignment 4** | Tagging and text classification | CO4 | TS4 | 5h SL | Comparative analysis and evaluation |
| **Assignment 5** | Sentence analysis, semantic similarity, transformer models | CO5, CO6 | TS5, TS6 | 5h SL | Design-oriented analytical report |
| **Video Learning Report** | Advanced NLP Systems and Text Classification Techniques | CO3, CO4 | TS3, TS4 | 10h SL | Technical presentation and reflection |
| **Mini NLP Case Study** | Machine Translation, Information Extraction, and Corpus Management Applications | CO5, CO6 | TS5, TS6 | 10h SL | Industry-oriented application analysis |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ **MTE** *covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **5** | **TS1** Conceptual Understanding of NLP, **TS2** Corpus & Lexical Resource Interpretation | **CO1, CO2** | Definitions, conceptual explanations, corpus-based questions |
| **Section B** | **10** | **TS3** NLP Programming & Text Processing, **TS4** NLP Model Analysis & Information Extraction | **CO3, CO4** | NLP programming, tokenization, tagging, text processing numerical |
| **TOTAL** | **25** | TS1–TS4 | **CO1–CO4** | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ **ETE** *is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1, TS2 | CO1, CO2 | Short conceptual and explanatory questions |
| **Section B** | **25** | TS3, TS4, TS5 | CO3, CO4, CO5 | Medium analytical and NLP programming questions |
| **Section C** | **20** | TS5, TS6 | CO5, CO6 | Long-answer and design-oriented questions |
| **TOTAL** | **60** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Understand NLP fundamentals | ✓ | ✓ | ✓ | TS1 | PO1 |
| **CO2** | Explain corpora and lexical resources | ✓ | ✓ | ✓ | TS2 | PO5 |
| **CO3** | Apply NLP programming concepts | ✓ | ✓ | ✓ | TS3 | PO3, PO5 |
| **CO4** | Analyze tagging and classification techniques | ✓ | ✓ | ✓ | TS4 | PO2, PO5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO5** | Analyze sentence semantics and logic | ✓ | — | ✓ | TS5 | PO2, |
| **CO6** | Design NLP applications | ✓ | — | ✓ | TS6 | PO1, PO2, PO3, PO4, PO5, PO8 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 is covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ **Strength** *Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | – | – | 2 | – | – | – | – | – | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | – | – | 3 | – | – | – | – | – | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 3 | – | 3 | – | – | 1 | – | 1 | 2 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | – | – | 3 | – | – | – | – | – | 2 | 1 | 1 | 2 |
| **CO5** | 2 | 3 | – | – | 1 | – | – | – | – | – | 1 | 1 | 1 | 2 |
| **CO6** | 3 | 3 | 3 | 3 | 3 | 2 | – | 3 | – | 2 | 3 | 3 | 3 | 3 |
| **Avg** | **2.34** | **2.5** | **1** | **0.5** | **2.5** | **0.34** | **–** | **0.67** | **-** | **0.5** | **2.0** | **2.0** | **2.0** | **2.34** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | M | | | | | | M | M | M | H |
| CO2 | M | M | | | H | | | | | | M | M | M | M |
| CO3 | M | M | H | | H | | | M | | M | M | H | H | M |
| CO4 | M | H | | | H | | | | | | M | M | M | M |
| CO5 | M | H | | | M | | | | | | M | M | M | M |
| CO6 | H | H | H | H | H | M | | H | | M | H | H | H | H |

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **NLP Programming Assignments and Text Analysis** | 5 assignments × 5 hrs each<br>Total = 25 hrs | CO1–CO4<br>TS1–TS4 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance |
| 2 | **Video-based Learning on Transformers, LLMs, Chatbots** | Video viewing: 5 hrs<br>Report preparation: 3 hrs<br>Presentation: 2 hrs<br>Total = 10 hrs | CO2, CO3<br>TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, algorithms, and personal reflections |
| 3 | **NLP Case Studies and Research Paper Review** | Data collection/study: 7 hrs<br>Report preparation: 3 hrs<br>Total = 10 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, and analytical conclusions drawn |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

| | | |
|---|---|---|
| L6 — Create: Design, develop, and produce new artefacts | | |

★ **OBE** *Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

⚠ **Theory** *attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**CSAI4200 — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks

# COURSE PLAN

**Communication, Coding & Career Readiness Skills (SKP3501)**

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester V | Batch 2026–2030*

*Lab-Only Course Plan — All 6 Lab COs (CO1–CO6) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I COURSE SYLLABUS** *Course Identification, Details, Outcomes, BTL Mapping & Lab Session Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–2029 |
| **Branch:** | CSE-AIML | **Semester:** | V |
| **Course Code:** | SKP3501 | **Course Type:** | Core - Practical |

## 2. Course Details

**LAB-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), Course Examination (CE), and End Semester Examination (ESE). No theory lecture component.**

| | | |
|---|---|---|
| **1** | **Course Code** | SKP3501 |
| **2** | **Course Title** | Communication, Coding & Career Readiness Skills |
| **3** | **Credits** | 3 |
| **4** | **Contact Hours (L-T-P-SL)** | 0-0-6-0 (Lab: 90 hrs =Total: 90 hrs) |
| **5** | **Course Status** | Core — Lab Only (No Theory Lecture Component) |
| **6** | **Course Objectives** | The objective of this course is to develop learners into confident, industry-ready, and effective communicators by strengthening their verbal ability, soft skills, quantitative aptitude, and logical reasoning competencies, while concurrently developing advanced computational problem-solving, Generative AI fundamentals, modern frontend engineering, and optimization techniques using advanced algorithms and React-based application development. The course enables students to understand transformer |

| | | |
|---|---|---|
| | | architectures, prompt engineering, retrieval-augmented systems, dynamic programming, graph algorithms, and scalable frontend state management for building industry-oriented intelligent applications and modern web systems. It aims to enhance professional communication through activities such as elevator pitches, group discussions, JAM sessions, public speaking, and LSRW practices while fostering leadership, managerial effectiveness, decision-making abilities, and workplace etiquette. It also focuses on preparing learners for recruitment and corporate environments through LinkedIn profile optimization, HR sensitization, understanding KRAs/KPAs/CTC, and constructive feedback mechanisms. In addition, the course seeks to improve analytical thinking, problem-solving skills, and reasoning ability through quantitative aptitude, critical reasoning, data interpretation, seating arrangements, inequalities, and statement-based reasoning exercises. By the end of the course, learners will demonstrate improved confidence, clarity of expression, professional readiness, analytical aptitude, and the ability to communicate, build, and perform effectively in academic, corporate, and real-world technological situations. |
| **7** | **Course Outcomes (COs)** | After successful completion of this course, the students will be able to:<br>**CO1 (Remember – L1):Fundamentals of Professional Communication & Intelligent Systems**<br>Recall and identify the fundamental concepts of professional communication, self-branding, business etiquette, managerial skills, HR sensitization, Generative AI, transformer architectures, React fundamentals, greedy strategies, and optimization techniques used in intelligent systems, frontend development, and academic or corporate environments.<br>**CO2 (Understand – L2): Principles of Leadership, AI Models & Frontend Architecture**<br>Explain the principles of leadership, decision-making, public speaking, constructive feedback, language modeling workflows, prompt engineering techniques, dynamic programming paradigms, React state management, and API-driven frontend architectures for effective professional interaction and software development.<br>**CO3 (Apply – L3): Application of Employability Skills & Computational Workflows**<br>Demonstrate effective communication and employability skills through elevator pitches, group discussions, and LinkedIn optimization, while applying React components, hooks, routing, APIs, dynamic programming, graph algorithms, and Generative AI workflows to solve computational and real-world application problems.<br>**CO4 (Analyze – L4):Analysis of Communication Competencies & Scalable System Design**<br>Analyze spoken and written content by applying listening, speaking, reading, and writing (LSRW) skills and critical reasoning, while simultaneously analyzing transformer architectures, fine-tuning strategies, graph traversal techniques, asynchronous frontend workflows, and optimization algorithms for scalable system development. |

| | | |
|---|---|---|
| | | **CO5 (Evaluate – L5): Evaluation of Analytical Reasoning & Application Performance**<br>Evaluate and solve quantitative and logical reasoning problems (involving data interpretation, time-speed-distance, and inequalities), while also evaluating AI model outputs, ethical implications, optimization techniques, React application performance, and algorithmic efficiencies for intelligent application design.<br>**CO6 (Create – L6): Creation of Professional Profiles & AI-Powered Applications**<br>Create structured verbal and written responses, professional profiles, and logical solutions, and design and develop complete AI-powered React applications by integrating prompt engineering, APIs, advanced algorithms, state management, and communication skills for real-world corporate and technical scenarios. |
| **8** | **Course Description** | This course provides an interdisciplinary framework integrating professional communication, employability skills, and logical reasoning with Generative AI, advanced algorithms, and modern React-based frontend engineering. Learners enhance their presentation skills, public speaking, group discussion abilities, and LSRW competencies through structured activities such as elevator pitches, JAM sessions, leadership exercises, and workplace communication practices. Parallel, students are introduced to transformer architectures, prompt engineering, LLM ecosystems, retrieval-augmented generation, and responsible AI practices. The course strengthens analytical and computational thinking through quantitative aptitude, critical reasoning, data interpretation, and advanced algorithmic techniques including greedy algorithms, dynamic programming, backtracking, branch and bound, and advanced graph algorithms. Furthermore, it develops practical frontend engineering competencies using React, hooks, routing, APIs, authentication workflows, Redux Toolkit, and deployment methodologies. By emphasizing project-based learning, LinkedIn profile optimization, HR sensitization, business etiquette, and industry-oriented software engineering practices, this course prepares students to communicate confidently, solve complex problems, and build scalable, intelligent applications in real-world, career-oriented situations." |
| **9** | **Teaching & Learning Scheme** | Lab Instructions (LI): 90 hrs \| Tutorial (T): 0 hrs \| Self Learning (SL): 0 hrs \| Total: 90 hrs \| Credits: 3 |
| **10** | **Mode of Examination** | Lab Only. CA: 30% \| CE: 30% \| ESE: 40% \| Total: 100 marks |
| **11** | **Self Learning (SL: 0 hrs)** | -. |
| **12** | **Textbook** | 7. **Soft Skills: Know Yourself & Know the World** – Dr. Alex K.<br>8. **Quantitative Aptitude for Competitive Examinations**– R.S. Aggarwal<br>9. **A Modern Approach to Verbal & Non-Verbal Reasoning** – R.S. Aggarwal<br>10. **Business Communication** – Meenakshi Raman & Prakash Singh |

| | | |
|---|---|---|
| | | 11. Word Power Made Easy – Norman Lewis<br>12. Jurafsky and Martin – Speech and Language Processing<br>13. AurélienGéron – Hands-On Machine Learning with Scikit-Learn and TensorFlow<br>14. Jon Duckett – React and Modern Frontend Development<br>15. Thomas H. Cormen – Introduction to Algorithms<br>16. Full Stack Open Documentation and React Official Docs |
| **13** | **References** | 1 Ian Goodfellow – Deep Learning<br>2 Sebastian Raschka – Build a Large Language Model From Scratch<br>3 Kyle Simpson – You Don't Know JS<br>4. Aditya Bhargava – Grokking Algorithms<br>5 David Flanagan – JavaScript: The Definitive Guide<br>6 Hugging Face Documentation<br>7 OpenAI API Documentation<br>8 React Official Documentation<br>9 Redux Toolkit Documentation<br>10 LeetCode Advanced DSA Problems<br>11 GeeksforGeeks – DP and Graph Algorithms<br>12 LangChain Documentation |

## 3. Outline Syllabus — Lab Units with CO Mapping

*i All CO mappings refer to Lab COs (CO1–CO6). This is a lab-only course; all assessment is via CA, CE, and ESE.*

| | Topic / Activity | CO Mapping |
|---|---|---|
| | **Unit 1 : Professional Branding, Corporate Communication, and Generative AI Foundations and Language Models (0-0-18-0 = 18hrs)** | |
| **A** | Elevator Pitch – Art of Self Branding, professional self-introduction, confidence building, and personal branding techniques. | **CO1** |
| **B** | LinkedIn Profile Optimization, professional networking, profile enhancement, and digital professional presence. | **CO1** |
| **C** | Profile Updating on Job Portals & Placement Consultancies, HR Sensitization – KRAs/KPAs – Understanding CTC, recruitment awareness, and employability readiness. | **CO1** |
| **D** | Introduction to Generative AI, Key Concepts, Comparison with Traditional AI, Applications in Text, Image and Code Generation **OR** Introduction to React, SPA Architecture, Virtual DOM and Modern Frontend Workflow | **C01** |

| | | |
|---|---|---|
| **E** | Language Modeling Fundamentals, Statistical vs Neural Models, N-Grams, Perplexity and Training Objectives **OR** React Setup using Vite, npm, Folder Structure and React DevTools | **C02** |
| **F** | Evolution of LLMs and Generative AI Landscape: Word2Vec to GPT, Transfer Learning, Pretraining vs Fine-Tuning, GPT-4o, Claude, Gemini, LLaMA, Mistral | **C02** |
| **G** | Greedy Choice Property, Optimal Substructure and Exchange Argument Proofs, Activity Selection, Interval Scheduling and Meeting Room Problems, Huffman Encoding, Fractional Knapsack and Minimum Platforms Problem | **C03** |
| **H** | Dijkstra's Algorithm, Prim's MST and Kruskal's MST with Union-Find | **C03** |
| | **Unit 2: Managerial Skills & Tech Foundations: LLMs, Frontend Components, and Dynamic Programming-— 1D & 2D (0-0-18-0 = 18hrs)** | |
| **A** | Introduction to Managerial Skills, workplace coordination, organizational behavior, and professional responsibilities. | **CO2** |
| **B** | Business Etiquette, workplace communication ethics, professional behavior standards, and Crisis Management. | **CO2** |
| **C** | Introduction to Leadership Skills, Decision Making Skills, Constructive Criticism & Feedback, leadership qualities, and professional interaction strategies. | **CO2** |
| **D** | Attention Mechanism, Self-Attention and Positional Encoding **OR** Functional Components, Props and Reusable Components | **C04** |
| **E** | Transformer Architecture, Encoder-Decoder Models, BERT, GPT, T5 and LLaMA **OR R**useState Hook, Event Handling and Dynamic UI Updates | **C03** |
| **F** | Multimodal Transformers, CLIP, Scaling Laws, Zero-Shot and Few-Shot Learning **OR** Controlled Components, Forms Handling and Validation | **C05** |
| **G** | Dynamic Programming Fundamentals, Memorization and Tabulation, 1D Dynamic Programming: Fibonacci, Climbing Stairs, Coin Change and LIS, 2D Dynamic Programming: Grid Paths, Edit Distance and LCS, | **CO2** |
| **H** | DP on Strings, Wildcard Matching and Distinct Subsequences | **C04** |
| | **Unit 3: Public Speaking, Group Discussion & Verbal Communication Skills / Prompt Engineering, APIs and Toolkits / Hooks, Rendering & React APIs / Advanced DP & Divide and Conquer (0-0-18-0 = 18hrs)** | |
| **A** | Advance Toastmaster – Public Speaking, speech organization, audience engagement, voice modulation, and confidence building. | **CO3** |
| **B** | JAM Sessions, Group Discussion – Case Study, spontaneous speaking, teamwork, and discussion participation skills. | **CO3** |
| **C** | LSRW 2 – Listening, Speaking, Reading & Writing, Contextual Vocabulary, Active & Passive Voice – Company & AMCAT Specific, grammar accuracy, and | **CO4** |

| | | |
|---|---|---|
| | verbal communication enhancement. | |
| **D** | Prompt Engineering Fundamentals, Zero-shot, One-shot and Few-shot Prompting **OR** useEffect Hook, Dependency Arrays and Side Effects | **CO2** |
| **E** | Chain-of-Thought, Tree-of-Thought, ReAct and Self-Consistency Prompting **OR** Conditional Rendering, Dynamic Rendering, Error and Loading States | **CO4** |
| **F** | OpenAI API, Anthropic API, Hugging Face, LangChain and Function Calling **OR** Custom Hooks and Reusable Logic Extraction | **CO6** |
| **G** | DP on Trees, Tree Diameter and Tree DP Patterns, DP on Graphs, Bellman-Ford and Floyd-Warshall Algorithms | **C04** |
| **H** | Bitmask DP, Interval DP and Partition DP | **CO5** |
| | **Unit 4: Quantitative Aptitude & Numerical Problem-Solving Skills.Fine-Tuning, Evaluation, Bias and Ethics Backtracking & Branch and Bound Routing, API Integration & Authentication (0-0-18-0 = 18 hrs)** | |
| **A** | Number Series – Missing & Wrong, pattern recognition, logical numerical analysis, and aptitude-solving techniques. | **CO5** |
| **B** | Allegation & Mixtures, Time & Work (LCM and Efficiency Based), Time, Speed & Distance, quantitative problem-solving methods and analytical calculations. | **CO5** |
| **C** | Clocks, Data Interpretation – Line/Bar, Tabular/Pie, Radar/Web Charts, graphical data analysis, and interpretation techniques. | **CO5** |
| **D** | Fine-Tuning LLMs, LoRA, QLoRA and PEFT Techniques **OR** React Router, Nested Routes, Protected Routes and Navigation | **CO4** |
| **E** | BLEU, ROUGE, Perplexity and AI Output Evaluation **OR** Fetch API, Axios, Async/Await and API Integration | **C05** |
| **F** | Bias, Hallucination, Red Teaming and Responsible AI Frameworks **OR** Authentication, Token Storage and Frontend–Backend Integration | **C05** |
| **G** | Backtracking Templates, State-Space Exploration and Decision Tree Pruning, Permutations, Combinations, N-Queens, Sudoku Solver and Word Search | **CO4** |
| **H** | Constraint Propagation, Arc Consistency and Pruning Heuristics, Branch and Bound, 0/1 Knapsack and Graph Coloring | **CO5** |
| | **Unit 5: Logical Reasoning & Critical Thinking Skills, RAG Applications/Advanced React State Management & Project Development Advanced Graph Algorithms (0-0-18-0 = 18 hrs)** | |

| | | |
|---|---|---|
| **A** | Critical Reasoning – Moderate to Advance, analytical thinking, logical interpretation, and reasoning strategies. | **CO4** |
| **B** | Statement & Conclusions, Statement & Assumptions, logical analysis, inference building, and argument evaluation. | **CO4** |
| **C** | Linear Sitting Arrangement, Circular Sitting Arrangement, Rectangular and Square Seating Arrangement, Inequalities (Reasoning), arrangement-based reasoning and logical problem-solving techniques. | **CO5** |
| **D** | Chatbots, AI Tutors, Creative Writing and Code Completion Systems **OR** Context API, createContext and useContext | **C06** |
| **E** | Retrieval-Augmented Generation, Embeddings and Vector Databases **OR** Redux Toolkit, Reducers, Store Management and ReduxDevTools | **CO4** |
| **F** | End-to-End LLM Project Design and AI Workflow Integration **OR** Performance Optimization, Lazy Loading, Deployment and Git Workflow | **CO6** |
| **G** | Bellman-Ford, SPFA and Negative Cycle Detection, Floyd-Warshall, Transitive Closure and Path Reconstruction | **CO4** |
| **H** | Tarjan's SCC, Articulation Points and Bridges, Max Flow, Edmonds-Karp, Bipartite Matching and Min-Cut | **CO5** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A – Elevator Pitch & Self Branding | ✔ | ✔ | ✔ | | | |
| 2 | 1.B – LinkedIn Profile Optimization | ✔ | ✔ | ✔ | | | ✔ |
| 3 | 1.C – HR Sensitization & Employability Readiness | ✔ | ✔ | ✔ | | | |
| 4 | 1.D – Generative AI Fundamentals / React Architecture | ✔ | ✔ | | ✔ | | |
| 5 | 1.E – Language Modeling / React Setup using Vite | ✔ | ✔ | ✔ | | | |
| 6 | 2.A – Managerial & Leadership Skills | | ✔ | ✔ | ✔ | | |
| 7 | 2.B – Transformer Architecture / React Components | ✔ | ✔ | ✔ | ✔ | | |
| 8 | 2.C – Dynamic Programming Fundamentals | ✔ | ✔ | ✔ | ✔ | ✔ | |
| 9 | 3.A – Public Speaking & Group Discussion | ✔ | ✔ | ✔ | ✔ | | |
| 10 | 3.B – Prompt Engineering / React Hooks | ✔ | ✔ | ✔ | ✔ | | |
| 11 | 3.C – OpenAI APIs, LangChain & Custom Hooks | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| 12 | 4.A – Quantitative Aptitude & Data Interpretation | ✔ | ✔ | ✔ | ✔ | ✔ | |
| 13 | 4.B – Fine-Tuning, Evaluation & Responsible AI | ✔ | ✔ | ✔ | ✔ | ✔ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | 4.C – Backtracking & Branch and Bound | ✔ | ✔ | ✔ | ✔ | ✔ | |
| 15 | 5.A – Critical Reasoning, RAG & Advanced Graph Algorithms | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

*ℹ Only strong/dominant alignments are mapped. Lab COs span all three domains — Cognitive (L3–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of lab and project work.*

| | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **L1** | **L2** | **L3** | **L4** | **L5** | **L6** | **A1** | **A2** | **A3** | **A4** | **A5** | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** | **P7** |
| **CO1** | ✔ | ✔ | | | | | | ✔ | ✔ | | | | | ✔ | ✔ | | | |
| **CO2** | | ✔ | ✔ | | | | | ✔ | ✔ | ✔ | | | | ✔ | ✔ | | | |
| **CO3** | | | ✔ | ✔ | | | | ✔ | ✔ | ✔ | ✔ | | | ✔ | ✔ | ✔ | | |
| **CO4** | | | ✔ | ✔ | ✔ | | | | ✔ | ✔ | ✔ | | | | ✔ | ✔ | ✔ | |
| **CO5** | | | | ✔ | ✔ | | | | ✔ | ✔ | ✔ | | | | ✔ | ✔ | ✔ | |
| **CO6** | | | ✔ | ✔ | ✔ | ✔ | | | | ✔ | ✔ | | | | ✔ | ✔ | ✔ | |

*Legend: ✓= Strong / Dominant mapping only.*

## 6. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs & Skill Dimensions Assessed |
|---|---|---|---|
| Continuous Assessment (CA) | 30% | 30 | CO1–CO6 \| Communication Skills \| Aptitude \| AI/React Activities \| Problem-Solving Exercises |
| Course Examination (CE) | 30% | 30 | CO1–CO6 \| Public Speaking \| Coding Skills \| APIs \| Dynamic Programming \| Practical + Viva |
| End Semester Examination (ESE) | 40% | 40 | CO1–CO6 \| Quantitative & Logical Reasoning \| Algorithm Design \| AI Workflows \| Frontend Development |
| **TOTAL** | **100%** | **100** | **All COs assessed across communication, reasoning, AI, React, and advanced problem-solving domains** |

## 7. Continuous Assessment (CA) — 30 Marks

### 7.1 Per-Experiment CA Rubric (3.0 Marks each)

| Criterion | Marks | Lab Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| Communication & Professional Participation | 1 | Public speaking, GD participation, LinkedIn/profile activities, HR interaction, teamwork | 1.0: Active & professional \| 0.5: Partial participation \| 0: Absent | CO1–CO3 |
| Technical Implementation & Problem Solving | 1 | React implementation, API usage, AI workflows, DP/Graph algorithms, coding exercises | 1.0: Correct & executable \| 0.5: Minor issues \| 0: Incomplete/incorrect | CO2–CO5 |
| Analysis, Documentation & Interpretation | 0.75 | Output interpretation, reasoning analysis, prompt evaluation, aptitude/problem-solving documentation | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO3–CO5 |
| Professional Ethics & Collaboration | 0.25 | Responsible AI practices, teamwork, constructive feedback, professional conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO6 |
| **Total** | **3** | **Communication, AI, React, Aptitude, Reasoning & Coding dimensions covered** | | **CO1–CO6** |

### 7.2 Best-N-of-15 Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| >10 | Best 10 | **30 Marks** | Best 10 of all sessions (3 marks × 10 = 30) |
| < 10 | All attended | **≤ 30 Marks** | Each missed session = zero; cannot be compensated |

## 8. Continuous Evaluation (CE) — 30 Marks

*ℹ CE is a mid-point practical/theoretical evaluation covering Units 1–3 (CO1–CO3). Advanced analytical, optimization, and project-oriented outcomes from CO4–CO6 are primarily assessed in ESE.*

| Section | Marks | Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Sec A | 10 | Communication Skills, Professional Branding, Prompting Fundamentals, React/AI Basics | CO1, CO2 | Activities based on elevator pitch, LinkedIn optimization, React setup, AI fundamentals, aptitude basics, or short implementation tasks |
| Sec B | 10 | Problem Solving, Dynamic Programming, APIs, Reasoning & Analysis | CO2, CO3 | Coding/problem-solving questions on DP, graph algorithms, prompt engineering, APIs, React hooks, reasoning or quantitative aptitude |
| Sec C (Viva) | 10 | Documentation, Analytical Interpretation, Professional Interaction | CO1–CO3 | Viva based on communication skills, AI workflows, React concepts, algorithm design, output interpretation, and practical activities |
| **TOTAL** | **30** | **Communication, AI, React, Aptitude, Reasoning & Coding Skills** | **CO1–CO3** | **Units 1–3 focused assessment. Higher-order evaluation and project integration assessed in ESE.** |

## 9. End Semester Examination (ESE) — 40 Marks

*ℹ ESE is comprehensive — all 5 units and all 6 COs are assessed. The examination evaluates communication proficiency, analytical reasoning, AI workflows, React/frontend development, aptitude, and advanced algorithmic problem-solving. Minimum 16/40 required to pass.*

| Section | Marks | Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| Sec A | 10 | Technical Implementation, Communication Skills, React/AI Fundamentals | CO1, CO2, CO4 | Short-answer/problem-solving questions on Generative AI, React fundamentals, aptitude, professional communication, DP basics, or frontend implementation |
| Sec B | 20 | Algorithm Analysis, Reasoning, APIs, Optimization & Output Interpretation | CO3, CO4, CO5 | Analytical and coding-based questions involving graph algorithms, DP, prompt engineering, API integration, reasoning, quantitative aptitude, and optimization analysis |
| Sec C | 10 | Design Thinking, Innovation, AI Workflow Integration & System Development | CO5, CO6 | Case-study/project-oriented questions involving AI-powered application design, React integration, RAG workflows, performance optimization, or scalable system design |
| **TOTAL** | **40** | **Communication, AI, React, Aptitude, Reasoning, Design & Advanced Problem-Solving Skills** | **CO1–CO6** | **Comprehensive assessment across all five units. Minimum 16/40 required to pass.** |

## 9.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (30) | CE (30) | ESE (40) | Skill Dimensions | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Recall fundamentals of communication, AI, React & optimization techniques | ✔ | ✔ | ✔ | Communication, AI Basics, Professional Skills | PO1, PO2, PO9 |
| CO2 | Explain leadership, AI workflows, React architecture & DP concepts | ✔ | ✔ | ✔ | Analytical Thinking, Leadership, Frontend Concepts | PO1, PO2, PO3 |
| CO3 | Apply employability skills, APIs, React workflows & algorithms | ✔ | ✔ | ✔ | Coding, APIs, Communication & Problem Solving | PO1, PO3, PO5 |
| CO4 | Analyze LSRW skills, transformer architectures & scalable systems | ✔ | — | ✔ | Reasoning, Analysis, Optimization & System Design | PO1, PO2, PO4 |
| CO5 | Evaluate aptitude, AI outputs & algorithmic efficiencies | ✔ | — | ✔ | Quantitative Aptitude, Evaluation & Performance Analysis | PO1, PO2, PO8, PO10 |
| CO6 | Create AI-powered applications & professional solutions | ✔ | — | ✔ | Innovation, Integration, Project Development & Deployment | PO1, PO3, PO10, PO11 |

⚠ *CO4, CO5, and CO6 are primarily assessed through CA activities and comprehensive ESE evaluation. CE focuses mainly on foundational and applied concepts from Units 1–3.*

**PART III COMBINED MAPPINGS & REFERENCE** *CO–PO Matrix, CO–PO Alignment, Bloom's Reference, Attendance & Pass/Fail*

# 10. CO–PO and CO–PSO Mapping Matrix

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | - | 2 | - | - | - | 2 | 3 | 2 | 2 | 2 | 1 |
| CO2 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | - | 3 | 3 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 3 | 3 | 2 | 3 | 1 | 1 | - | 3 | 3 | 2 | 3 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 3 |
| CO5 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 |
| CO6 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **Avg** | **2** | **2.83** | **2.5** | **2.2** | **2.5** | **1.4** | **1.6** | **1.75** | **2.67** | **2.83** | **2.5** | **2.67** | **2.83** | **2.33** |

## 11. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | M | | M | | | | M | H | M | M | M | |
| CO2 | M | H | M | | M | | | | H | H | M | H | H | M |
| CO3 | M | H | H | M | H | | | | H | H | M | H | H | H |
| CO4 | M | H | H | H | H | | M | M | H | M | H | H | H | H |
| CO5 | M | H | M | M | M | M | M | M | M | H | H | M | H | M |
| CO6 | M | H | H | H | H | M | M | H | H | H | H | H | H | H |

*H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment*

## 12. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>4 — Analyze: Break down information, examine patterns<br>5 — Evaluate: Judge, justify, assess, make decisions<br>6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend \n<br>A2 — Responding: Active participation and reaction \n<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

*ℹ OBE Compliance Statement: This is a lab-only course. All 6 COs span all three domains — Cognitive (L3–L6) as the primary domain, Psychomotor (P3–P6) for implementation and design skills, and Affective (A2–A4) for professional and collaborative conduct — reflecting the skill-based, hands-on nature of laboratory assessment.*

# 13. Attendance Policy & Pass/Fail Criteria

## 13.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Lab / Practical Sessions** | **75%** | All sessions | Debarred from ESE, if below threshold |

*⚠ Minimum 75% attendance is mandatory in practical/activity sessions. Non-submission of self-learning tasks, coding activities, analytical exercises, or communication assignments directly impacts internal assessment and is not compensable through external examination performance.*

## 13.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ESE Score** | **≥ 16 / 40** | **MANDATORY** | 40% of ESE marks required; failing ESE means failing the course regardless of CA + CE performance |
| **Overall Total (CA + CE + ESE)** | **≥ 40 / 100** | **Must pass overall** | CA 30 + CE 30 + ESE 40 = 100; 40% overall minimum required |

**SKP 3501 — COURSE PLAN — MEASUREMENT ARCHITECTURE**
11 ProgrammeOutcomes → 6 Lab COs (CO1–CO6) → 3 Assessment Instruments →
CO1–CO3: Apply/Analyse → LS1–LS3, LS6 → CA + CE + ESE
CO4–CO5: Analyse/Evaluate → LS3–LS5, LS7 → CA + ESE
CO6: Create → LS7–LS8 → CA + ESE Sec C
**Marks: CA 30 + CE 30 + ESE 40 = Total 100**

| School: SSCSE | | Batch: 2026-2030 | |
|---|---|---|---|
| Program: B.Tech. | | Current Academic Year: 2028-29 | |
| Branch: CSE-AIML | | Semester: V | |
| 1 | Course Code | **CSCR3600** | |
| 2 | Course Title | Project Based Learning (PBL) -3 (Hackathon Based) | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P-SL) | 0-0-4-3 | |
| 5 | Course Status | Compulsory | |
| 6 | Course Objective | 1. To align student's skill and interests with a realistic problem or project.<br>2. To understand the significance of problem and its scope.<br>3. Students will make decisions within a framework. | |
| 7 | Course Outcomes | Students will be able to:<br>CO1: Identify and formulate problem statement.<br>CO2: Design relational database schema.<br>CO3: Develop the solution by using different aspects of programming language.<br>CO4: Classify and understand various test techniques for verification and validation of project.<br>CO5: Analyze and make use of modern for solving real word problems.<br>CO6: Develop teamwork and need to engage in life-long learning, along with the ability to communicate effectively with others. | |
| 8 | Course Description | In PBL-3, the students will learn how to define the problem for developing projects, and Design applicable solutions in one or more application domains using software engineering approaches that integrate ethical, social, legal and economic concerns. | |
| 9 | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | Problem Definition and identification, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any. | CO1, CO4 |
| | **Unit 2** | Use of the relational algebra operations from mathematical set theory (union, intersection, difference, and Cartesian product) and the relational algebra operations developed specifically for relational databases (select (restrict), project, join, and division).. | CO2, CO6 |
| | **Unit 3** | Design; implement project work in any programming language. | CO3 |
| | **Unit 4** | Use of various test tools and techniques for software verification and validation of project | CO4, CO5 |

| | | | | |
|---|---|---|---|---|
| | **Unit 5** | Demonstrate and execute Project with the team. | | CO6 |
| | | Report should include Abstract, Hardware / Software Requirement, Problem Statement, Design/Algorithm, ER diagrams, Use Case Diagrams, State Diagrams, Sequence Diagrams, Communication Diagrams, and Activity Diagrams, Implementation Detail. Validation Reports. References, Test cases if any.<br>The presentation, report, work done during the term supported by the documentation, forms the basis of assessment. | | |
| | Mode of examination | Practical /Viva | | |
| | Weight age Distribution | CA | CE (Viva) | ESE |
| | | 30% | 30% | 40% |

**CO and PO Mapping**

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | CO1: Identify and formulate problem statement. | PO1, PO2, PSO1 |
| 2. | CO2: Design relational database schema. | PO1, PO2, PO3, PO5, PSO1, PSO2 |
| 3. | CO3: Develop the solution by using different aspects of programming language. | PO1, PO2, PO3, PO5, PSO1, PSO2 |
| 4. | CO4: Classify and understand various test techniques for verification and validation of project. | PO2, PO3, PO4, PO5, PSO1, PSO2 |
| 5. | CO5: Analyze and make use of modern for solving real word problems. | PO1, PO2, PO3, PO4, PO5, PO11, PSO1, PSO2 |
| 6. | CO6: Develop teamwork and need to engage in life-long learning, along with the ability to communicate effectively with others. | PO9, PO10, PO11 |

**PO and PSO mapping with level of strength for Course Name Project Based Learning -3 (Course Code CSP391)**

| COs \ POs/PSOs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 1 | 1 | – | – | – | – | – | 1 | 1 | 2 | – | – |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO2** | 2 | 2 | 3 | 1 | 2 | – | – | – | – | – | 1 | 3 | 2 | – |
| **CO3** | 2 | 2 | 3 | 1 | 3 | – | – | – | 1 | 1 | 1 | 3 | 2 | 1 |
| **CO4** | 1 | 3 | 2 | 3 | 2 | – | – | – | – | 1 | 1 | 2 | 2 | – |
| **CO5** | 2 | 3 | 2 | 2 | 3 | 1 | – | – | – | 1 | 2 | 3 | 2 | 1 |
| **CO6** | – | 1 | – | – | – | 1 | – | 1 | 3 | 3 | 3 | – | 1 | 1 |
| **Avg PO attained** | 1.8 | 2.3 | 2.2 | 1.6 | 2.5 | 1 | 0 | 1 | 2 | 1.4 | 1.5 | 2.6 | 1.8 | 1 |

**Strength of Correlation: 22.7**
**1.** Addressed to **Slight (Low=1) extent**
**2.** Addressed to **Moderate (Medium=2) extent**
**3.** Addressed to **Substantial (High=3) extent**

| | | |
|---|---|---|
| **School: SSCSE** | | **Batch: 2026-2030** |
| **Program: B Tech.** | | **Current Academic Year: 2028-29** |
| **Branch: CSE-AIML** | | **Semester: V** |
| 1 | Course Code | **CCP3001** |
| 2 | Course Title | Community Connect |
| 3 | Credits | 2 |
| 4 | Contact Hours (L-T-P-SL) | 0-0-4-0 |
| | Course Status | Compulsory |
| 5 | Course Objective | 1. The objective of assigning the project related to community work is to expose our students to different social issues faced by the people in different sections of society.<br>2. This type of project work will help the students to develop better understanding of problems of people living in disadvantage position in the society, may be socially, medically, economically, or otherwise.<br>3. This type of live project work will help our students to connect their class-room learning with practical issues/problems in the society. |
| 6 | Course Outcomes | Students will be able to:<br>1. **CO1: Students develop awareness** of the social, health, and environmental challenges faced by the community<br>2. **C02: Students are more appreciative** of socio-economic realities beyond textbooks and classrooms<br>3. **CO3: Students learn to apply their knowledge** through research, awareness creation, and services for community benefit<br>4. **CO4: Students are able to carry** out community-based projects with sincerity, teamwork and timely delivery<br>5. **CO5: Students learn to respectfully engage** with communities with purposive intent to contribute to society and sustainable development<br>6. **C06: Students are able to document and present** their community project findings in an academically robust manner |
| 7 | Course Description | In Community Connect projects, students will learn how to identify problems of rural and underprivileged communities by conducting surveys or will help the communities by providing services or solutions for the issues faced by them. |
| 8 | **Outline syllabus** | **CO Mapping** |
| | **Unit 1** | Team/Group formation and Project Assignment. Problem Definition & Finalizing the problem statement, Resource requirement, if any. — CO1, CO2 |
| | **Unit 2** | Develop a useful questionnaire or service to the community that will aid in achieving the objectives of the project. — CO2, CO3. CO4 |

| | | | |
|---|---|---|---|
| | **Unit 3** | Learn how to interact with the community members, whether in survey or service-based project – to help develop a more open mindset in the students. | CO3, CO4, CO5 |
| | **Unit 4** | Analysis of survey data and/or impact on the community members. | CO3, CO4 |
| | **Unit 5** | Demonstrate and justify their findings in light of the data they have gathered, or show the benefits to the community of the actions they have taken. | CO4, CO5, CO6 |
| | Mode of examination | Practical /Viva | |
| | Weight age Distribution | CA: 30% | CE: 30% / ESE: 40% |

**CO and PO Mapping**

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | **CO1: Students develop awareness** of the social, health, and environmental challenges faced by the community | PO6, PO7, PO8, PO11 |
| 2. | **C02: Students are more appreciative** of socio-economic realities beyond textbooks and classrooms | PO6, PO7, PO8, PO11 |
| 3. | **CO3: Students learn to apply their knowledge** through research, awareness creation, and services for community benefit | PO2, PO6, PO7, PO9, PO10, PO11 |
| 4. | **CO4: Students are able to carry** out community-based projects with sincerity, teamwork and timely delivery | PO9, PO10, PO11 |
| 5. | **CO5: Students learn to respectfully engage** with communities with purposive intent to contribute to society and sustainable development | PO6, PO7, PO8, PO9, PO11 |
| 6. | **CO6: Students are able to document and present** their community project findings in an academically robust manner | PO10, PO11 |

**PO and PSO mapping with level of strength for Course Name: Community Connect (Course Code CCP3001)**

| COs \ POs/PSOs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | – | 1 | – | – | – | 3 | 3 | 2 | 1 | 1 | 2 | – | – | – |
| **CO2** | – | 1 | – | – | – | 2 | 2 | 2 | 1 | 1 | 2 | – | – | – |
| **CO3** | 1 | 2 | 1 | 1 | – | 2 | 2 | 1 | 2 | 2 | 2 | – | 1 | – |
| **CO4** | – | 1 | 1 | – | – | 1 | 1 | 1 | 3 | 2 | 2 | – | – | – |
| **CO5** | – | 1 | – | – | – | 3 | 3 | 3 | 2 | 1 | 2 | – | – | – |
| **CO6** | 1 | 1 | – | 1 | – | – | – | 1 | 1 | 3 | 2 | – | – | 1 |
| **Avg PO attained** | 1 | 0.83 | 1 | 1 | 0 | 1.2 | 1.2 | 1 | 1.33 | 1.33 | 1.33 | 0 | 1 | 1 |

**Strength of Correlation: 13.22**
**1.** Addressed to **Slight (Low=1) extent**
**2.** Addressed to **Moderate (Medium=2) extent**
**3.** Addressed to **Substantial (High=3) extent**

| School: SSCSE | | Batch: 2026-2030 | | |
|---|---|---|---|---|
| Program: B Tech | | Current Academic Year: 2028-29 | | |
| Branch: CSE-AIML | | Semester: V | | |
| 1 | Course Code | CSCR3700 | Course Name: **Summer Internship-I** | |
| 2 | Course Title | **Summer Internship-I** | | |
| 3 | Credits | 2 | | |
| 4 | Contact Hours (L-T-P) | 0-0-0 | | |
| | Course Status | UG | | |
| 5 | Course Objective | 1. Experience the activities and functions of business professionals.<br>2. Develop and refine oral and written communication skills.<br>3. Identify areas for future knowledge and skill development. | | |
| 6 | Course Outcomes | Students will be able to:<br>• CO1. Integrate the concepts and strategies of academic study in a real time environment.<br>• CO2. Identify, formulate and model problems and find engineering solution based on a systems approach.<br>• CO3. Develop teamwork and apply prior acquired knowledge in problem solving.<br>• CO4. Develop communication, interpersonal and other critical skills required for career growth.<br>• CO5. Practice engineer's responsibilities, self-understanding, self-discipline and ethical standards.<br>• CO6. Explore career alternatives prior to graduation. | | |
| 7 | Course Description | An internship experience provides the student with an opportunity to explore career interests while applying knowledge and skills learned in the classroom in a work setting. The experience also helps students gain a clearer sense of what they still need to learn and provides an opportunity to build professional networks. | | |
| 8 | Outline syllabus | | | CO Mapping |
| | **Unit 1** | Define objectives and conditions for the internship, ensuring students that it is related to the study path carried out at the University | | **CO1, CO2** |
| | **Unit 2** | Problem Definition and identification, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any. | | **CO2** |
| | **Unit 3** | The internship work plan is drawn up by developing team work and applies prior acquired knowledge in problem solving. | | **CO3** |
| | **Unit 4** | Demonstrate and execute Project with the team. Submission of evaluation form and final report completed by the intern. | | **CO4** |

| | | | | | |
|---|---|---|---|---|---|
| | **Unit 5** | Final evaluation form completed by the supervisor at the Host Organization and final presentation before departmental committee. | | | **CO5,CO6** |
| | Mode of examination | Practical | | | |
| | Weightage Distribution | CA | CE (Viva) | ETE | |
| | | 30% | 30% | 40% | |
| | Text book/s* | NA | | | |
| | Other References | NA | | | |

**CO and PO Mapping**

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | CO1. Integrate the concepts and strategies of academic study in a real time environment. | PO1, PO2, PO4, PO5, PO7, PO8, PO9, PSO1, PSO2, PSO3 |
| 2. | CO2. Identify, formulate and model problems and find engineering solution based on a systems approach. | PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO9, PSO1, PSO2 |
| 3. | CO3. Develop teamwork and apply prior acquired knowledge in problem solving. | PO1, PO3, PO4, PO5, PO8, PO9, PO11, PSO1, PSO2, PSO3 |
| 4. | CO4. Develop communication, interpersonal and other critical skills required for career growth. | PO8, PO10 |
| 5. | CO5. Practice engineer's responsibilities, self-understanding, self-discipline and ethical standards. | PO6, PO8 |
| 6. | CO6. Explore career alternatives prior to graduation. | PSO1, PSO2 |

**PO and PSO mapping with level of strength for Course Name Summer Internship-I (CSCR3700)**

| Cos | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | - | 3 | 2 | 1 | 1 | 1 | - | - | - | 1 | 2 | 2 |
| CO2 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | - | - | - | 1 | 2 | - |
| CO3 | 2 | - | 2 | 2 | 2 | - | 1 | 3 | - | 1 | 1 | 1 | 2 | 2 |
| CO4 | - | - | - | - | - | - | 1 | - | 3 | - | - | - | - | - |
| CO5 | - | - | - | - | - | 2 | 3 | - | - | - | - | - | - | - |
| CO6 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 | - |
| Avg PO attained | 1 | 0.7 | 0.5 | 1.2 | 1 | 0.3 | 1.2 | 1 | 1 | 0 | 1 | 1 | 1.3 | 0.7 |

***Strength of Correlation***

*1.* Addressed to ***Slight (Low=1) extent*** *2.* Addressed to ***Moderate (Medium=2) extent***
*3.* Addressed to ***Substantial (High=3) extent***

| Semester 6, Credits: 23 | |
|---|---|
| **COURSE CODE** | **COURSE NAME** |
| CSAI3103 | Deep Learning and Its Applications |
| CSAI3101 | Computer Vision & Pattern Recognition |
| CSAI3303 | Data Analytics (Using Visualization Tools) |
| CSAI3*** & CSOT3*** | Program Elective-3 |
| SKP3601 | Skills&Informatics-4: Strategic Professionalism and Computational Informatics |
| BST3351 | Management for Engineers |
| CSCR3601 | Project Based Learning (PBL) -4 (Product Based) |
| CSCR30** | Open Elective – 1 |

**Syllabus: CSAI3103, Deep Leaning and its Applications**

| | | |
|---|---|---|
| **School: SSCSE** | | **Batch : 2026-2030** |
| **Program: B.Tech.** | | **Current Academic Year: 2028-29** |
| **Branch: CSE-AIML** | | **Semester: VI** |
| **1** | **Course Code** | CSAI3103 |
| **2** | **Course Title** | Deep Leaning and its Applications |
| **3** | **Credits** | 3 |
| **4** | **Contact Hours (L-T-P-SL)** | 3-0-0-3 |
| | **Course Status** | CORE |
| **5** | **Course Objective** | This course aims to present the mathematical, statistical and computational challenges of building stable representations for high-dimensional data, such as images, text and data. We will delve into selected topics of Deep Learning, discussing recent models from both supervised and unsupervised learning. Special emphasis will be on convolutional architectures, invariance learning, unsupervised learning and non-convex optimization.To understand and demonstrate how to solve general learning from a large series of data using computer based deep learning algorithms |
| **6** | **Course Outcomes (CO's)** | Upon successful completion of the course, students will be able to:<br>CO-1. Recall Neural Networks relate it with Deep Learning concepts to solve real life applications<br>CO-2. Compare and classify Regularization approaches for Deep Learning.<br>CO-3. Build Convolutional Neural Networks models for image analysis and its applicability in societal problem solving.<br>CO-4. Examine the Sequence models and analyse the relationships among them.<br>CO-5. Assess the different Deep learning models based on their design processes.<br>CO-6. Predict the behaviour of Deep learning models and apply them to solve real life applications. |
| **7** | **Course Description** | This course starts with introduction to Deep Learning and further build, train, and deploy real world applications such as object recognition and Computer Vision, image and video processing, text analytics, Natural Language Processing, recommender systems, and other types of classifiers. |

**8 Teaching and Learning Scheme (in Hours per Semester)**

| Classroom Instructions (CI) | | Lab Instruction s (LI) | Team Work (TW) and Self Learning (SL) (TW+SL) | Total number of Hours | Total Credits TH/30 |
|---|---|---|---|---|---|
| L | T | P | SL | TH | |
| 45 | 0 | 0 | 45 | 90 | 3 |

| **9** | **Syllabus Outline** | | **CO Mapping** |
|---|---|---|---|
| | **Unit 1** | **Deep Feed forward Networks** | |
| | **A** | Recall Neural networks, Deep learning and its Practical aspects for real life applications ,Introduction to Simple Deep Neural Networks, Platform for Deep Learning, Deep Learning Software Libraries | CO1, CO6 |

| | | | |
|---|---|---|---|
| | **B** | Introduction to Deep Feed Forward Networks ,Learning XOR, Gradient-Based Learning, Activation Functions, ReLU, Softmax, Sigmoid , Error Functions | CO1 |
| | **C** | Architecture Design- Hidden Units Back-Propagation and Other Differentiation Algorithms | CO1 |
| | **Unit 2** | **Regularization for Deep Learning** | |
| | **A** | Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Multitask Learning, Early Stopping, Parameter Tying and Parameter Sharing, Bagging , Drop Out, Difficulty of training deep neural networks, Greedy layer wise training, Adversarial Training | CO2 |
| | **B** | How Learning Differs from Pure Optimization, Challenges in Neural Network Optimization,<br>Basic Algorithms: Stochastic Gradient Descent, Momentum, Nesterov Momentum<br>Parameter Initialization Strategies<br>Algorithms with Adaptive Learning Rates, AdaGrad. RMSProp. Adam | CO2 |
| | **C** | Introduction to Autoencoder, Undercomplete Autoencoder, Regularized Autoencoders, Representational Power, Layer Size and Depth. Stochastic Encoders and Decoders, Applications of Encoder Decoder models | CO2 |
| | **Unit 3** | **Convolutional Neural Networks** | |
| | **A** | Why CNN?, Its role, significance and applicability in societal problem solving , The Convolution Operation, Motivation, Pooling, The Neuroscientific Basis for Convolutional Networks | CO1, CO3, CO6 |
| | **B** | Prior probability distribution, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data types with different dimensionalities and number of channel | CO1, CO3 |
| | **C** | Efficient Convolution Algorithms, Random or Unsupervised Features of CNN , Normalization, Applications of CNN in Computer Vision – ImageNet | CO1, CO3, CO6 |
| | **Unit 4** | **Sequence Modeling: Recurrent Neural Networks** | |
| | **A** | Sequence Learning Problems , Recurrent Neural Network and its significance in real world, RNN model, Backpropagation through time ,Bidirectional RNNs | CO4, CO6 |
| | **B** | Different types of RNNs, Gated Recurrent Unit (GRU) Recursive Neural Networks , The Challenge of Long-Term Dependencies | CO4 |
| | **C** | Introduction of Long Short Term Memory Neural Networks, Learning Algorithm of LSTM/ RNN Bidirectional LSTMs | CO4 |
| | **Unit 5** | **Deep Networks and design process** | |
| | **A** | Introduction to Generative Adversarial Networks , Generative Adversarial Networks – Architecture, | CO5,CO6 |
| | **B** | DCGAN, GAN hack, Applications of Generative Adversarial Networks | CO5,CO6 |
| | **C** | Practical design process for deep learning techniques based on real world problems: | CO5,CO6 |

| | | | |
|---|---|---|---|
| | | Performance Metrics , Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyperparameters, Debugging Strategies | |

| 10 | **List of activities for Self Learning (SL)** | **S. No.** | **Name of the Activity** | **No. of Hours** | **Evaluation Criteria** |
|---|---|---|---|---|---|
| | | 1 | Study and implementation of Deep Neural Networks, activation functions, and regularization techniques (Unit 1 & 2) | 12 | Concept clarity, implementation accuracy, comparative analysis |
| | | 2 | Design and development of Convolutional Neural Network (CNN) for image classification with real-world application study (Unit 3) | 11 | Model performance, architecture design, application relevance |
| | | 3 | Implementation and analysis of Sequence Models (RNN, LSTM, GRU) for prediction problems (Unit 4) | 11 | Correct implementation, comparison, output quality |
| | | 4 | Mini Project: Design a complete Deep Learning solution using GAN/CNN/RNN including model tuning and performance evaluation (Unit 5) | 11 | Innovation, end-to-end implementation, report and presentation |

| | | | | |
|---|---|---|---|---|
| | **Mode of examination** | Theory | | |
| | **Weightage Distribution** | CA | MTE | ETE |
| | | 25% | 15% | 60% |
| | **Text Books** | **1.** Deep Learning, by Goodfellow I., Bengio Y. & Courville A. (2016)<br>**2.** Visualizing and Understanding Convolutional Networks, by Matt Zeiler, Rob Fergus<br>**3.** TensorFlow: a system for large-scale machine learning, by Martín A., Paul B., Jianmin C., Zhifeng C., Andy D. et al. (2019) | | |
| | **Reference Books** | 1. Deep learning in neural networks, by JuergenSchmidhuber (2015)<br>2. Deep Learning: A Practitioner's Approach by Josh Patterson, Oreilly. | | |
| | **Online Materials** | https://towardsdatascience.com/september-edition-machine-learning-case-studies-a3a61dc94f23 | | |

**PO and PSO mapping with level of strength for Course Name: Introduction to Deep Leaning (Course Code- CSAI3103)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | Engineering Knowledge | Problem Analysis | Design/Development of Solutions | Conduct Investigations of Complex Problems | Engineering Tool Usage | The Engineer and The World | Ethics | Individual and Collaborative Team work | Communication | Project Management and Finance | Life-Long Learning | Familiarity and practical proficiency | Understand, analyze and develop | Apply standard Software |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | 2 | 2 | 2 | 1 |
| **CO 2** | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 2 |
| **CO 3** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 1 | 3 | 2 | 2 |
| **CO 4** | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | 1 | 1 | 1 | 2 |
| **CO 5** | 3 | 2 | 2 | 2 | 2 | - | - | - | - | - | 1 | 1 | 1 | 2 |
| **CO 6** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 2 | 3 | 3 | 3 |

**Average of non-zeros entry in following table (should be auto calculated).**

| Course Code/ Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineering Knowledge | Problem Analysis | Design/Development of Solutions | Conduct Investigations of Complex Problems | Engineering Tool Usage | The Engineer and The World | Ethics | Individual and Collaborative Team work | Communication | Project Management and Finance | Life-Long Learning | Familiarity and practical proficiency | Understand, analyze and develop | Apply standard Software |
| **CSAI3103/ Introduction to Deep Leaning** | 2.67 | 2.17 | 2.40 | 2.40 | 2.20 | - | - | - | - | - | 1.33 | 1.83 | 1.67 | 2.00 |

**Strength of Correlation**

**1.** Addressed to **Slight (Low=1) extent**
**2.** Addressed to **Moderate (Medium=2) extent**
**3.** Addressed to **Substantial (High=3) extent**

**Course-to-SDG Matrix**

The Course-to-SDG (Sustainable Development Goals) matrix for the subject *CSAI3103: Deep Learning and its Applications* highlights the alignment of course outcomes with global sustainability objectives by integrating advanced computational techniques to address real-world challenges. The course contributes significantly to SDG 4 (Quality Education) by equipping students with cutting-edge knowledge in deep learning, fostering innovation and research skills. It supports SDG 9 (Industry, Innovation, and Infrastructure) through the development of intelligent systems for automation, predictive analytics, and smart technologies. Additionally, applications of deep learning in climate modeling, healthcare diagnostics, and resource optimization align with SDG 3 (Good Health and Well-being) and SDG 13 (Climate Action). By encouraging ethical AI practices and responsible data usage, the course also indirectly contributes to SDG 16 (Peace, Justice, and Strong Institutions). Overall, the subject empowers students to apply deep learning methodologies for sustainable development and societal benefit.

Mapping uses a 3-point scale:

- Addressed to ***Substantial (High=3)*** ***extent***: Core content directly contributes
- Addressed to ***Moderate (Medium=2)*** ***extent***: Supports through skills/activities
- Addressed to ***Slight (Low=1)*** ***extent***: Indirect awareness/benefit

| SDG Goal | Description | Mapping Strength | Justification |
|---|---|---|---|
| **SDG 4** | Quality Education | 3 (High) | The course builds strong knowledge in deep learning concepts, enhancing analytical and computational skills in modern AI technologies. |
| **SDG 8** | Decent Work and Economic Growth | 3 (High) | Students develop industry-ready skills in deep learning, improving employability and contributing to economic growth. |
| **SDG 9** | Industry, Innovation and Infrastructure | 3 (High) | The course promotes development of intelligent systems such as CNNs, RNNs, and GANs, supporting innovation and digital infrastructure. |
| **SDG 16** | Peace, Justice and Strong Institutions | 2 (Moderate) | Deep learning applications are used responsibly in areas like data analysis and decision-making, supporting ethical AI practices. |

Total Mapped SDGs: 4 out of 17.

# COURSE PLAN

## Computer Vision & Pattern Recognition (CSAI3101)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VI | Batch 2024–2028*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026-2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028-29 |
| **Branch:** | CSE-AIML | **Semester:** | VI |
| **Course Code:** | CSAI3101 | **Course Type:** | Core — Theory Only |

## 2. Course Details

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI3101 |
| 2 | **Course Title** | **Computer Vision & Pattern Recognition** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 30 hrs Classroom + 30 hrs Self Learning = 60 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |

| | | |
|---|---|---|
| 6 | **Course Objectives** | 1. Introduce the fundamental concepts and techniques of Computer Vision and Pattern Recognition.<br>2. Develop understanding of image processing, feature extraction, and object representation methods.<br>3. Enable the design and analysis of algorithms for image classification, segmentation, and recognition tasks.<br>4. Develop the ability to implement Computer Vision models and evaluate their performance in real-world applications. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>**CO1 (Understand – L1/L2):** Identify the challenges and understand the fundamental concepts, applications, and components of Computer Vision and Pattern Recognition systems.<br>**CO2 (Explore – L2/L3):** Explore image representation, image enhancement, filtering, feature extraction, and feature selection techniques used in Computer Vision.<br>**CO3 (Apply – L3):** Apply image processing and pattern recognition algorithms for object detection, image classification, segmentation, and recognition tasks.<br>**CO4 (Analyze – L4/L5):** Analyze and evaluate different machine learning and deep learning approaches used in Computer Vision applications.<br>**CO5 (Analyze – L4/L5):** Analyze various feature matching, clustering, and classification techniques for efficient pattern recognition and decision-making systems.<br>**CO6 (Analyze – L2/L4):** Understand and analyze real-world applications of Computer Vision such as face recognition, medical image analysis, autonomous systems, and surveillance systems. |
| 8 | **Course Description** | This course introduces the fundamental concepts and techniques of Computer Vision and Pattern Recognition, focusing on image processing, feature extraction, object detection, image classification, and recognition methods. It also covers machine learning and deep learning approaches for analyzing visual data and developing intelligent vision-based applications. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 30 hrs \| Self Learning (SL): 30 hrs \| Total: 60 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Digital Image Processing and Computer Vision"Cengage Learning, 1st Edition, 2008<br>2. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill. |
| 12 | **References** | 1, Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.<br>2. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992.<br>3. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982. |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Introduction to Computer Vision & Pattern Recognition** | |
| **A** | Introduction to Computer Vision and Pattern Recognition; Applications and Challenges; Human Vision vs Computer Vision | **CO1** |
| **B** | Digital Images and Image Representation; Pixels, Resolution, Color Models (RGB, Gray Scale) | **CO1** |
| **C** | Basics of Pattern Recognition; Types of Patterns; Recognition Systems and Applications | **CO1** |
| | **Unit 2: Image Processing Fundamentals** | |
| **A** | Image Enhancement Techniques: Contrast Stretching, Histogram Equalization, Noise Removal | **CO1, CO2** |
| **B** | Image Filtering: Mean Filter, Median Filter, Edge Detection Basics | **CO1, CO2** |
| **C** | Image Transformation Basics: Thresholding, Morphological Operations, Segmentation Introduction | **CO1, CO2** |
| | **Unit 3: Feature Extraction & Pattern Analysis** | |
| **A** | Feature Extraction Concepts; Shape, Color, and Texture Features | **CO1, CO2** |
| **B** | Feature Matching and Similarity Measures; Distance Metrics | **CO1, CO2, CO3, CO4** |
| **C** | Basics of Pattern Classification; Supervised and Unsupervised Learning | **CO1, CO2, CO3, CO4** |
| | **Unit 4: Object Detection & Recognition** | |
| **A** | Object Detection Fundamentals; Face Detection and Recognition Basics | **CO1, CO2, CO3, CO5** |
| **B** | Image Classification Techniques; K-Nearest Neighbor (KNN), Decision Trees | **CO1, CO2, CO3, CO5** |
| **C** | Introduction to Deep Learning in Vision; Basics of CNN and Transfer Learning | **CO1, CO2, CO3, CO5** |
| | **Unit 5: Applications of Computer Vision** | |

| | | |
|---|---|---|
| A | Medical Image Analysis and Disease Detection Applications | CO1, CO2, CO3, CO6 |
| B | Applications in Autonomous Vehicles, Surveillance, and Smart Systems | CO1, CO2, CO3, CO4, CO6 |
| C | Case Studies and Mini Projects in Computer Vision & Pattern Recognition | CO1, CO2, CO3, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | | | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | ✓ | ✓ | ✓ | | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | ✓ | | | | | ✓ | | | | |
| CO4 | | | | ✓ | ✓ | | | | | ✓ | | | | ✓ | | | | |
| CO5 | | | | ✓ | ✓ | | | | ✓ | | | | | ✓ | ✓ | | | |
| CO6 | | ✓ | | ✓ | | | | ✓ | | | | | | | ✓ | | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Computer Vision and Pattern Recognition; Applications and Challenges | UNIT-1 | 4 |
| DD/MM/YY | Human Vision vs Computer Vision; Digital Image Fundamentals | | |
| DD/MM/YY | Image Representation: Pixels, Resolution, Gray Scale and RGB Images | | |
| DD/MM/YY | Basics of Pattern Recognition; Recognition Systems and Applications | | |
| DD/MM/YY | Image Enhancement Techniques: Contrast Stretching and Histogram Equalization | UNIT-2 | 6 |
| DD/MM/YY | Noise Removal Techniques and Image Smoothing Filters | | |
| DD/MM/YY | Image Filtering: Mean, Median and Gaussian Filters | | |
| DD/MM/YY | Edge Detection Basics: Sobel, Prewitt and Canny Operators | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Thresholding and Morphological Operations | | |
| DD/MM/YY | Introduction to Image Segmentation Techniques | | |
| DD/MM/YY | Feature Extraction Concepts; Shape, Color and Texture Features | UNIT-3 | 8 |
| DD/MM/YY | Feature Matching and Similarity Measures | | |
| DD/MM/YY | Distance Metrics and Feature Selection Techniques | | |
| DD/MM/YY | Basics of Pattern Classification; Supervised Learning | | |
| DD/MM/YY | Unsupervised Learning and Clustering Techniques | | |
| DD/MM/YY | K-Nearest Neighbor (KNN) Classification Algorithm | | |
| DD/MM/YY | Decision Trees and Classification Performance Measures | | |
| DD/MM/YY | Case Studies on Pattern Recognition Applications | | |
| DD/MM/YY | Object Detection Fundamentals and Applications | UNIT-4 | 6 |
| DD/MM/YY | Face Detection and Face Recognition Techniques | | |
| DD/MM/YY | Image Classification using Traditional Machine Learning Techniques | | |
| DD/MM/YY | Introduction to Deep Learning and Neural Networks | | |
| DD/MM/YY | Basics of Convolutional Neural Networks (CNNs) | | |
| DD/MM/YY | Transfer Learning Concepts and Pre-trained Models | | |
| DD/MM/YY | Medical Image Analysis and Disease Detection Applications | UNIT-5 | 6 |
| DD/MM/YY | Applications in Autonomous Vehicles and Smart Surveillance | | |
| DD/MM/YY | Object Tracking and Activity Recognition Basics | | |
| DD/MM/YY | Computer Vision Applications in Robotics and Industry | | |
| DD/MM/YY | Mini Project Discussion and Real-World Case Studies | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Revision and Problem Solving Session | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Conceptual Recall & Vision Fundamentals | Recall fundamental concepts of Computer Vision and Pattern Recognition; identify image components, vision systems, and applications | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | Image Processing & Feature Interpretation | Explain image enhancement, filtering, segmentation, and feature extraction techniques; interpret processed image outputs | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | Algorithmic Application & Classification | Apply classification and pattern recognition algorithms such as KNN, clustering, and feature matching techniques to solve problems | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | Vision System Analysis & Performance Evaluation | Analyze the effectiveness of object detection, image classification, and deep learning approaches; compare performance measures | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |

| | | | | |
|---|---|---|---|---|
| **TS5** | Recognition System Analysis & Evaluation | Analyze feature selection, clustering, and recognition models; evaluate classification accuracy and efficiency | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | Real-World Vision Application Evaluation | Analyze real-world Computer Vision applications such as medical imaging, surveillance, autonomous systems, and robotics | CO6 \| L2–L4 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Process Interpretation | TS3 Algorithmic Application | TS4 Performance Evaluation | TS5 Memory System Analysis | TS6 File & Disk Evaluation |
|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | | | | |
| **CO2** | **M** | **H** | **M** | | | |
| **CO3** | | **M** | **H** | **M** | | |
| **CO4** | | | **M** | **H** | **M** | |
| **CO5** | | | | **M** | **H** | **M** |
| **CO6** | | **M** | | **M** | **M** | **H** |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |

| | | | | |
|---|---|---|---|---|
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| **Real-World Case Study (Report)** | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Introduction to Computer Vision, applications, image representation, color models | CO1 | TS1 | 5h SL | Report submission + evaluation |
| **Assignment 2** | Image enhancement, filtering, edge detection, segmentation techniques | CO2 | TS2 | 5h SL | Numerical problems on process management |
| **Assignment 3** | Feature extraction, feature matching, similarity measures, classification basics | CO2, CO3 | TS2, TS3 | 5h SL | Numerical computation + comparison |
| **Assignment 4** | KNN classification, clustering, object detection and recognition problems | CO3, CO4 | TS3, TS4 | 5h SL | Step-by-step numerical trace required |
| **Assignment 5** | CNN basics, transfer learning, image classification models | CO3, CO4, CO5 | TS3, TS4, TS5 | 5h SL | Algorithm application + performance analysis |
| **Video Learning Report** | Technical video on Computer Vision applications (medical imaging, surveillance, autonomous systems); self-learning presentation | CO2, CO3 | TS2, TS3 | 9h SL | Report: learning outcomes, key concepts, self-reflection. Presentation: 10 min |
| **Case Study Report** | Real-world Computer Vision case study (e.g., face recognition, autonomous vehicles, smart surveillance, medical diagnosis) | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Technical depth, data collection, fact finding, comparative analysis |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **10** | TS1 — Conceptual Recall & OS Identification TS2 — Conceptual Explanation & Process Interpretation | **CO1, CO2** | Short-answer: define OS types, explain process states, IPC mechanisms, describe semaphore working, identify scheduling criteria |
| **Section B** | **15** | TS3 — Algorithmic Application TS4 — Algorithmic Analysis & Performance Evaluation | **CO2, CO3, CO4** | Numerical problems: compute Gantt charts, CPU utilization, waiting/turnaround time; apply Banker's Algorithm; compare scheduling algorithms on performance criteria |
| **TOTAL** | **25** | TS1–TS4 | **CO1–CO4** | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1 — Conceptual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions (all units): definitions, OS type identification, process state diagrams, IPC mechanisms, synchronization concepts |
| **Section B** | **25** | TS3 — Algorithmic Application TS4 — Performance Evaluation TS5 — Memory System Analysis | **CO3, CO4, CO5** | Medium questions: scheduling algorithm numericals, deadlock handling, paging/segmentation calculations, page replacement algorithm traces, performance comparisons |
| **Section C** | **10** | TS5 — Memory System Analysis TS6 — File & Disk Management Evaluation | **CO5, CO6** | Long/evaluation questions: virtual memory analysis, thrashing, disk scheduling comparisons (FCFS/SSTF/SCAN/C-SCAN), file system design, Windows OS case study analysis |
| **TOTAL** | **50** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Identify the challenges and understand the fundamental concepts, applications, and components of Computer Vision and Pattern Recognition systems. | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| **CO2** | Explore image representation, image enhancement, filtering, feature extraction, and feature selection techniques used in Computer Vision. | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| **CO3** | Apply image processing and pattern recognition algorithms for object detection, image classification, segmentation, and recognition tasks. | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Analyze and evaluate different machine learning and deep learning approaches used in Computer Vision applications. | ✓ | ✓ | ✓ | TS4 | PO9, PO10, PO11 |
| **CO5** | Analyze various feature matching, clustering, and classification techniques for efficient pattern recognition and decision-making systems. | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Understand and analyze real-world applications of Computer Vision such as face recognition, medical image analysis, autonomous systems, and surveillance systems. | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

## COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | 1 | | | | | | | 3 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | | | | | | | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 2 | | | | 1 | | | 3 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 3 | 3 | | | | 1 | 1 | | 3 | 3 | 2 |
| CO5 | 2 | 3 | 2 | 3 | 3 | | | | | 1 | | 3 | 3 | 2 |
| CO6 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | | 1 | 1 | | 2 | 3 | 2 |
| **Avg** | **2.5** | **2.67** | **2.4** | **2.6** | **2.17** | **1** | **1** | | **1** | **1** | | **2.83** | **2.83** | **2.5** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | H | H | | | | M | M | M | M | H | M | M |
| CO2 | H | M | H | H | | | | M | M | M | M | M | H | M |
| CO3 | H | H | H | H | | | | M | M | M | H | H | M | M |
| CO4 | M | M | M | M | M | | | M | H | H | H | M | M | M |
| CO5 | M | M | H | | | | | H | H | M | M | H | | |
| CO6 | H | M | | | | | | | | M | H | M | M | |

## 14. Self-Learning Activities (SL: 30 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 1 | **Numerical Assignment Writing (5 assignments, problem-based, one per unit focus area)** | 5 assignments × 3 hrs each<br>Total = 15 hrs | CO1–CO4 TS1–TS4 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance |
| 2 | **Technical Video-Based Learning related to the subject (e.g., OS scheduling, deadlock, memory management)** | Video viewing: 3 hrs<br>Report preparation: 3 hrs<br>Presentation: 3 hrs<br>Total = 9 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, algorithms, and personal reflections |
| 3 | **Real-World Case Studies (e.g., Linux/Windows OS internals, Android memory management, cloud OS design)** | Data collection/study: 4 hrs<br>Report preparation: 2 hrs<br>Total = 6 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, and analytical conclusions drawn |
| | **TOTAL Self-Learning Hours** | **30 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**CSE 254 — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks

# COURSE PLAN

## Data Analytics (Using Visualization Tools) ( CSAI3303)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester I | Batch 2026–2030*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | VI |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI3303 |
| 2 | **Course Title** | **Data Analytics (Using Visualization Tools)** |
| 3 | **Credits** | 4 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-2-2 |
| 5 | **Course Status** | Core |
| 6 | **Course Objective** | To equip students with the knowledge and practical skills required to analyze, interpret, and present data effectively using modern visualization tools. The course focuses on transforming raw data into meaningful insights through data preparation, analysis, and interactive visualizations, enabling informed decision-making in business and research environments. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:**<br>CO1 (Remember – L1): Define and recall the fundamental concepts of data analytics, data visualization, business intelligence, and data-driven decision-making. |

| | | |
|---|---|---|
| | | CO2 (Understand – L2): Explain the data analytics lifecycle, data preprocessing techniques, and principles of effective data visualization and visual storytelling.<br>CO3 (Apply – L3): Apply statistical and analytical techniques to transform data into meaningful information and select appropriate visualization methods for different data types.<br>CO4 (Analyze – L4): Analyze datasets to identify trends, patterns, relationships, and anomalies using analytical and visualization approaches.<br>CO5 (Evaluate – L5): Evaluate the effectiveness of various visualization techniques, dashboard designs, and analytical models in supporting business and organizational decisions.<br>CO6 (Create – L6): Design comprehensive data analytics solutions and visualization frameworks to solve real-world problems and communicate actionable insights to stakeholders.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Import, clean, transform, and prepare datasets for analysis using tools such as Microsoft Excel, Power Query, and Power BI.<br>CO8 (Create – L5/L6): Create effective data visualizations, including charts, graphs, maps, and dashboards, using Power BI, Tableau, and Microsoft Excel to represent analytical results.<br>CO9 (Apply – L2/L3): Perform exploratory data analysis to identify trends, patterns, correlations, and key performance indicators using Power BI, Tableau, and Python (Pandas & Matplotlib).<br>CO10 (Apply – L3): Design and deploy interactive dashboards and business intelligence reports using Power BI and Tableau, and communicate actionable insights for data-driven decision-making. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 60 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | 1. Minimum 15 visualization tasks/dashboards covering charts, KPIs, filters, drill-downs, and interactive report— 15 coding problems minimum. 2. Virtual Labs (NPTEL): Data Analytics and Data Visualization experiments. 3. MOOC course on Data Analytics/Data Visualization (SWAYAM/Coursera) topics such as Data Analytics, Business Intelligence, Power BI, Tableau, or Data Visualization. |
| 11 | **References** | Data Analytics Made Accessible by Anil Maheshwari, McGraw Hill & Storytelling with Data by Cole Nussbaumer Knaflic, Wiley, Practical Tableau by Ryan Sleeper, O'Reilly, Microsoft Power BI Cookbook by Brett Powell, Packt Publishing |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction to Data Analytics (4-0-10-6 = 20 hrs)** | |
| **A** | Overview of data analytics, analytics lifecycle, types of analytics Basics of Big Data, Types of Analytics (Descriptive, Diagnostic, Predictive, Prescriptive). | CO1, CO2 |
| **B** | Data collection, data sources, data quality and preprocessing | |
| **C** | Introduction to visualization tools and business intelligence concepts. The role of vision in understanding data, Cognitive load, and Gestalt Principles. | |

| | | |
|---|---|---|
| **Tools Used** | Microsoft Excel , Power BI Desktop , Tableau Public/Desktop Google Looker Studio | |
| **Activities** | **Objective:** To understand the fundamentals of data analytics, analytics lifecycle, data sources, data quality, and the role of visualization in extracting meaningful insights from data.<br>• Identify and classify different types of analytics: Descriptive, Diagnostic, Predictive, and Prescriptive.<br>• Explore various sources of structured and unstructured data used in analytics applications.<br>• Analyze issues related to data quality and preprocessing requirements.<br>• Study the importance of data visualization in decision-making and business intelligence.<br>• Apply Gestalt Principles and cognitive load concepts to evaluate visual representations of data.<br>• Compare features and capabilities of popular visualization tools such as Power BI and Tableau.<br>• Interpret business scenarios and identify appropriate analytics approaches. | |
| **Unit 2** | **Data Preparation & Modeling (6-0-12-6 = 24 hrs)** | |
| **A** | Data cleaning and transformation techniques, Handling missing values, outliers, and data blending. | CO2, CO3 |
| **B** | Descriptive statistics and correlation analysis, Data Connection: Connecting to various data sources (Excel, SQL, Cloud). | |
| **C** | Data Modeling: Understanding schemas (Star and Snowflake), Joins vs. Blending. | |
| **Tools Used** | Microsoft Excel (Power Query) , Power BI , Tableau , SQL(MySQL/PostgreSQL) | |
| **Activities** | **Objective:** To understand data preparation techniques, statistical analysis methods, and data modeling concepts required for effective analytics.<br>• Apply data cleaning techniques to handle missing values, duplicate records, and outliers.<br>• Perform data transformation and blending operations on datasets from multiple sources.<br>• Calculate and interpret descriptive statistical measures for business datasets.<br>• Analyze relationships among variables using correlation techniques. | |

| | | |
|---|---|---|
| | • Connect visualization tools with various data sources such as Excel, SQL databases, and cloud platforms.<br>• Design Star Schema and Snowflake Schema models for analytical applications.<br>• Compare joins and data blending techniques for integrating data from multiple sources. | |
| **Unit 3** | **Functions & Arrays (8-0-16-6 = 30 hrs)** | |
| **A** | Visualization techniques using charts, graphs, and plots. Charts: Bar charts, Line graphs, Scatter plots, Heat maps, and Treemaps. | CO2, CO3, CO4, CO5 |
| **B** | Advanced Visuals: Pareto charts, Box plots, and Waterfall charts. | |
| **C** | Filters & Parameters: Using dynamic filters and calculated fields. | |
| **Tools Used** | Power BI, Tableau, Microsoft Excel (Power Query) | |
| **Activities** | **Objective:** To understand and apply various visualization techniques for representing data effectively and generating actionable insights. | |
| **Unit 4** | **Pointers & Strings (6-0-12-6 = 24 hrs)** | |
| **A** | Introduction to Tableau and Power BI, Creating dashboards, filters, and interactive reports | CO4, CO6 |
| **B** | Design Principles: Layout, Color theory, and Typography in Dashboards, Creating a logical flow from data to insight. | |
| **C** | Storytelling with data visualization, Interactivity: Actions, Tooltips, and Drill-down capabilities. | |
| **Tools Used** | Power BI ,Tableau , Canva (for dashboard mockups) | |
| **Activities** | **Objective:** To understand dashboard design principles and develop interactive reports that communicate insights through effective storytelling.<br>• Design interactive dashboards using Power BI and Tableau.<br>• Apply principles of layout design, color theory, and typography in dashboard development.<br>• Create meaningful KPIs and performance indicators for business reporting.<br>• Implement drill-down, drill-through, and tooltip functionalities in dashboards.<br>• Develop visual stories that communicate analytical findings effectively. | |

| | | |
|---|---|---|
| | • Analyze user requirements and design dashboards to support decision-making.<br>• Evaluate dashboard usability and presentation quality using industry best practices. | |
| **Unit 5** | **User-Defined Data Types & File Handling (6-0-10-6 = 22 hrs)** | |
| **A** | Tool-Specific Skills: DAX (Power BI) and Calculated Fields (Tableau), Creating map-based visualizations and spatial analysis. | CO4, CO5, CO6 |
| **B** | Sharing reports and managing workspace permissions. Avoiding misleading scales, data privacy, and bias in visualization. Augmented Analytics, AI in BI tools, and Real-time data streaming visuals. | |
| **C** | Business analytics and decision support systems. Healthcare, finance, and social media analytics. Case studies and industry applications of visualization tools | |
| **Tools Used** | Power BI (DAX) , Tableau (Calculated Fields) , Excel , Power BI Service | |
| **Activities** | **Objective:** To understand advanced visualization features, business intelligence concepts, and real-world applications of data analytics.<br>• Create calculated fields and DAX measures for advanced analytical reporting.<br>• Develop map-based visualizations and perform spatial data analysis.<br>• Publish, share, and manage reports using Power BI Service and Tableau platforms.<br>• Analyze ethical issues related to data privacy, bias, and misleading visualizations.<br>• Explore the role of AI and augmented analytics in modern business intelligence tools.<br>• Evaluate business analytics solutions across healthcare, finance, and social media domains.<br>• Design an end-to-end analytics solution and present actionable insights through interactive dashboards and reports. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | ✓ | | | |
| 3 | 1.C | ✓ | ✓ | ✓ | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | 2.A | | ✓ | ✓ | ✓ | | |
| 5 | 2.B | | ✓ | ✓ | ✓ | | |
| 6 | 2.C | | ✓ | ✓ | ✓ | | |
| 7 | 3.A | | ✓ | ✓ | ✓ | | |
| 8 | 3.B | | ✓ | ✓ | ✓ | ✓ | |
| 9 | 3.C | | ✓ | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | ✓ | ✓ | | ✓ |
| 11 | 4.B | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 12 | 4.C | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 13 | 5.A | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 14 | 5.B | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 15 | 5.C | | ✓ | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | ✓ | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | ✓ | | | | | ✓ | | | | | |
| CO4 | | | | ✓ | | | | ✓ | | | | | | ✓ | | | | |
| CO5 | | | | | ✓ | | | | ✓ | | | | ✓ | | | | | |
| CO6 | | | | | | ✓ | | | ✓ | | | | ✓ | ✓ | | | | |
| CO7 | | | ✓ | ✓ | | | | | ✓ | | | ✓ | ✓ | | | | | |
| CO8 | | ✓ | | | ✓ | | | | | ✓ | | | | | | | | |
| CO9 | | | | ✓ | | ✓ | | | ✓ | ✓ | | | ✓ | ✓ | | | | |
| CO10 | | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | ✓ | | |

*Legend: ✓ = Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Overview of data analytics, analytics lifecycle, types of analytics | UNIT-1 | 5 |
| DD/MM/YY | Basics of Big Data, Types of Analytics (Descriptive, Diagnostic, Predictive, Prescriptive). | | |
| DD/MM/YY | Data collection, data sources, data quality and preprocessing | | |
| DD/MM/YY | Introduction to visualization tools and business intelligence concepts. | | |
| DD/MM/YY | . The role of vision in understanding data, Cognitive load, and Gestalt Principles | | |
| DD/MM/YY | Data cleaning and transformation techniques | UNIT-2 | 5 |
| DD/MM/YY | Handling missing values, outliers, and data blending. | | |
| DD/MM/YY | Descriptive statistics and correlation analysis | | |
| DD/MM/YY | Data Connection: Connecting to various data sources (Excel, SQL, Cloud). | | |
| DD/MM/YY | Data Modeling: Understanding schemas (Star and Snowflake), Joins vs. Blending. | | |
| DD/MM/YY | Visualization techniques using charts, graphs, and plots. | UNIT-3 | 5 |
| DD/MM/YY | Charts: Bar charts, Line graphs, Scatter plots | | |
| DD/MM/YY | Heat maps, and Treemaps | | |
| DD/MM/YY | Advanced Visuals: Pareto charts, Box plots, and Waterfall charts. | | |
| DD/MM/YY | Filters & Parameters: Using dynamic filters and calculated fields. | | |
| DD/MM/YY | Introduction to Tableau and Power BI | UNIT-4 | 7 |
| DD/MM/YY | Power BI: Microsoft's Analytics Tool, Key Elements, Core Features | | |
| DD/MM/YY | Creating dashboards, filters, and interactive reports | | |
| DD/MM/YY | Design Principles: Layout, Color theory, and Typography in Dashboards, | | |
| DD/MM/YY | Creating a logical flow from data to insight. | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Storytelling with data visualization | | |
| DD/MM/YY | Interactivity: Actions, Tooltips, and Drill-down capabilities. | | |
| DD/MM/YY | Tool-Specific Skills: DAX (Power BI) and Calculated Fields (Tableau), | UNIT-5 | 8 |
| DD/MM/YY | Creating map-based visualizations and spatial analysis. | | |
| DD/MM/YY | Sharing reports and managing workspace permissions | | |
| DD/MM/YY | Avoiding misleading scales, data privacy, and bias in visualization. Augmented Analytics. | | |
| DD/MM/YY | AI in BI tools, and Real-time data streaming visuals. | | |
| DD/MM/YY | Business analytics and decision support systems. | | |
| DD/MM/YY | Healthcare, finance, and social media analytics. | | |
| DD/MM/YY | Case studies and industry applications of visualization tools | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Introduction to Power BI/Tableau Interface and Data Import | CO7 | 3.0 |
| | S-1.2 | Connecting Excel Data Sources and Basic Visualization Creation | CO7 | |
| W2 | S-2.1 | Data Cleaning and Transformation using Power Query | CO7 | 3.0 |
| | S-2.2 | Handling Missing Values and Data Formatting using Excel | CO7 | |
| W3 | S-3.1 | Creating Bar Charts and Column Charts using Power BI and Tableau | CO7 | 3.0 |
| | S-3.2 | Creating Line Charts and Area Charts with Power BI and Tableau | CO7 | |
| W4 | S-4.1 | Designing Pie Charts and Donut Charts | CO7 | 3.0 |
| | S-4.2 | Creating Scatter Plots and Bubble Charts | CO7 | |
| W5 | S-5.1 | Building Interactive Dashboards using Multiple Visuals | CO7 | 3.0 |
| | S-5.2 | Using Slicers and Filters for Dynamic Reporting | CO7 | |
| | S-6.1 | Creating KPI Cards and Summary Visualizations | CO7 | |

| | | | | |
|---|---|---|---|---|
| **W6** | S-6.2 | Developing Drill-Down and Drill-Through Reports | **CO7** | 3.0 |
| **W7** | S-7.1 | Implementing Calculated Fields and Measures | **CO7** | 3.0 |
| | S-7.2 | Introduction to DAX Functions in Power BI(DAX) | **CO7** | |
| **W8** | S-8.1 | Correlation Analysis using Scatter Visualizations | **CO7** | 3.0 |
| | S-8.2 | Exploratory Data Analysis and Visual Reporting | **CO7** | |
| **W9** | S-9.1 | Creating Heat Maps and Treemaps using Tableau | **CO7** | 3.0 |
| | S-9.2 | Advanced Visualizations: Waterfall and Funnel Charts | **CO7** | |
| **W10** | S-10.1 | Geospatial Analysis using Map Visualizations | **CO7** | 3.0 |
| | S-10.2 | Location-Based Analytics and Interactive Maps | **CO7** | |
| **W11** | S-11.1 | Dashboard Formatting and Design Principles | **CO7** | 3.0 |
| | S-11.2 | Applying Color Theory and Visual Storytelling Concepts with canva | **CO7** | |
| **W12** | S-12.1 | Publishing Dashboards and Sharing Reports | **CO7** | 3.0 |
| | S-12.2 | Workspace Management and Report Collaboration | **CO7** | |
| **W13** | S-13.1 | Case Study: Sales/Marketing Dashboard Development | **CO8** | 3.0 |
| | S-13.2 | Business Insight Generation and KPI Analysis | **CO8** | |
| **W14** | S-14.1 | Mini Project Phase-I: Dashboard Design and Data Modeling | **CO8/CO9** | 3.0 |
| | S-14.2 | Mini Project Phase-II: Interactive Report Development | **CO8/CO10** | |
| **W15** | S-15.1 | Mini Project Demonstration and Presentation | **CO8/CO9** | 3.0 |
| | S-15.2 | Final Project Evaluation and Documentation | **CO9/CO10** | |

ℹ *Instructions: Write the Dataset Used, Procedure/Steps, Tool(s) Used, Visualizations Created, for every BI program.. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

📘 **THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Fundamental Knowledge of Data Analytics** | Understanding of analytics concepts, Big Data, BI fundamentals, and visualization principles | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| **TS2** | **Data Preparation & Processing Skills** | Ability to preprocess, clean, transform, and model data for analysis | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| **TS3** | **Visualization & Analytical Tool Usage** | Application of charts, graphs, filters, parameters, and visualization techniques using BI tools | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| **TS4** | **Dashboard Design & Interactive Reporting** | Analysis and creation of dashboards, storytelling, interactivity, and report design principles | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | **Business Intelligence & Decision Support** | Evaluation of insights using DAX, spatial analytics, AI in BI tools, and real-time visualization | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | **Industry Applications & Advanced Analytics** | Understanding and analysis of real-world analytics applications in healthcare, finance, and social media | CO6 \| L2–L4 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| **Sec A** | **4** | TS1- Fundamental Knowledge of Data Analytics & BI Concepts,TS2- Data Preparation, Processing & Interpretation Skills | **CO1, CO2** | Short answer and conceptual questions covering fundamentals of data analytics, BI concepts, preprocessing, and data preparation. Focus on understanding and basic interpretations. |
| **Sec B** | **6** | TS3- Visualization & BI Tool Application Skills,TS4- Dashboard Design, Storytelling & Interactive Analytics | **CO2, CO3, CO4** | Analytical and application-oriented questions involving visualization techniques, dashboard design, data modeling, filters, and interactive reporting. |
| **TOTAL** | **10** | TS1–TS4 | **CO1–CO4** | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Sec A** | **25** | TS1- Fundamental Knowledge of Data Analytics & BI Concepts,TS2- Data Preparation, Processing & Interpretation Skills | **CO1, CO2** | Short-answer and conceptual questions covering fundamentals of data analytics, preprocessing, BI concepts, and visualization principles. Focus on understanding and interpretation |
| **Sec B** | **50** | TS3- Visualization & BI Tool Application Skills,TS4- Dashboard Design, Storytelling & Interactive Analytics,TS5- Analytical Evaluation & Decision Support Skills | **CO3, CO4, CO5** | Application-based and analytical questions on visualization techniques, dashboard design, storytelling, Tableau/Power BI implementation, DAX, and AI-assisted BI tools. |
| **Sec C** | **25** | TS5- Analytical Evaluation & Decision Support Skills,TS6- Industry Application & Advanced Analytics Evaluation | **CO5, CO6** | Case-study and evaluation-oriented questions involving business analytics applications, real-time streaming visuals, ethics, privacy, and industry-specific decision support systems. |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria<br>CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **Problem Identification & Data Understanding** | **1.5** | P1 — Identification of a real-world analytics problem<br>P2 — Understanding dataset characteristics and business requirements. | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |

| | | | | |
|---|---|---|---|---|
| | | P4 — Selection of appropriate analytical and visualization approach | | |
| **Project Planning & Resource Management** | **1.5** | P2 — Project planning, milestones, and workflow design<br>P11 — Resource utilization, software/tool selection, and feasibility analysis | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **Data Preparation & Dashboard Implementation** | **2.0** | P5 — Effective use of Power BI/Tableau/Excel tools<br>P6 — Data cleaning, transformation, modeling, and dashboard development<br>P7 — Functional implementation and testing of reports/dashboards | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Analytics, Insights & Reporting** | **2.0** | P8 — Insight generation and outcome measurement<br>P9 — Statistical analysis, visualization quality, and technical documentation | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Dashboard Presentation & Communication** | **2.0** | P3 — Visualization design strategy and storytelling<br>P10 — Professional dashboard presentation, report quality, and demonstration | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |
| **Reflection, Ethics & Professional Conduct** | **1.0** | P12 — Reflection on learning outcomes and skill development<br>P13 — Ethical use of data, privacy considerations, and professional conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define the analytics problem, identify business objectives, KPIs, dataset attributes, and measurable success criteria | CO7,C08 |
| CA2 | **Experimental Design & Tool Setup** | Plan the analytics workflow; configure Power BI, Tableau, Excel, SQL connections, and data sources | CO7 |
| CA3 | **Code Implementation & Execution** | Create dashboards, reports, charts, calculated fields, filters, and interactive visualizations to meet requirements | CO7 |
| CA4 | **Computational Efficiency & Optimization** | valuate dashboard usability, visualization effectiveness, performance, and propose improvements | CO7,CO8 |
| CA5 | **Output Analysis & Result Interpretation** | Analyze trends, patterns, correlations, and KPIs; interpret results and derive actionable insights | CO8 |
| CA6 | **Documented Outcome with Verification** | Prepare complete experiment documentation with methodology, screenshots, observations, and validate results against objectives | CO7,CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Develop dashboard layouts, KPI frameworks, visual storytelling plans, and justify visualization choices before implementation | CO7,CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records and demonstrate conceptual understanding of data analytics, visualization principles, and tools during viva | CO7,C09 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | SDG Alignment & Social Relevance | Map the analytics project to relevant SDGs; demonstrate societal, business, or organizational impact through data-driven insights | CO8 \| PO6 |
| P2 | Problem Scoping & Requirements | Define business problem, stakeholders, KPIs, dataset requirements, project scope, and measurable objectives | CO8 \| PO2 |
| P3 | Communication & Testing Strategy | Develop a communication plan, dashboard review strategy, testing approach, and coordinate team activities | CO10 \| PO9 |
| P4 | Innovative Solution Proposal | Propose suitable analytics and visualization solutions; compare alternatives and justify the selected approach | CO8 \| PO3 |
| P5 | Professional Toolchain | Select and justify Power BI, Tableau, Excel, SQL, or other BI tools; configure data connections and workspace environment | CO7 \| PO5 |
| P6 | End-to-End Implementation | Develop a complete analytics solution including data preparation, modeling, visualization, and dashboard deployment | CO7, CO8 \| PO3 |
| P7 | System Commissioning & Testing | Validate calculations, KPIs, filters, interactivity, and dashboard functionality using test scenarios | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform trend analysis, comparative studies, insight generation, and prepare a structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver dashboard demonstrations, present findings effectively, and exhibit collaborative teamwork and role allocation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document learning outcomes, skill enhancement in analytics tools, and individual project contributions | CO9 \| PO11 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate ethical data usage, privacy awareness, avoidance of misleading visualizations, and professional conduct | CO9 \| PO7 |

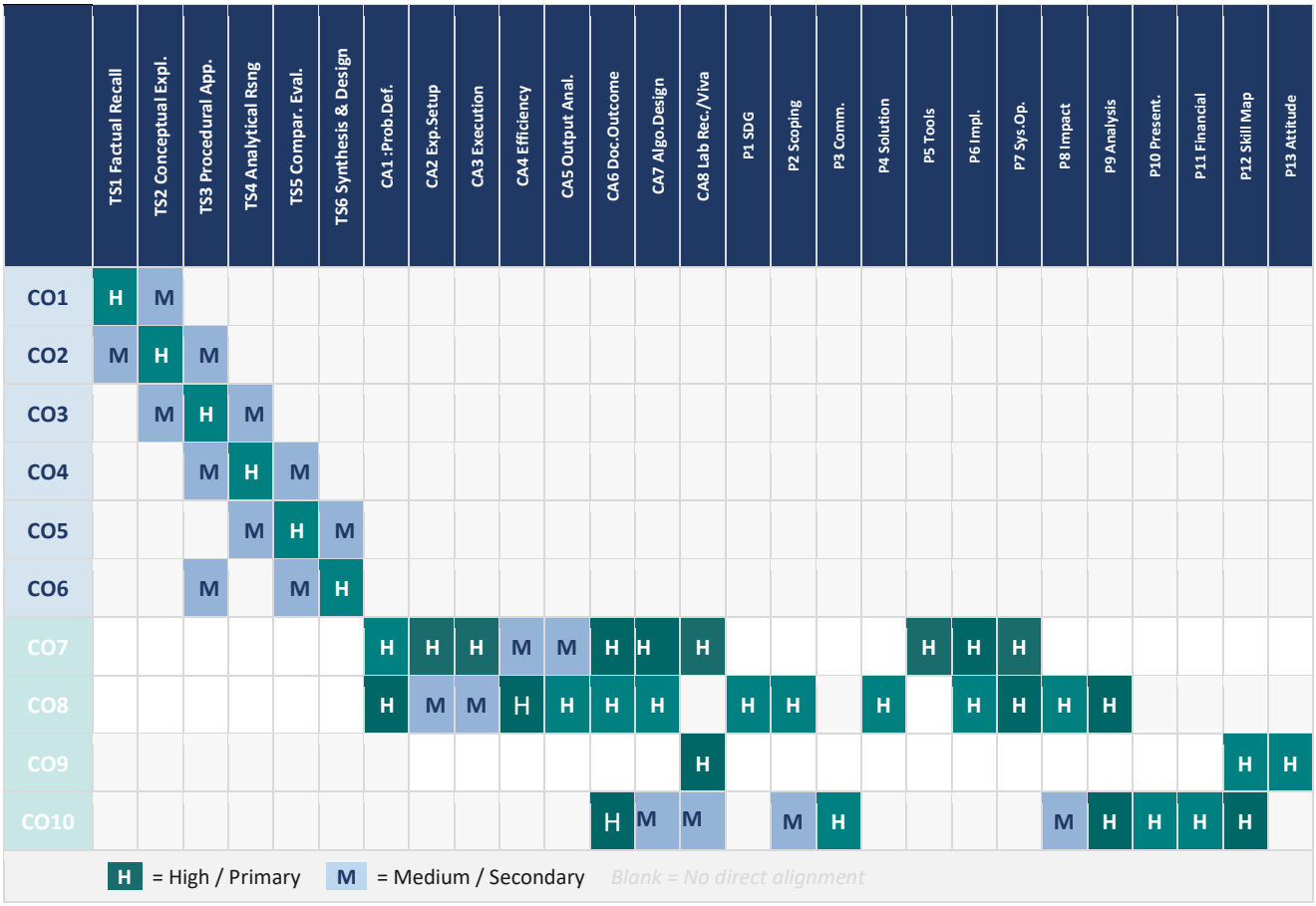
## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | CA Skill Dimensions | Project Skill Dimensions |
|---|---|---|---|




PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | – | – | – | – | – | – | – | – | 1 | 2 | 1 | – |
| CO2 | 3 | 2 | – | – | – | – | – | – | 1 | – | 2 | 2 | 2 | – |
| CO3 | 2 | 3 | 2 | – | 2 | 1 | – | – | 1 | – | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 2 | 1 | – | – | – | – | 2 | 2 | 3 | 2 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 2 | 3 | 3 | 2 | 2 | 1 | – | – | – | – | 2 | 2 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 2 | – | 1 | 1 | 1 | 3 | 3 | 3 | 3 |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 2 | 3 | 2 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | 1 | 2 | – | 3 | – | 1 | 2 |
| CO10 | – | – | 2 | – | 1 | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| **Avg** | **2.33** | **2.29** | **2.29** | **2.00** | **2.13** | **1.43** | **3.00** | **1.67** | **1.60`** | **2.00** | **2.13** | **2.22** | **2.30** | **2.38** |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |
| CO2 | H | M | | | | | | | M | | |
| CO3 | M | H | M | | M | M | | | M | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | M | H | | H |
| CO10 | | | M | | M | | H | H | H | M | M |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds strong foundation in computational thinking and structured programming; aligned with lifelong learning (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant programming and professional tool skills (CO7) directly applicable to employment in technology sectors. |

| | | | |
|---|---|---|---|
| **SDG 9** | **Industry, Innovation & Infrastructure** | **3 (High)** | Enables development of efficient software solutions; business intelligence systems, fosters innovation through real-world application design (CO6, CO8) and team-based projects (CO10). |
| **SDG 12** | **Responsible Consumption & Production** | **2 (Moderate)** | Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**PPS INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Data Pipeline (CSAI3304)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VI | Batch 2025–2029*

*Integrated Course Plan — Theory COs (CO1–CO6) + Lab COs (CO7–CO10) | New AICTE 11-PO Framework | Full Skill Mapping*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture/Lab Plans*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE–AIML | **Semester:** | VI |

## 2. Course Details

★ *Integrated theory + laboratory model. 10 COs in two tiers: Theory COs (CO1–CO6) via MTE + ETE; Lab COs (CO7–CO10) via Laboratory Assessment only. No cross-evaluation.*

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI3304 |
| 2 | **Course Title** | **Data Pipeline** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 2-0-4-2 |
| 5 | **Course Status** | Program Elective-3 |
| 6 | **Course Objective** | To equip students with foundational and advanced knowledge of data pipeline components and architecture. To enable practical skills in designing, developing, and managing data ingestion, transformation, and storage workflows. To train students in using industry-standard tools such as Apache Kafka, Apache Spark, Airflow, and cloud platforms. To foster understanding of data quality, security, and ethical aspects in data engineering. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, the student will be able to:**<br>**THEORY COs — Assessed via MTE + ETE:** |

| | | |
|---|---|---|
| | | CO1 (Remember – L1): Recall the fundamental architecture, components, types, and use cases of data pipelines.<br>CO2 (Understand – L2): Explain data ingestion strategies, tools (Kafka, NiFi), and source types used in pipeline design.<br>CO3 (Apply – L3): Develop data processing and transformation pipelines using ETL/ELT frameworks such as Apache Spark and Beam.<br>CO4 (Analyze – L4): Analyze and implement pipeline orchestration, scheduling, DAG design, and failure-handling using Apache Airflow.<br>CO5 (Evaluate – L5): Evaluate and optimize pipeline performance, data quality, monitoring strategies, and scalability trade-offs.<br>CO6 (Create – L6): Design and document end-to-end data pipeline solutions applying industry best practices for security, governance, and compliance.<br>**LAB COs — Assessed via Laboratory Assessment only:**<br>CO7 (Apply – L3): Implement data pipeline components using professional tools (Python, Kafka CLI, Airflow UI, Spark); configure experimental environments; demonstrate pipeline operation; maintain structured lab records.<br>CO8 (Create – L5/L6): Design and develop modular, real-world data pipeline solutions addressing societal or industry problems; evaluate pipeline outcomes analytically with SDG alignment.<br>CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible data engineering practices; perform skill self-assessment; reflect on learning for lifelong professional growth.<br>CO10 (Apply – L3): Collaborate and communicate effectively in team-oriented lab activities; plan, implement, and present data pipeline solutions; apply project management principles. |
| 8 | **Teaching & Learning** | Classroom Instructions (CI) 30 hrs + Lab Instructions (LI) 60 hrs + Self Learning (SL) 30 hrs = 120 hrs |
| 9 | **Mode of Examination** | Lab (40 marks) + MTE (10 marks) + ETE (50 marks) = 100 marks. Theory COs: MTE + ETE only. Lab COs: Lab only. |
| 10 | **Self Learning (SL: 30 hrs)** | 1. Practical exercises on Apache Kafka, Spark, and Airflow via official documentation and sandboxes. 2. Virtual Labs (NPTEL): Data Engineering experiments. 3. MOOC course on Data Engineering / Big Data (SWAYAM/Coursera/edX). |
| 11 | **References** | Textbook: James Densmore — Data Pipelines Pocket Reference, O'Reilly. Reference: Sev Leonord — Cost-Effective Data Pipelines, O'Reilly. Reference: Penikalapati & Mangaonkar — Data Engineering for AI/ML Pipelines, O'Reilly. |

## 3. Outline Syllabus — Theory Units with CO Mapping (CO1–CO6)

ℹ *Unit CO mappings refer to Theory COs (CO1–CO6) only. Lab experiments reinforce these units but are assessed under Lab COs (CO7–CO10).*

| | Topic / Activity | CO Mapping |
|---|---|---|
| **Unit 1** | **Introduction to Data Pipelines (4-0-10-6 = 20 hrs)** | |
| **A** | Definition, architecture, and use cases of data pipelines | CO1, CO6 |
| **B** | Components: ingestion, processing, storage, serving | |
| **C** | Types: batch vs streaming pipelines; Lambda and Kappa architectures | |
| **Tools Used** | Whiteboard, draw.io / Lucidchart, Python (basic), Linux CLI, Reference datasets | |

| | | |
|---|---|---|
| | | |
| **Activities** | **Objective:** To familiarize students with the fundamental concepts, architecture, and types of data pipelines.<br>Explore real-world data pipeline diagrams and identify components.<br>Compare batch and streaming pipelines using case studies (e.g., ETL nightly jobs vs. Kafka-based real-time feeds).<br>Illustrate data flow from source to serving layer using architectural diagrams.<br>Discuss Lambda and Kappa architectures with examples. | |
| **Unit 2** | **Data Ingestion Techniques (4-0-10-6 = 20 hrs)** | |
| **A** | Data ingestion challenges and strategies (push vs pull, micro-batch) | CO1, CO2, CO6 |
| **B** | Tools: Apache Kafka, Apache NiFi, AWS Glue, Debezium | |
| **C** | Source types: relational databases, flat files, REST APIs, message queues | |
| **Tools Used** | Apache Kafka (CLI + Python kafka-python), Apache NiFi (demo), Python requests library, PostgreSQL | |
| **Activities** | **Objective:** To understand and implement various data ingestion strategies using industry-standard tools.<br>Produce and consume messages using Apache Kafka CLI and Python.<br>Compare push vs pull ingestion models with example scenarios.<br>Ingest data from a REST API into a local data store using Python.<br>Explore NiFi flow designer for no-code ingestion pipeline creation.<br>Discuss Change Data Capture (CDC) with Debezium use case. | |
| **Unit 3** | **Data Processing and Transformation (6-0-14-6 = 26 hrs)** | |
| **A** | ETL vs ELT concepts; when to use each approach | CO2, CO3, CO6 |
| **B** | Data transformations: filtering, enrichment, aggregation, deduplication | |
| **C** | Frameworks: Apache Spark (PySpark), Apache Flink, Apache Beam; Python Pandas pipelines | |
| **Tools Used** | Apache Spark (PySpark), Apache Beam, Python Pandas, Jupyter Notebook, Google Colab | |
| **Activities** | **Objective:** To develop practical data processing and transformation pipelines using modern frameworks.<br>Implement ETL pipeline using Python Pandas: read CSV, transform, write to output.<br>Run PySpark transformations on a sample dataset (filter, groupBy, join).<br>Compare ETL vs ELT with a real data warehouse use case (e.g., BigQuery/Redshift).<br>Build an Apache Beam pipeline for batch word-count and analyze the runner abstraction.<br>Implement data deduplication and enrichment logic in PySpark. | |
| **Unit 4** | **Pipeline Orchestration and Scheduling (6-0-14-6 = 26 hrs)** | |

| | | |
|---|---|---|
| **A** | Workflow orchestration basics; need for orchestration in data engineering | CO3CO4, CO5 |
| **B** | Apache Airflow: introduction, architecture, DAGs, Operators, XComs | |
| **C** | Failure handling, retries, SLAs, alerting, backfilling, monitoring dashboards | |
| **Tools Used** | Apache Airflow (local Docker setup), Python, Cron, Airflow UI, Slack/email alerting (demo) | |
| **Activities** | **Objective:** To design and implement orchestrated, scheduled pipeline workflows using Apache Airflow.<br>Install Airflow via Docker and explore the UI: DAG view, task logs, Gantt.<br>Write a simple DAG with BashOperator and PythonOperator tasks.<br>Implement a multi-task DAG with dependencies, retries, and SLA miss alerts.<br>Demonstrate DAG parameterization and scheduling (cron expressions).<br>Discuss XComs for inter-task data sharing with hands-on exercise.<br>Simulate pipeline failure and observe retry and alerting behavior. | |
| **Unit 5** | **Pipeline Optimization, Monitoring, and Real-World Applications (6-0-12-6 = 24 hrs)** | |
| **A** | Scaling and performance tuning: partitioning, parallelism, resource management | CO5, CO6 |
| **B** | Data quality testing and validation: Great Expectations, custom checks, data contracts | |
| **C** | Case studies: end-to-end pipelines at industry scale; best practices for security, governance, compliance | |
| **Tools Used** | Great Expectations, Apache Spark tuning tools, Grafana/Prometheus (demo), cloud pipeline case studies | |
| **Activities** | **Objective:** To optimize, monitor, validate, and evaluate data pipelines using industry-grade tools and practices.<br>• Profile a slow PySpark job; apply partitioning and caching optimizations.<br>• Write Great Expectations test suites for a sample dataset (null checks, range checks, schema validation).<br>• Explore a Grafana dashboard for pipeline monitoring (pre-built demo environment).<br>• Analyze a real-world pipeline case study (e.g., Airbnb's data platform, Uber's Michelangelo).<br>• Discuss data security best practices: encryption, RBAC, data masking, audit logging.<br>• Implement a simple data contract and validate incoming data against it. | |

## 4. Topic-wise Bloom's Taxonomy Level Mapping (Theory)

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | | ✓ | ✓ | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | | ✓ | ✓ | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | ✓ | | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | | ✓ | ✓ | ✓ | ✓ |
| 14 | 5.B | | | ✓ | ✓ | ✓ | |
| 15 | 5.C | | | ✓ | | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains (Updated for 10 COs)

ℹ *Only strong/dominant alignments are mapped. Lab COs (CO7–CO10) extend into Psychomotor and Affective domains, reflecting the skill-based nature of lab and project work.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | | | | | | | | | | | ✓ | | | | |
| CO4 | | | | ✓ | | | | | | | | | | | ✓ | | | |
| CO5 | | | | | ✓ | | | | | | | | | | | ✓ | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | | | | | | ✓ | | | ✓ | | | | | | | ✓ | ✓ | |
| CO7 | | | ✓ | | | | | ✓ | | | | | | ✓ | ✓ | | | |
| CO8 | | | | | ✓ | ✓ | | | ✓ | | | | | | ✓ | ✓ | ✓ | |
| CO9 | | | ✓ | | | | | | | ✓ | ✓ | | | | | | | |
| CO10 | | | ✓ | | | | | ✓ | | | ✓ | | | ✓ | | | | |

*Legend: ✓ = Strong / Dominant mapping only. Theory COs: primarily Cognitive. Lab COs: span all three domains.*

## 6. Lecture Plan Outline (Theory — 30 Lectures)

| Date | Topics to be Covered | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Definition, architecture, use cases of data pipelines; pipeline lifecycle | Unit 1 | 4 |
| DD/MM/YY | Components: ingestion, processing, storage, serving layers | | |
| DD/MM/YY | Types: batch pipelines; Lambda architecture | | |
| DD/MM/YY | Streaming pipelines; Kappa architecture; comparison | | |
| DD/MM/YY | Data ingestion challenges: latency, throughput, schema evolution | Unit 2 | 6 |
| DD/MM/YY | Ingestion strategies: push vs pull, micro-batch, change data capture | | |
| DD/MM/YY | Apache Kafka: architecture, producers, consumers, topics, partitions | | |
| DD/MM/YY | Apache NiFi; source types: databases, flat files, REST APIs | | |
| DD/MM/YY | ETL vs ELT: concepts, trade-offs, when to apply each | | |
| DD/MM/YY | Data transformations: filtering, enrichment, aggregation | | |
| DD/MM/YY | Deduplication; data normalization and standardization | Unit 3 | 8 |
| DD/MM/YY | Introduction to Apache Spark; RDDs vs DataFrames | | |
| DD/MM/YY | PySpark transformations and actions; lazy evaluation | | |
| DD/MM/YY | Apache Beam overview; portability and runner abstraction | | |
| DD/MM/YY | Workflow orchestration: need, concepts, DAG definition | | |
| DD/MM/YY | Apache Airflow architecture: Scheduler, Executor, Workers | | |
| DD/MM/YY | Writing DAGs: Operators (Bash, Python, Sensor), dependencies | | |
| DD/MM/YY | XComs, Variables, Connections, templates in Airflow | | |
| DD/MM/YY | Failure handling: retries, SLAs, alerting, backfill | Unit 4 | 6 |
| DD/MM/YY | Monitoring: Airflow UI, Gantt view, task logs, metrics | | |
| DD/MM/YY | Performance tuning: partitioning, parallelism, caching in Spark | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Scaling strategies: horizontal vs vertical; cloud-native pipelines | | |
| DD/MM/YY | Data quality testing: Great Expectations; data contracts | | |
| DD/MM/YY | Monitoring pipelines: Prometheus, Grafana, custom dashboards | | |
| DD/MM/YY | Data security: encryption, RBAC, masking, audit logging | Unit 5 | 6 |
| DD/MM/YY | Case studies: industry pipelines + best practices; governance & compliance | | |
| DD/MM/YY | Revision: Unit 1 & 2 — architecture, ingestion, Kafka | | |
| DD/MM/YY | Revision: Unit 3 & 4 — processing, Spark, Airflow DAGs | | |
| DD/MM/YY | Revision: Unit 5 — quality, monitoring, security | | |
| DD/MM/YY | Practice: pipeline design exercise (end-to-end scenario) | | |

## 7. Lab Session Plan — List of Experiments (Updated CO7–CO10)

*W1–W12: All experiments develop CO7 skills (professional implementation, tool usage, documentation). W13–W15 (teal rows): CO8 (design/real-world), CO9 (ethics/reflection), CO10 (teamwork/presentation). Theory knowledge is applied but NOT re-evaluated in lab.*

| Week | Session | Experiment | Lab CO | Marks |
|---|---|---|---|---|
| W1 | S-1.1 | Setting up environment: Python venv, pip, Jupyter Notebook, Kafka CLI installation — professional tool setup | CO7 | 3.0 |
| | S-1.2 | Write a Python script to read a CSV file and print summary statistics using Pandas | CO7 | |
| W2 | S-2.1 | Produce and consume messages using Apache Kafka CLI; explore topic, partition, offset concepts | CO7 | 3.0 |
| | S-2.2 | Implement a Kafka producer in Python (kafka-python); send structured JSON events | CO7 | |
| W3 | S-3.1 | Implement a Kafka consumer in Python; subscribe, poll, process messages, commit offsets | CO7 | 3.0 |
| | S-3.2 | Build a simple data ingestion pipeline: CSV → Python → Kafka topic → Consumer → Output file | CO7 | |
| W4 | S-4.1 | Ingest data from a public REST API (e.g., Open-Meteo weather API) into a local JSON file | CO7 | 3.0 |
| | S-4.2 | Extend W4.1: add schema validation, error handling, and retry logic to the API ingestion script | CO7 | |
| W5 | S-5.1 | Introduction to Apache Spark (PySpark): SparkSession, loading data, basic transformations | CO7 | 3.0 |
| | S-5.2 | PySpark transformations: filter, select, groupBy, agg — analyze a sample sales dataset | CO7 | |
| W6 | S-6.1 | Build an ETL pipeline with PySpark: read raw CSV → transform → write cleaned Parquet output | CO7 | 3.0 |
| | S-6.2 | Implement data deduplication and null-handling logic in PySpark; compare before/after record counts | CO7 | |
| W7 | S-7.1 | Install Apache Airflow via Docker; explore Airflow UI: DAG list, task states, logs | CO7 | 3.0 |
| | S-7.2 | Write a simple DAG with BashOperator and PythonOperator; run and monitor in Airflow UI | CO7 | |

| | | | | |
|---|---|---|---|---|
| **W8** | S-8.1 | DAG with dependencies and branching: simulate a multi-step pipeline (ingest → validate → transform → load) | **CO7** | 3.0 |
| | S-8.2 | Configure retries, SLA miss alerts, and email notifications in an Airflow DAG | **CO7** | |
| **W9** | S-9.1 | Scheduling: parameterize DAGs with cron expressions; implement backfill for historical data runs | **CO7** | 3.0 |
| | S-9.2 | Use XComs to pass metadata (record counts, status flags) between Airflow tasks | **CO7** | |
| **W10** | S-10.1 | Data quality with Great Expectations: create a data context, define expectations for a CSV dataset | **CO7** | 3.0 |
| | S-10.2 | Extend W10.1: run expectation suite, generate data docs HTML report, handle validation failures | **CO7** | |
| **W11** | S-11.1 | Performance tuning: compare Spark job execution with and without caching, partitioning, and broadcast join | **CO7** | 3.0 |
| | S-11.2 | Monitor a Spark job using the Spark UI: DAG visualization, stage timing, shuffle analysis | **CO7** | |
| **W12** | S-12.1 | End-to-end mini pipeline review: Kafka producer → PySpark transformation → Parquet storage → Great Expectations validation | **CO7** | 3.0 |
| | S-12.2 | Peer code review session: review and document a classmate's pipeline; identify improvements and document findings | **CO7** | |
| **W13** | S-13.1 | Real-world pipeline design: build an end-to-end pipeline ingesting COVID-19 / climate data, applying transformations and SDG context discussion | **CO8** | 3.0 |
| | S-13.2 | Design a pipeline for a societal use case (e.g., traffic monitoring, healthcare data); document problem statement, architecture diagram, and tool choices | **CO8** | |
| **W14** | S-14.1 | Complex pipeline ADT: design a configurable, reusable pipeline module — document design decisions and reflect on code quality (CO9 reflection form submitted) | **CO8/CO9** | 3.0 |
| | S-14.2 | Team-based project: role assignment (Data Engineer, QA, Orchestration, Docs), peer review, collaborative pipeline build | **CO8/CO10** | |
| **W15** | S-15.1 | Data security and ethics lab: implement data masking, access control, and audit logging in a pipeline — ethical data handling discussion; skill self-assessment form submitted | **CO8/CO9** | 3.0 |
| | S-15.2 | Final presentation: team presents end-to-end pipeline — architecture, code walkthrough, results, SDG impact; group reflection and Q&A | **CO9/CO10** | |

ℹ *Instructions: Write C programs, compile, execute and test with suitable test cases. Lab record (aim, algorithm, code, output, result) must be submitted before the next session.*

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, MTE & ETE Structure for Theory COs (CO1–CO6)*

## 8. Theory Skill Dimensions (TS1–TS6) — CO1 through CO6

**THEORY COs (CO1–CO6) — Assessed exclusively via MTE and ETE only**

★ *Six theory skill dimensions — one per Bloom's level L1–L6 — correspond directly to CO1–CO6. They define the competency measured in each section of MTE and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Factual Recall & Conceptual Recognition | Recall pipeline terminology, architecture components, tools, and syntax; identify correct definitions and concepts | CO1 \| L1–L2 | MTE Sec A \| ETE Sec A |
| TS2 | Conceptual Explanation & Logical Interpretation | Explain pipeline stages and tool roles; interpret data flow; predict output of a given pipeline configuration | CO2 \| L2 | MTE Sec A \| ETE Sec A |
| TS3 | Procedural Application & Problem Solving | Apply ingestion, transformation, and Spark/Beam constructs to design and implement pipeline stages | CO3 \| L3 | MTE Sec B \| ETE Sec B |
| TS4 | Analytical Reasoning & Program Tracing | Trace execution of DAGs and Spark jobs; detect bottlenecks; analyze failure scenarios and debug pipelines | CO4 \| L4 | MTE Sec B \| ETE Sec B |
| TS5 | Comparative Evaluation & Algorithmic Justification | Compare ETL vs ELT, batch vs streaming, orchestration tools; evaluate performance trade-offs with evidence | CO5 \| L5 | ETE Sec B/C |
| TS6 | Synthesis & Holistic Design | Design complete, secure, monitored data pipeline solutions integrating ingestion, transformation, orchestration, and quality checks | CO6 \| L6 | ETE Sec C |

## 9. Theory Assessment Structure — MTE and ETE

### 9.1 Mid Term Examination (MTE) — 10 Marks (CO1–CO4 only)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | 4 | TS1 — Factual Recall TS2 — Conceptual Explanation | CO1, CO2 | Short-answer: definitions, output prediction, syntax identification |
| Sec B | 6 | TS3 — Procedural Application TS4 — Analytical Reasoning | CO3, CO4 | Program writing; program tracing — detect errors and trace execution |
| TOTAL | 10 | TS1–TS4 | CO1–CO4 | Units 1–3 covered; CO5 and CO6 assessed only in ETE |

### 9.2 End Term Examination (ETE) — 100 Marks (Scaled to 50) (CO1–CO6)

| Section | Marks | Skill Dimensions | COs | Question Type |
|---|---|---|---|---|
| Sec A | 25 | TS1 — Factual Recall TS2 — Conceptual Explanation | CO1, CO2 | Short questions: definitions, syntax, output tracing, concept MCQs (all units) |
| Sec B | 50 | TS3 — Procedural Application TS4 — Analytical Reasoning TS5 — Comparative Evaluation | CO3, CO4, CO5 | Medium questions: program writing, debugging, algorithm comparison, complexity analysis |

| | | | | |
|---|---|---|---|---|
| **Sec C** | **25** | TS5 — Comparative Evaluation TS6 — Synthesis & Design | **CO5, CO6** | Long/design questions: design modular solutions, justify choices, complete application |
| **TOTAL** | **100** | TS1–TS6 (all) | **CO1–CO6** | Scaled to 50 marks. Minimum 20/50 required to pass. |

PART III

# LABORATORY ASSESSMENT FRAMEWORK

*Evaluation Scheme, CA Rubric, Mini Project Rubric, Skill Dimensions for Lab COs (CO7–CO10)*

## 10. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs Assessed |
|---|---|---|---|
| **Laboratory Assessment** | 40% | **40** | Lab COs only: CO7 (CA experiments), CO8, CO9, CO10 (Mini Project) |
| Mid Semester Examination (MTE) | 10% | **10** | Theory COs only: CO1, CO2, CO3, CO4 |
| End Semester Examination (ETE) | 50% | **50** | Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6 |
| **TOTAL** | **100%** | **100** | Strict separation — no cross-assessment |

## 11. Laboratory Assessment (40 Marks)

**LAB COs (CO7–CO10) — Assessed exclusively via Laboratory Assessment only (CA + Mini Project)**

### 11.1 Component Breakdown

| Sub-Component | Quantum | Marks | Remarks |
|---|---|---|---|
| **Lab Experiments (CA)** | Best 10 of 12 | **30** | 3.0 marks each — assesses CO7, CO8, CO9 |
| **Mini Project** | 1 Project | **10** | Design, implementation, demo & reflection — all 4 Lab COs (CO7–CO10) |
| **TOTAL** | — | **40** | |

### 11.2 Per-Experiment CA Rubric (3.0 Marks each — Assesses CO7, CO8, CO9)

| Criterion | Marks | CA Skill Dimensions Covered | Marking Guide | Lab CO |
|---|---|---|---|---|
| **Problem Definition & Experimental Design** | **1.0** | CA1 — Problem definition: attributes, metrics, success criteria | 1.0: Well-defined with design \| 0.5: Partial \| 0: Missing | CO7, CO8 |

| | | | | |
|---|---|---|---|---|
| | | CA2 — Experimental design and tool configuration<br>CA7 — Algorithm/flowchart/solution plan | | |
| **Code Execution & Computational Efficiency** | **1.0** | CA3 — Execution correctness; output matches expected<br>CA4 — Efficiency: time/space complexity, optimization | 1.0: Correct & efficient \| 0.5: Correct, not optimized \| 0: Fails | CO7 |
| **Output Analysis, Outcome & Lab Documentation** | **0.75** | CA5 — Output analysis and result interpretation<br>CA6 — Documented outcome with verification<br>CA8 — Lab record completeness; viva-voce comprehension | 0.75: Thorough \| 0.5: Adequate \| 0.25: Partial \| 0: Absent | CO8, CO9 |
| **Professional Attitude & Ethical Conduct** | **0.25** | CO9 — Documentation ethics, responsible practice<br>PO7 — Professional responsibility and ethical conduct | 0.25: Consistent \| 0.10: Occasional \| 0: Absent | CO9 |
| **Total** | **3.0** | All 8 CA skill dimensions covered | | |

### 11.3 Best-10-of-N Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|
| **> (10 + x)** | Best 10 | **30 Marks** | x worst dropped |
| **10** | All 10 | **30 Marks** | No drop |
| **< 10** | All | **≤ 30 Marks** | Deficit = zero |

### 11.4 Mini Project Evaluation Rubric (10 Marks — All 4 Lab COs)

| Criterion | Marks | Project Skill Dimensions | Marking Guide | Lab CO / PO |
|---|---|---|---|---|
| **SDG Alignment & Problem Scoping** | **1.5** | P1 — SDG mapping; societal relevance<br>P2 — Problem scope and stakeholder requirements<br>P4 — Innovative solution proposal with alternatives | 1.5: Comprehensive \| 1.0: Adequate \| 0.5: Partial \| 0: Absent | CO8 / PO3, PO6 |
| **Project Planning & Financial Awareness** | **1.5** | P2 — Timeline, milestones, resource planning<br>P11 — Financial feasibility and cost estimation | 1.5: Detailed \| 1.0: Adequate \| 0.5: Basic \| 0: Absent | CO10 / PO10 |
| **End-to-End Implementation & System Operation** | **2.0** | P5 — Professional toolchain selection<br>P6 — Complete project build and integration<br>P7 — System commissioning and operational testing | 2: Fully operational \| 1–1.5: Partial \| 0–0.5: Non-functional | CO7, CO8 / PO3, PO5 |
| **Impact Assessment & Critical Reporting** | **2.0** | P8 — Measurable outcome vs stated goals<br>P9 — Statistical/comparative analysis; technical report | 2: Rigorous \| 1.5: Good \| 1: Basic \| 0: Absent | CO8, CO10 / PO6 |
| **Communication, Presentation & Teamwork** | **2.0** | P3 — Communication plan and testing strategy<br>P10 — Professional presentation quality and delivery | 2: Excellent \| 1.5: Good \| 1: Adequate \| 0: Poor | CO10 / PO8, PO9 |

| | | | | |
|---|---|---|---|---|
| **Skill Reflection, Ethics & Professional Attitudes** | **1.0** | P12 — Skill growth mapping (pre/post project)<br>P13 — Professional attitudes and ethical conduct | 1.0: Reflective & honest \| 0.5: Partial \| 0: Absent | CO9 / PO7, PO11 |
| **Total** | **10** | All 13 Project skill dimensions; all 4 Lab COs (CO7–CO10) | | |

## 12. CA Skill Dimensions (8 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO Anchor |
|---|---|---|---|
| CA1 | **Problem Definition & Metrics** | Define pipeline experiment problem; identify measurable attributes, parameters, success criteria | CO7, CO8 |
| CA2 | **Experimental Design & Tool Setup** | Plan experiment; configure development environment (Python, Kafka, Spark, Airflow) | CO7 |
| CA3 | **Code Implementation & Execution** | Write correct pipeline code; run tools to produce expected output | CO7 |
| CA4 | **Computational Efficiency & Optimization** | Evaluate throughput/latency/resource use; identify bottlenecks; propose optimizations | CO7 |
| CA5 | **Output Analysis & Result Interpretation** | Analyse pipeline output critically; explain deviations; draw evidence-based inferences | CO8 |
| CA6 | **Documented Outcome with Verification** | Record final outcome formally; verify against the problem statement | CO7, CO8 |
| CA7 | **Algorithmic Design & Solution Planning** | Produce pipeline architecture/pseudocode/flowchart before implementation; justify design choices | CO7, CO8 |
| CA8 | **Lab Record Maintenance & Viva-Voce** | Maintain complete lab records; demonstrate conceptual understanding orally | CO7, CO9 |

## 13. Project Skill Dimensions (13 Dimensions — Lab COs only)

| ID | Dimension | What is Measured | Lab CO / PO Anchor |
|---|---|---|---|
| P1 | **SDG Alignment & Social Relevance** | Map project to relevant SDGs; articulate societal value and intended impact | CO8 \| PO6 |
| P2 | **Problem Scoping & Requirements** | Define boundaries; produce formal problem statement with measurable goals | CO8 \| PO2 |
| P3 | **Communication & Testing Strategy** | Develop communication plan; design testing strategy; coordinate group activities | CO10 \| PO9 |
| P4 | **Innovative Solution Proposal** | Propose solution with alternatives; justify selection using design criteria | CO8 \| PO3 |
| P5 | **Professional Toolchain** | Select and justify development tools; configure professional project environment | CO7 \| PO5 |
| P6 | **End-to-End Implementation** | Build complete integrated solution incorporating at least 3 syllabus topics | CO7, CO8 \| PO3 |

| | | | |
|---|---|---|---|
| P7 | System Commissioning & Testing | Deploy and operate system; conduct edge-case and stress tests | CO7, CO8 \| PO5 |
| P8 | Measurable Impact & Outcome | Evaluate actual outcomes against goals; quantify impact using defined metrics | CO8 \| PO6 |
| P9 | Critical Analysis & Reporting | Perform comparative/statistical analysis; produce structured technical report | CO8, CO10 \| PO2, PO4 |
| P10 | Professional Presentation & Teamwork | Deliver professional presentation; evidence team collaboration and role differentiation | CO10 \| PO8, PO9 |
| P11 | Financial Feasibility & Planning | Estimate project cost; justify resource allocation; discuss cost-effectiveness | CO10 \| PO10 |
| P12 | Individual Skill Growth Mapping | Document pre/post skill gaps; map personal contributions to project dimensions | CO9 \| PO11 |
| P13 | Professional Attitude, Ethics & Responsibility | Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout | CO9 \| PO7 |

## 14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

ℹ *Theory COs (CO1–CO6) are fully mapped. Lab COs (CO7–CO10) intentionally have no TS mapping — confirming strict assessment separation.*

ℹ *Theory COs (CO1–CO6) have NO CA alignment — confirms they are NOT evaluated in lab. All CA alignments confined to Lab COs (CO7–CO10).*

ℹ *Theory COs (CO1–CO6) have NO project alignment — confirms strict lab-only assessment. All 13 Project dimensions anchored exclusively to Lab COs (CO7–CO10).*

| CO | Theory Skill Dimensions | | | | | | CA Skill Dimensions | | | | | | | | Project Skill Dimensions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TS1 Factual Recall | TS2 Conceptual Expl. | TS3 Procedural App. | TS4 Analytical Rsng | TS5 Compar. Eval. | TS6 Synthesis & Design | CA1 :Prob.Def. | CA2 Exp.Setup | CA3 Execution | CA4 Efficiency | CA5 Output Anal. | CA6 Doc.Outcome | CA7 Algo.Design | CA8 Lab Rec./Viva | P1 SDG | P2 Scoping | P3 Comm. | P4 Solution | P5 Tools | P6 Impl. | P7 Sys.Op. | P8 Impact | P9 Analysis | P10 Present. | P11 Financial | P12 Skill Map | P13 Attitude |
| CO1 | H | M | | | | | | | | | | | | | | | | | | | | | | | | | |
| CO2 | M | H | M | | | | | | | | | | | | | | | | | | | | | | | | |
| CO3 | | M | H | M | | | | | | | | | | | | | | | | | | | | | | | |
| CO4 | | | M | H | M | | | | | | | | | | | | | | | | | | | | | | |
| CO5 | | | | M | H | M | | | | | | | | | | | | | | | | | | | | | |
| CO6 | | | M | | M | H | | | | | | | | | | | | | | | | | | | | | |
| CO7 | | | | | | | H | H | H | M | | M | M | H | | | | | H | M | H | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO8 | | | | | | | M | | M | | H | H | H | | H | H | | H | M | H | M | H | M | | | | |
| CO9 | | | | | | | | | | | | | | M | | | | | | | | | | | | H | H |
| CO10 | | | | | | | | | | | | | | | | | H | | | | | | M | H | H | | |

H = High / Primary  M = Medium / Secondary  *Blank = No direct alignment*

PART IV

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, SDG Mapping, Bloom's Taxonomy Reference, Attendance & Pass/Fail*

## 15. CO–PO and CO–PSO Mapping Matrix (All 10 COs)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | – | – | – | – | – | – | – | – | 1 | 2 | 1 | – |
| CO2 | 3 | 2 | – | – | – | – | – | – | 1 | – | 2 | 2 | 2 | – |
| CO3 | 3 | 3 | 2 | – | 2 | 2 | – | – | 1 | – | 2 | 3 | 2 | 2 |
| CO4 | 2 | 3 | 2 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 2 | 2 | – | – | – | – | – | 2 | 2 | 3 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 3 | 2 | – | 2 | 1 | 1 | 3 | 3 | 3 | 3 |
| CO7 | – | – | 1 | – | 3 | 1 | – | – | – | – | – | 2 | 3 | 3 |
| CO8 | – | 1 | 3 | 1 | 2 | 3 | – | – | – | – | – | 2 | 3 | 3 |
| CO9 | – | – | – | – | – | – | 3 | – | – | – | 3 | – | 1 | 2 |
| CO10 | – | – | – | – | – | 1 | – | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| Avg | 2.50 | 2.14 | 2.33 | 1.75 | 2.33 | 1.80 | 3.00 | 2.50 | 1.50 | 2.00 | 2.13 | 2.22 | 2.30 | 2.38 |

★ *PO7 (Ethics) now receives mapping from CO9 (strength 3). PO11 (Life-Long Learning) is addressed by both Theory COs and CO9. Lab COs (CO7–CO10) extend coverage to POs 3, 5, 6, 7, 8, 9, 10, 11.*

## 16. CO × PO Alignment Map (H/M Indicators — All 10 COs × 11 POs)

| CO | PO1 Eng.Know. | PO2 Prob.Analysis | PO3 Design | PO4 Investigation | PO5 Tool Usage | PO6 Engineer & World | PO7 Ethics | PO8 Teamwork | PO9 Comm. | PO10 Proj.Mgmt | PO11 Lifelong |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | H | M | | | | | | | M | | |
| CO3 | M | H | M | | M | M | | | M | | |
| CO4 | M | H | M | H | M | | | | | | |
| CO5 | M | H | H | M | M | | | | | | |
| CO6 | M | M | H | M | H | M | | M | M | M | M |
| CO7 | | | M | | H | M | | | | | |
| CO8 | | M | H | M | M | H | | | | | |
| CO9 | | | | | | | H | | | | H |
| CO10 | | | | | | M | | H | H | H | M |

H = High / Primary  M = Medium / Secondary  Blank = No direct alignment

## 17. Course-to-SDG Mapping Matrix

| SDG Goal | Description | Mapping | Justification |
|---|---|---|---|
| SDG 4 | Quality Education | 3 (High) | Builds expertise in modern data engineering tools and scalable pipeline design; aligned with lifelong learning (CO1–CO6, CO9). |
| SDG 8 | Decent Work & Economic Growth | 3 (High) | Develops industry-relevant data engineering skills (Kafka, Spark, Airflow) directly applicable to high-demand technology careers. |
| SDG 9 | Industry, Innovation & Infrastructure | 3 (High) | Enables design of scalable, efficient data infrastructure; fosters innovation through real-world pipeline applications (CO6, CO8) and team projects (CO10). |
| SDG 12 | Responsible Consumption & Production | 2 (Moderate) | Promotes efficient, optimized pipeline design; encourages ethical data handling, responsible resource use, and data governance (CO9, CO6). |

## 18. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, principles<br>L3 — Apply: Use knowledge to solve new problems<br>L4 — Analyze: Break down information, examine patterns<br>L5 — Evaluate: Judge, justify, assess, make decisions<br>L6 — Create: Design, develop, produce new solutions | A1 — Receiving: Awareness, willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Showing commitment, assigning value<br>A4 — Organizing: Integrating values into personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Basic practice through imitation<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: Theory COs (CO1–CO6) are primarily mapped to the Cognitive domain (L1–L6). Lab COs (CO7–CO10) span all three domains — Cognitive (L2–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of laboratory and project assessment.*

## 19. Attendance Policy & Pass/Fail Criteria

### 19.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **70%** | All lecture sessions | Debarred from ETE |
| **Practical / Lab** | **70%** | All lab sessions | Debarred from ETE |
| **Combined (Theory + Lab)** | **75%** | Combined sessions | Debarred from ETE |

⚠ *Both theory and practical attendance must independently meet 70%. The combined must be 75%. Satisfying one does NOT compensate for a shortfall in the other.*

### 19.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score (scaled)** | **≥ 20 / 50** | **MANDATORY** | 40% of ETE; equivalent to ≥ 40/100 on the full paper |
| **Overall Total** | **≥ 40 / 100** | **Must pass overall** | Lab 40 + MTE 10 + ETE 50 = 100; 40% overall minimum required |

**DATA PIPELINE INTEGRATED COURSE PLAN — MEASUREMENT ARCHITECTURE**

*11 AICTE Programme Outcomes → 10 COs (6 Theory + 4 Lab) → 3 Assessment Instruments → 27 Skill Dimensions (6 TS + 8 CA + 13 Project)*

**Theory Tier CO1–CO6 (MTE + ETE): PO1, PO2, PO3, PO4, PO9 | 6 Theory Skill Dims (TS1–TS6)**

**Lab Tier CO7–CO10 (Lab only): PO3, PO5, PO6, PO7, PO8, PO9, PO10, PO11 | 8 CA Dims + 13 Project Dims**

Marks: Lab 40 (Experiments 30 @ 3.0 each + Project 10) + MTE 10 + ETE 50 = Total 100

# COURSE PLAN

## Introduction to NoSQL Databases (CSAI3003)

SSCSE | B.Tech CSE-AIML | Semester VI | Batch 2026–2030

Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA 25% + MTE 15% + ETE 60% Assessment

**PART I COURSE SYLLABUS** Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan

### 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | VI |
| **Course Code:** | CSAI3003 | **Course Type:** | Theory Only |

### 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI3003 |
| 2 | **Course Title** | Introduction to NoSQL Databases |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs Classroom + 45 hrs Self Learning = 90 hrs total) |
| 5 | **Course Status** | Professional Elective — Theory Only (No Laboratory Component) |
| 6 | **Pre-requisites** | Basic Knowledge of Database Management Systems (DBMS) |
| 7 | **Course Objectives** | 1. Introduce the landscape of NoSQL databases — their origins, motivation, types, and positioning relative to RDBMS. 2. Enable comparison of relational and NoSQL data models, distribution strategies, and consistency trade-offs. 3. Develop in-depth understanding of Document-oriented NoSQL databases (MongoDB) including architecture, CRUD, aggregation, and indexing. 4. Cover Column-Family databases (HBase, Cassandra) with architecture, features, and suitable use cases. 5. Introduce Key-Value (Riak) and Graph (Neo4j) databases and evaluate NoSQL development tools and programming interfaces. |

| | | |
|---|---|---|
| 8 | **Course Outcomes (COs)** | After successful completion of this course, students will be able to: CO1 (Understand – L1/L2): Explain and compare the four types of NoSQL databases, their historical context, motivations for emergence, and their positioning relative to traditional RDBMS. CO2 (Analyze – L2/L4): Compare and contrast RDBMS with NoSQL databases on data models, consistency, distribution, replication, sharding, and the CAP theorem. CO3 (Apply – L3): Demonstrate the architecture, data modelling, CRUD operations, indexing, aggregation pipelines, and performance characteristics of Document-oriented NoSQL databases (MongoDB). CO4 (Analyze – L4): Analyze the architecture, column-family data model, consistency, transactions, and suitable use cases of Column-Family NoSQL databases (Apache HBase and Cassandra). CO5 (Apply – L3/L4): Apply Key-Value (Riak) and Graph (Neo4j) NoSQL database concepts and development tools to suitable real-world use cases. CO6 (Evaluate – L4/L5): Evaluate and select the appropriate NoSQL database type, development tool, and polyglot persistence strategy for a given application requirement. |
| 9 | **Course Description** | This course introduces the principles, architectures, and practical applications of NoSQL database systems. Starting from the limitations of RDBMS in web-scale environments, the course covers all four NoSQL database families — Document, Column-Family, Key-Value, and Graph — with focused treatment of MongoDB, Apache HBase, Cassandra, Riak, and Neo4j. Students develop the analytical ability to compare data models, evaluate distribution strategies, and select the right database for a given use case. |
| 10 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 11 | **Mode of Examination** | Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks |
| 12 | **Textbook** | 1. Sadalage, P. & Fowler, M. (2019). NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence (1st Ed.). Wiley Publications. 2. Chodorow, K. (2019). MongoDB: The Definitive Guide (3rd Ed.). O'Reilly Media. |
| 13 | **References** | 1. Seguin, K. (2011). The Little MongoDB Book. Openmymind.net (freely available).<br>2. MongoDB Manual — https://www.mongodb.com/docs/manual/<br>3. IBM Cloud. Introduction to NoSQL Databases — https://www.ibm.com/cloud/learn/nosql-databases<br>4. Apache HBase Reference Guide — https://hbase.apache.org/book.html<br>5. Apache Cassandra Documentation — https://cassandra.apache.org/doc/latest/<br>6. GeeksforGeeks. Introduction to NoSQL — https://www.geeksforgeeks.org/introduction-to-nosql/<br>7. Tripathi, N. (2025). NoSQL database education: A review of models, tools and teaching methods. *Journal of Systems and Software*, *226*, 112391. https://doi.org/10.1016/j.jss.2025.112391 |

## 3. Outline Syllabus with CO Mapping

ℹ All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Overview and History of NoSQL Databases** | |
| **A** | Introduction to NoSQL: definition, origins, the relational model's strengths (persistent data, concurrency, integration, standard query), and its limitations in web-scale environments; Impedance mismatch between object-oriented applications and relational tables | **CO1** |
| **B** | Motivations for NoSQL: application vs. integration databases, rise of internet-scale data, attack of the clusters, horizontal scalability needs; Overview of the four NoSQL database families — Document, Key-Value, Column-Family, Graph | **CO1** |
| **C** | The CAP Theorem (Consistency, Availability, Partition Tolerance) and BASE properties (Basically Available, Soft state, Eventually consistent); Comparison with ACID; Aggregate data models; Eventual consistency patterns; Key NoSQL ecosystem milestones | **CO1, CO2** |
| | **Unit 2: NoSQL Data Models, Distribution, and Comparison with RDBMS** | |
| **A** | Comparison of RDBMS and NoSQL stores: structural differences, schema flexibility, horizontal vs. vertical scaling, join limitations; NoSQL deployment examples — MongoDB, Cassandra, HBase, Neo4j; RDBMS approach vs. NoSQL approach challenges | **CO1, CO2** |
| **B** | NoSQL data models: Key-Value model, Document model (JSON/BSON), Column-Family model (wide-row), Graph model; Aggregate-Oriented databases; polyglot persistence concept; MapReduce on databases — principles and workflow | **CO2** |
| **C** | Distribution models: Single Server, Sharding (horizontal partitioning, shard keys, range and hash-based sharding), Master-Slave Replication, Peer-to-Peer Replication, combining Sharding and Replication; Consistency across distributed NoSQL nodes; Vector clocks and conflict resolution | **CO2, CO3** |
| | **Unit 3: Document-Oriented NoSQL Databases — MongoDB** | |
| **A** | MongoDB architecture: document model (BSON format, JSON file format), collections, databases, Mongo Shell, configuration file; Data modelling in MongoDB — embedding vs. referencing, schema design patterns; Advantages of MongoDB over RDBMS | **CO1, CO3** |
| **B** | MongoDB operations: CRUD — inserting documents (insert, insertMany), reading (find, projections, query operators), updating (updateOne, updateMany, $set, $inc, $push modifiers), removing documents; Document replacement; Indexing — single-field, compound, multikey, text and geospatial indexes; Index strategies for performance | **CO3** |
| **C** | MongoDB Aggregation Framework: aggregation pipeline, pipeline stages — $match, $group, $sort, $project, $unwind, $limit, $skip; MapReduce in MongoDB; Aggregation commands; Suitable use cases — Event logging, Content Management, Real-Time Analytics, E-Commerce, Blogging platforms; Database operations: backup/restore (mongodump/mongorestore), export/import (CSV, JSON); Replication — replica sets, primary-secondary architecture, automatic failover; Scaling and performance tuning | **CO3, CO5** |
| | **Unit 4: Column-Family NoSQL Databases — Apache HBase and Cassandra** | |
| **A** | Column-Family data model: rows, column families, columns, timestamps, cells; HBase architecture — HMaster, RegionServers, ZooKeeper coordination, WAL (Write-Ahead Log), MemStore, HFiles, compaction; HDFS as storage layer; HBase shell and basic operations | **CO4** |
| **B** | Apache Cassandra architecture: masterless peer-to-peer design, consistent hashing ring, virtual nodes (vnodes), Gossip protocol, Snitch, commit log, memtable, SSTables; CQL (Cassandra Query Language); Data modelling in Cassandra — partition key, clustering columns, denormalization principles | **CO4** |

| | | |
|---|---|---|
| C | Column-Family data store features: Consistency (tunable in Cassandra — ONE, QUORUM, ALL; HBase strong consistency), Transactions (limited; compare-and-set), Availability, Query features, Scaling; Suitable use cases — Event logging, Content Management Systems, Blogging platforms, Counters, Expiring usage/TTL data; Performance tuning in HBase and Cassandra; Comparison: HBase vs. Cassandra | **CO4, CO6** |
| | **Unit 5: Key-Value Databases, Graph Databases, and NoSQL Development Tools** | |
| A | Key-Value Databases using Riak: architecture, consistent hashing, bucket-key-value model, Key-Value store features — Consistency (eventual), Transactions, Query features, Structure of data, Scaling; Suitable use cases — session information, user profiles and preferences, shopping cart data; Multi-operation transactions; Query by data and operations by sets | **CO5** |
| B | Graph Databases using Neo4j: graph model (nodes, relationships, properties, labels), Neo4j architecture and storage, Cypher Query Language (CQL) — MATCH, CREATE, MERGE, WHERE, RETURN; Graph database features — Consistency, Transactions (ACID), Availability, Query features, Scaling; Suitable use cases — social networks, recommendation engines, fraud detection, knowledge graphs; Relationships among data; Comparison of graph vs. relational approach | **CO5, CO6** |
| C | NoSQL development tools and programming languages: MongoDB drivers (Python PyMongo, Node.js Mongoose, Java), HBase Java API, Cassandra drivers, Neo4j Java/Python drivers; Polyglot persistence design patterns; Choosing the right NoSQL database — decision framework based on data model, consistency requirements, query patterns, scalability, and cost; Strengths, weaknesses, and open-source landscape of NoSQL databases | **CO5, CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | **1.A** | ✓ | ✓ | | | | |
| 2 | **1.B** | ✓ | ✓ | | | | |
| 3 | **1.C** | | ✓ | | ✓ | | |
| 4 | **2.A** | | ✓ | | ✓ | | |
| 5 | **2.B** | | ✓ | ✓ | | | |
| 6 | **2.C** | | | ✓ | ✓ | | |
| 7 | **3.A** | | ✓ | ✓ | | | |
| 8 | **3.B** | | | ✓ | ✓ | | |
| 9 | **3.C** | | | ✓ | ✓ | ✓ | |
| 10 | **4.A** | | ✓ | | ✓ | | |
| 11 | **4.B** | | ✓ | ✓ | | | |
| 12 | **4.C** | | | | ✓ | ✓ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | **5.A** | | ✓ | ✓ | | | |
| 14 | **5.B** | | | ✓ | ✓ | | |
| 15 | **5.C** | | | | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ Only strong/dominant alignments are mapped. Theory-only course: Cognitive domain is primary. Psychomotor (P3) appears for CO3 and CO5 (algorithm/query tracing as mental practice). Affective (A3) for CO6 (valuing polyglot persistence and technology selection).

| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | ✓ | ✓ | | | | | | | | | | | | | | | | |
| **CO2** | | ✓ | | ✓ | | | | | | | | | | | | | | |
| **CO3** | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| **CO4** | | ✓ | | ✓ | | | | | | | | | | | | | | |
| **CO5** | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| **CO6** | | | | ✓ | ✓ | | | | ✓ | | | | | | | ✓ | | |

Legend: ✓ = Strong / Dominant mapping. Cognitive domain is primary. P3 for CO3/CO5 (MongoDB/Neo4j query tracing). A3 for CO6 (valuing appropriate technology selection and polyglot persistence).

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ Total classroom contact: 45 hours across 5 units (9 lectures each). Self-Learning activities (45 hrs) are structured separately in Section 14.

| Date | Topics to be Covered / Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to NoSQL: definition and scope; brief history of data management; the relational model and its core strengths | **UNIT-1** | **9** |
| DD/MM/YY | Persistent data access patterns; concurrency control in RDBMS; integration databases vs. application databases | | |
| DD/MM/YY | Impedance mismatch: object-relational mismatch problem, ORM overhead, schemaless flexibility motivation | | |
| DD/MM/YY | Attack of the clusters: web-scale data growth, horizontal scaling challenges for RDBMS; emergence of NoSQL — motivating factors and timeline | | |
| DD/MM/YY | The four NoSQL families: Document, Key-Value, Column-Family, Graph — definitions, data organisation, and primary differentiators | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | CAP Theorem: Consistency, Availability, Partition Tolerance; practical implications; CP vs. AP database classification examples | | |
| DD/MM/YY | ACID vs. BASE: strong vs. eventual consistency; Basically Available, Soft state, Eventually consistent — real-world trade-offs | | |
| DD/MM/YY | Aggregate data models: what is an aggregate, aggregate ignorance in relational vs. aggregate awareness in NoSQL; overview of polyglot persistence | | |
| DD/MM/YY | NoSQL ecosystem map: key products per family, open-source landscape, cloud-native NoSQL services (DynamoDB, Cosmos DB, Bigtable overview) | | |
| DD/MM/YY | RDBMS vs. NoSQL — structural comparison: schema rigidity, normalization vs. denormalization, query flexibility, transactional guarantees | **UNIT-2** | **9** |
| DD/MM/YY | NoSQL deployment case studies: MongoDB (document), Cassandra (column-family), HBase (column-family), Neo4j (graph) — use context and deployment profile | | |
| DD/MM/YY | Key-Value data model: simplicity, hash-table analogy, opaque value storage; Document data model: JSON/BSON, nested documents, schema evolution | | |
| DD/MM/YY | Column-Family model: rows with sparse columns, column families, wide rows vs. narrow rows; Graph model: nodes, edges, properties, traversal-centric queries | | |
| DD/MM/YY | MapReduce on databases: map phase, shuffle phase, reduce phase; MapReduce vs. SQL aggregation; use in Hadoop, MongoDB, and CouchDB | | |
| DD/MM/YY | Distribution models: Single Server — simplicity and limits; Sharding — horizontal partitioning, range-based and hash-based shard key strategies | | |
| DD/MM/YY | Master-Slave Replication: read scaling, replication lag, failover; Peer-to-Peer Replication: availability, conflict resolution, vector clocks | | |
| DD/MM/YY | Combining sharding and replication: shard + replica set architecture (MongoDB); consistent hashing ring (Cassandra/Riak); virtual nodes | | |
| DD/MM/YY | Consistency models in distributed NoSQL: read/write quorums, tunable consistency (Cassandra: ONE, QUORUM, ALL), read-your-writes consistency | | |
| DD/MM/YY | MongoDB architecture: document-oriented model, BSON format, collection and database hierarchy, Mongo Shell, configuration file (mongod.conf) | **UNIT-3** | **9** |
| DD/MM/YY | Data modelling in MongoDB: embedding (denormalisation) vs. referencing; schema design patterns — Bucket, Outlier, Computed, Polymorphic; JSON file format for document storage | | |
| DD/MM/YY | MongoDB CRUD — Create: insertOne(), insertMany(), _id field and ObjectId; Read: find(), projection, query operators ($eq, $gt, $lt, $in, $regex, $elemMatch) | | |
| DD/MM/YY | MongoDB CRUD — Update: updateOne(), updateMany(), $set, $unset, $inc, $push, $pull, $addToSet; Document replacement with replaceOne(); Remove: deleteOne(), deleteMany() | | |
| DD/MM/YY | Indexing in MongoDB: B-tree index structure, single-field index, compound index, multikey index (arrays), text index, geospatial index (2dsphere); explain() and index selection; index management strategies | | |
| DD/MM/YY | MongoDB Aggregation Framework: pipeline concept; $match, $group (accumulators: $sum, $avg, $min, $max, $count), $sort, $project; pipeline optimisation principles | | |
| DD/MM/YY | Aggregation pipeline — advanced stages: $unwind (array deconstruction), $limit, $skip, $lookup (left outer join), $addFields, $facet; MapReduce in MongoDB | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | MongoDB database operations: backup with mongodump, restore with mongorestore; export (mongoexport to JSON/CSV), import (mongoimport from JSON/CSV); admin commands | | |
| DD/MM/YY | MongoDB replication: replica set architecture (Primary, Secondary, Arbiter), oplog, automatic election, write concern, read preference; performance tuning — explain plan, slow query log, connection pooling; suitable use cases: Event Logging, CMS, E-Commerce, Real-Time Analytics | | |
| DD/MM/YY | Column-Family data model: concept of column families, rows as sorted maps, column qualifiers, timestamps, cell versioning; HBase vs. RDBMS structural comparison | **UNIT-4** | **9** |
| DD/MM/YY | HBase architecture: HMaster (region assignment, load balancing), RegionServer (regions, memstore, HFiles), ZooKeeper (coordination, leader election), HDFS storage layer | | |
| DD/MM/YY | HBase internals: Write path — WAL (Write-Ahead Log) → MemStore → flush → HFiles; Read path — BlockCache → MemStore → HFiles; Compaction (minor and major); HBase shell operations (create, put, get, scan, delete) | | |
| DD/MM/YY | HBase data model features: Consistency (strong, single-row ACID), Transactions (row-level atomicity, HBase MVCC), Availability, auto-sharding; Query features — row key range scans, filters; Scaling — auto-splitting regions | | |
| DD/MM/YY | Apache Cassandra architecture: masterless peer-to-peer ring, consistent hashing, virtual nodes (vnodes), Gossip protocol for cluster state, Snitch for topology awareness | | |
| DD/MM/YY | Cassandra data model: keyspace, table, partition key, clustering columns, static columns; CQL (Cassandra Query Language) — CREATE TABLE, INSERT, SELECT, UPDATE, DELETE; data modelling principles — query-driven design, denormalization | | |
| DD/MM/YY | Cassandra internals: write path — commit log → memtable → SSTable; read path — row cache → key cache → bloom filter → SSTable; Compaction strategies (SizeTiered, Leveled, TWCS) | | |
| DD/MM/YY | Column-Family store features: tunable consistency levels in Cassandra (ONE, QUORUM, LOCAL_QUORUM, ALL); lightweight transactions (Paxos); TTL and expiring data; Availability and partition tolerance design | | |
| DD/MM/YY | Column-Family use cases: Event logging (time-series data), Content Management, Blogging platforms, IoT sensor data, Counters, Expiring usage tracking; HBase use cases: Hadoop analytics, real-time read/write on big data; HBase vs. Cassandra comparison and selection criteria | | |
| DD/MM/YY | Key-Value Databases — Riak architecture: consistent hashing, vnode distribution, bucket-key-value model, Riak ring concept | **UNIT-5** | **9** |
| DD/MM/YY | Riak Key-Value store features: Consistency (eventual, read-repair, anti-entropy), Transactions (limited — conditional updates), Query features (secondary indexes, Riak Search), Structure of data (opaque values, links), Scaling (add nodes without downtime) | | |
| DD/MM/YY | Riak use cases: Storing session information, User profiles and preferences, Shopping cart data; Multi-operation transactions; Query by data; Operations by sets; Comparison: Riak vs. Redis vs. DynamoDB | | |
| DD/MM/YY | Graph Databases — Neo4j architecture: native graph storage (property graph model), nodes, relationships, properties, labels; Neo4j kernel, page cache, transaction log | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Cypher Query Language (CQL): MATCH, CREATE, MERGE, WHERE, RETURN, WITH, OPTIONAL MATCH; pattern matching; path queries; graph traversal algorithms (shortest path, BFS/DFS) | | |
| DD/MM/YY | Graph database features: Consistency (ACID transactions), Transactions (full ACID support), Availability, Query features (traversal, pattern matching), Scaling (vertical, sharding in cluster edition) | | |
| DD/MM/YY | Graph use cases: Social networks (friend-of-friend), Recommendation engines, Fraud detection, Knowledge graphs, Network and IT operations; Relationships among data — why graph wins over relational joins for connected data | | |
| DD/MM/YY | NoSQL development tools and programming languages: MongoDB drivers (PyMongo, Mongoose, Java), HBase Java API, Cassandra Python/Java drivers, Neo4j Java/Python drivers; Compass (MongoDB GUI), HBase shell, cqlsh, Neo4j Browser; Spring Data for NoSQL | | |
| DD/MM/YY | Polyglot persistence and database selection framework: decision criteria (data model, consistency requirements, query patterns, throughput, cost, ecosystem maturity); strengths, weaknesses, and open-source landscape; NOSQL vs. NewSQL; future outlook — multi-model databases and cloud-native NoSQL | | |

**PART II THEORY ASSESSMENT FRAMEWORK** Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

Six Theory Skill Dimensions — one per Bloom's progression (L1–L5) — correspond directly to the six COs. They define precisely what competency is measured in each section of CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **NoSQL Conceptual Recall & Identification** | Recall NoSQL history, CAP theorem, BASE properties, aggregate data models, and four NoSQL database family definitions; identify the appropriate NoSQL database family and key product for a given application scenario | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | **RDBMS vs. NoSQL Comparative Analysis** | Compare and contrast RDBMS and NoSQL stores on data models, consistency, distribution, replication, and sharding strategies; explain MapReduce concepts and distribution model trade-offs | CO2 \| L2–L4 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | **MongoDB Architecture & Operations Application** | Apply MongoDB data modelling (embed vs. reference), CRUD operations, indexing strategies, and aggregation pipeline stages to practical document database | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |

| | | | | |
|---|---|---|---|---|
| | | problems; trace query execution and pipeline output step-by-step | | |
| **TS4** | **Column-Family Database Architecture Analysis** | Analyze HBase and Cassandra architectures (write path, read path, compaction, replication), column-family data model design, tunable consistency, and use-case suitability; compare HBase vs. Cassandra on key architectural dimensions | CO4 \| L2–L4 | MTE Sec B \| ETE Sec B |
| **TS5** | **Key-Value & Graph Database Application** | Apply Riak Key-Value and Neo4j Graph database concepts to use-case problems; trace Cypher query patterns; evaluate NoSQL development tool selection and driver integration for a given technology stack | CO5 \| L3–L4 | ETE Sec B/C |
| **TS6** | **NoSQL Technology Evaluation & Selection** | Evaluate and select the appropriate NoSQL database type and polyglot persistence strategy for a stated application requirement; justify selection against data model, consistency, scalability, and query pattern criteria | CO6 \| L4–L5 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.

| CO | TS1 NoSQL Recall | TS2 RDBMS vs. NoSQL Analysis | TS3 MongoDB Application | TS4 Column-Family Analysis | TS5 KV & Graph Application | TS6 Technology Evaluation |
|---|---|---|---|---|---|---|
| **CO1** | **H** | M | | | | |
| **CO2** | M | **H** | M | | | |
| **CO3** | | M | **H** | M | | |
| **CO4** | | | M | **H** | M | |
| **CO5** | | | | M | **H** | M |
| **CO6** | | | M | | M | **H** |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 9. Continuous Assessment (CA) — 25 Marks

CA is formative and covers COs progressively as the syllabus is taught. Five unit-wise assignments, a literature/tool review, and a database selection case study mirror TS1 through TS6.

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Assignments 1–5 (Problem-based / Analytical) | 5 assignments | **15** | CO1–CO5 | TS1–TS5 |
| Technical Tool / Literature Review Report | 1 Report + Presentation | **5** | CO3, CO5 | TS3, TS5 |
| NoSQL Database Selection Case Study (Report) | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping (Unit-wise)

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **A. Problem-based Analytical Assignments (5 assignments — one per unit, 4 hrs each = 20 hrs total)** | | | | | |
| **A1** | Unit 1 — NoSQL Overview: define and distinguish the four NoSQL database families with examples; explain CAP theorem and classify 5 given databases as CP or AP; compare ACID vs. BASE with real-world examples | CO1 | TS1 | 4h SL | Accuracy of NoSQL family definitions; correct CAP classification; quality of ACID vs. BASE comparison |
| **A2** | Unit 2 — Data Models & Distribution: draw and explain the Key-Value, Document, Column-Family, and Graph data models with schema examples; compare Master-Slave vs. Peer-to-Peer replication; trace a sharding strategy for a given dataset | CO2 | TS2 | 4h SL | Correctness of data model diagrams; accuracy of replication comparison; logical shard key selection and justification |
| **A3** | Unit 3 — MongoDB: write MongoDB queries (insertMany, find with $gt/$in, updateMany with $set/$inc, deleteOne); design an aggregation pipeline for a given e-commerce dataset using $match, $group, $sort, $project; explain index selection using explain() | CO3 | TS3 | 4h SL | Syntactic correctness of queries; logical pipeline design; accurate explain() interpretation; schema design rationale |
| **A4** | Unit 4 — Column-Family Databases: draw HBase write path and read path; design a Cassandra table schema for a time-series IoT use case with partition key and clustering columns; compare HBase vs. Cassandra on consistency, write performance, and use-case fit | CO4 | TS4 | 4h SL | Correctness of architecture diagrams; sound CQL schema with correct key design; reasoned HBase vs. Cassandra comparison |
| **A5** | Unit 5 — KV, Graph & Tools: write Cypher queries for a social network dataset (MATCH friend-of-friend, shortest path); list suitable use cases for Riak vs. Neo4j vs. MongoDB; select and justify an appropriate NoSQL stack for two given application scenarios | CO5, CO6 | TS5, TS6 | 4h SL | Correct Cypher syntax; accurate use-case mapping; well-reasoned NoSQL stack selection with evidence |
| **B. Technical Tool / Literature Review Report (1 report + presentation = 11 hrs total)** | | | | | |
| **B1** | Critical review and hands-on exploration of one NoSQL tool or peer-reviewed NoSQL paper (2022–2025); e.g., MongoDB Atlas features, Cassandra 5.0 improvements, or a published | CO3, CO5 | TS3, TS5 | 11h SL | Scientific/technical accuracy; quality of critical analysis; hands-on demonstration evidence; presentation clarity and Q&A |

| | | | | | |
|---|---|---|---|---|---|
| | NoSQL benchmark study; structured report + 10-min class presentation | | | | |
| **C. NoSQL Database Selection Case Study (1 report = 14 hrs total)** | | | | | |
| **C1** | In-depth case study: given a real-world application scenario (e.g., a social media platform, an e-commerce recommendation engine, or an IoT sensor data platform), evaluate and justify selection of one or more NoSQL database(s); cover data model design, distribution strategy, consistency trade-offs, scalability plan, and polyglot persistence rationale | CO4, CO5, CO6 | TS4, TS5, TS6 | 14h SL | Technical depth of evaluation; rigour of database selection justification; quality of data model design; clarity of polyglot persistence rationale |
| | **TOTAL Self-Learning Hours** | **A: 20 hrs + B: 11 hrs + C: 14 hrs = 45 hours** | | CO1–CO6 | All 7 activities (A1–A5, B1, C1) are compulsory. Submission deadlines set at semester start. |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **10** | TS1 — NoSQL Conceptual Recall & Identification TS2 — RDBMS vs. NoSQL Comparative Analysis | CO1, CO2 | Short-answer: define CAP theorem, state ACID vs. BASE properties, identify NoSQL database type from description, compare sharding vs. replication, explain impedance mismatch, distinguish aggregate data models |
| **Section B** | **15** | TS3 — MongoDB Architecture & Operations Application TS4 — Column-Family Database Architecture Analysis | CO3, CO4 | Analytical problems: write a MongoDB aggregation pipeline for given requirements; trace HBase write path; design a Cassandra partition key for a stated query pattern; compare embed vs. reference decisions; explain index selection |
| **TOTAL** | **25** | TS1–TS4 | CO1–CO4 | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 24/60 required to pass.

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Section A** | **15** | TS1 — NoSQL Conceptual Recall TS2 — RDBMS vs. NoSQL Analysis | CO1, CO2 | Short questions (all units): CAP theorem classification, BASE properties, NoSQL family identification, replication model differences, MapReduce phases, distribution model selection, RDBMS vs. NoSQL trade-off scenarios |
| **Section B** | **30** | TS3 — MongoDB Application TS4 — Column-Family Analysis TS5 — KV & Graph Application | CO3, CO4, CO5 | Medium questions: MongoDB aggregation pipeline design; HBase architecture diagram and read/write path trace; Cassandra CQL schema design; Riak use-case justification; Neo4j Cypher query writing; performance comparison questions |
| **Section C** | **15** | TS5 — KV & Graph Application TS6 — Technology Evaluation & Selection | CO5, CO6 | Long/evaluation questions: select and justify a NoSQL database stack for a complex multi-faceted application; design a polyglot persistence architecture; evaluate trade-offs in consistency vs. availability for a stated business requirement |
| **TOTAL** | **60** | TS1–TS6 (all) | CO1–CO6 | Scaled from 100-mark paper if needed. Minimum 24/60 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Explain and compare NoSQL database types, history, CAP theorem, and BASE properties | ✓ | ✓ | ✓ | **TS1** | PO1, PO2, PO11 |
| **CO2** | Compare and contrast RDBMS with NoSQL on data models, distribution, and consistency | ✓ | ✓ | ✓ | **TS2** | PO1, PO2, PO4 |
| **CO3** | Demonstrate MongoDB architecture, CRUD, aggregation, indexing, and replication | ✓ | ✓ | ✓ | **TS3** | PO1, PO3, PO5 |
| **CO4** | Analyze HBase and Cassandra architecture, data model, and use-case suitability | ✓ | ✓ | ✓ | **TS4** | PO1, PO2, PO4 |
| **CO5** | Apply Key-Value (Riak) and Graph (Neo4j) databases and development tools to use cases | ✓ | — | ✓ | **TS5** | PO2, PO3, PO5, PO9 |
| **CO6** | Evaluate and select NoSQL databases and polyglot persistence strategies | ✓ | — | ✓ | **TS6** | PO2, PO4, PO6, PO10 |

CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA and ETE.

## PART III COMBINED MAPPINGS & REFERENCE CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per AICTE 11-PO structure.

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO 7 | PO 8 | PO9 | PO1 0 | PO1 1 | PO1 2 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | - | - | - | 1 | - | - | - | - | 3 | 1 | 3 | 2 | - |
| CO 2 | 3 | 3 | - | 3 | - | 1 | - | - | - | - | 2 | 1 | 3 | 3 | - |
| CO 3 | 2 | - | 3 | - | 3 | 2 | - | - | 2 | - | 2 | 2 | 2 | 3 | 3 |
| CO 4 | 3 | 3 | - | 3 | 2 | 1 | - | - | - | - | 2 | - | 2 | 3 | 3 |
| CO 5 | 2 | 2 | 3 | - | 3 | 2 | - | - | 2 | - | 2 | - | 1 | 3 | 2 |
| CO 6 | 2 | 3 | 2 | 3 | 2 | 3 | - | - | 2 | 2 | 1 | - | - | 2 | 2 |
| Avg | 2.50 | 2.60 | 2.67 | 3.00 | 2.50 | 1.67 | – | – | 2.00 | 2.00 | 2.00 | 1.33 | 2.20 | 2.67 | 2.50 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | H | M | | | | M | | | | | M | M | H | M | |
| CO 2 | H | H | | H | | M | | | | | M | M | H | H | |
| CO 3 | M | | H | | H | M | | | M | | M | M | M | H | H |
| CO 4 | H | H | | H | M | M | | | | | M | | M | H | H |
| CO 5 | M | M | H | | H | M | | | M | | M | | M | H | M |
| CO 6 | M | H | M | H | M | H | | | M | M | M | | | M | M |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| A. Problem-based Analytical Assignments (5 assignments — one per unit, 4 hrs each = 20 hrs total) | | | | |

| | | | | |
|---|---|---|---|---|
| **A1** | Unit 1 — NoSQL Overview: define and distinguish the four NoSQL families with product examples; classify 5 given databases as CP or AP per the CAP theorem; compare ACID vs. BASE with real-world scenarios | 4 hrs | CO1 TS1 | Accuracy of NoSQL family definitions; correct CAP classification; quality of ACID vs. BASE comparison |
| **A2** | Unit 2 — Data Models & Distribution: draw Key-Value, Document, Column-Family, and Graph data model schemas; compare Master-Slave vs. Peer-to-Peer replication on 4 criteria; select and justify shard key for a given dataset | 4 hrs | CO2 TS2 | Correctness of data model diagrams; replication comparison accuracy; logical shard key selection with justification |
| **A3** | Unit 3 — MongoDB: write MongoDB queries (insertMany, find with operators, updateMany with $set/$inc, deleteOne); design an aggregation pipeline for a given e-commerce dataset using $match, $group, $sort, $project, $unwind; explain index selection with explain() | 4 hrs | CO3 TS3 | Syntactic correctness of MongoDB queries; logical pipeline design; accurate explain() interpretation; schema design rationale (embed vs. reference) |
| **A4** | Unit 4 — Column-Family DBs: draw HBase write path and read path with components labelled; design a Cassandra CQL table schema for a time-series IoT sensor use case with correct partition key and clustering columns; compare HBase vs. Cassandra on consistency, write throughput, and operational model | 4 hrs | CO4 TS4 | Correctness of HBase architecture diagram; sound CQL schema with correct key design; reasoned comparative analysis |
| **A5** | Unit 5 — KV, Graph & Tools: write Neo4j Cypher queries for a social network (MATCH friend-of-friend, shortest path); map use cases to appropriate NoSQL family (Riak, Neo4j, MongoDB, Cassandra); select and justify a NoSQL stack for two stated application scenarios with polyglot persistence rationale | 4 hrs | CO5, CO6 TS5, TS6 | Correct Cypher syntax; accurate use-case mapping; well-reasoned NoSQL stack selection with evidence-based justification |
| **B. Technical Tool / Literature Review Report (1 report + 10-min presentation = 11 hrs total)** | | | | |
| **B1** | Critical review of one peer-reviewed NoSQL paper (2022–2025) or hands-on exploration of one NoSQL tool (e.g., MongoDB Atlas, Cassandra 5.0, ArangoDB multi-model, or a published NoSQL performance benchmark); structured report covering motivation, methodology, findings, critical analysis, and reflection; 10-min class presentation with Q&A | Paper/tool study: 4 hrs Report: 4 hrs Presentation: 3 hrs Total = 11 hrs | CO3, CO5 TS3, TS5 | Technical/scientific accuracy; quality of critical analysis; hands-on tool demonstration evidence; presentation clarity and Q&A handling |
| **C. NoSQL Database Selection Case Study (1 report = 14 hrs total)** | | | | |
| **C1** | In-depth case study: given a complex real-world application scenario (choose one — social media platform, e-commerce recommendation engine, IoT sensor data | Data collection/study: 8 hrs Report writing: 6 hrs Total = 14 hrs | CO4, CO5, CO6 TS4, | Technical depth of evaluation; rigour of database selection justification; quality of data model and architecture |

| | | | | |
|---|---|---|---|---|
| | platform, or healthcare record management system), evaluate and justify selection of one or more NoSQL databases; cover data model design, distribution and replication strategy, consistency trade-offs, scalability plan, development tool selection, and polyglot persistence rationale | | TS5, TS6 | design; clarity of polyglot persistence rationale and evidence-based conclusions |
| | **TOTAL Self-Learning Hours** | **A: 20 hrs + B: 11 hrs + C: 14 hrs = 45 hours** | CO1–CO6 TS1–TS6 | All 7 activities (A1–A5, B1, C1) are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts L2 — Understand: Explain ideas, concepts, and principles L3 — Apply: Use knowledge to solve problems in new situations L4 — Analyze: Break down information, examine relationships L5 — Evaluate: Judge, justify, assess, and make decisions L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend A2 — Responding: Active participation and reaction A3 — Valuing: Commitment and assigning value to content A4 — Organizing: Integrating values into a personal system A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity P2 — Set: Mental, physical readiness to act P3 — Guided Response: Practice through imitation/trial P4 — Mechanism: Habitual correct performance P5 — Complex Overt Response: Skilled performance P6 — Adaptation: Modify skills for special situations P7 — Origination: Create new solution patterns |

OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears for CO3 and CO5, reflecting mental algorithm and query tracing. Affective domain (A3) appears for CO6, reflecting valuing of appropriate technology selection and polyglot persistence design.

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

Theory attendance must meet 75% minimum. Missing SL activities (assignments, tool review, case study) directly impacts CA marks and is not compensable by exam performance.

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | Must pass overall | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**CSXXXX — MEASUREMENT ARCHITECTURE SUMMARY (3 Credits)**

Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)

**CO1–CO2: Recall / Analyze → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Apply / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

**CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks**

# COURSE PLAN

## Strategic Professionalism and Computational Informatics (SKP3601)

*School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VI | Batch 2024–2028*

*Lab-Only Course Plan — All 6 Lab COs (CO1–CO6) | New AICTE 11-PO Framework | Full Skill Mapping*

**PART I COURSE SYLLABUS** *Course Identification, Details, Outcomes, BTL Mapping & Lab Session Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE: Sharda School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech. | **Current Academic Year:** | 2028–29 |
| **Branch:** | CSE-AIML | **Semester:** | VI |
| **Course Code:** | SKP3601 | **Course Type:** | Core — Practical |

## 2. Course Details

**LAB-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), Course Examination (CE), and End Semester Examination (ESE). No theory lecture component.**

| | | |
|---|---|---|
| **1** | **Course Code** | SKP3601 |
| **2** | **Course Title** | Strategic Professionalism and Computational Informatics |
| **3** | **Credits** | 3 |
| **4** | **Contact Hours (L-T-P-SL)** | 0-0-6-0 (Tutorial: 00 hrs \| Lab: 90 hrs \| Self Learning: 00 hrs \| Total: 90 hrs) |
| **5** | **Course Status** | Core |
| **6** | **Course Objectives** | The objective of this course is to develop students' technical competency, quantitative aptitude, logical reasoning, verbal ability, and professional employability skills through industry-oriented and application-based learning. The course focuses on strengthening problem-solving, algorithmic thinking, software development, analytical reasoning, and workplace readiness by integrating advanced data structures, Agentic AI/Full Stack |

| | | |
|---|---|---|
| | | Development concepts, deployment practices, aptitude training, and professional communication skills. It also aims to enhance students' communication, presentation, collaboration, and decision-making abilities required for academic excellence, campus placements, and professional success. By the end of the course, students will be able to apply technical, analytical, and interpersonal skills effectively in real-world and industry-driven environments. |
| 7 | **Course Outcomes (COs)** | After successful completion of this course, the students will be able to:<br>**CO1 (Remember – L1):** Technical, Aptitude & Reasoning Foundations<br>Recall and identify fundamental concepts of advanced data structures (Red-Black Trees, Segment Trees, Tries, DSU, String Algorithms), Agentic AI/Full Stack development frameworks, quantitative aptitude formulas, verbal ability concepts, and logical reasoning techniques used in problem-solving and computational thinking.<br>**CO2 (Understand – L2):** Analytical Systems, Communication & Workflow Understanding<br>Explain the working principles of graph-based agent workflows, backend architectures, APIs, databases, logical reasoning patterns, data sufficiency approaches, professional communication strategies, and workplace interaction techniques used in technical and professional environments.<br>**CO3 (Apply – L3):** Application Development, Quantitative Problem Solving & Professional Communication<br>Apply LangChain, LangGraph, CrewAI, Node.js, Express.js, MongoDB, and advanced data structure operations along with quantitative aptitude techniques, data interpretation methods, group discussion strategies, presentation skills, and logical reasoning approaches to solve technical, analytical, and workplace problems.<br>**CO4 (Analyze – L4):** Critical Thinking, Data Analysis & Verbal Reasoning<br>Analyze multi-agent system architectures, REST API workflows, algorithmic efficiency, reading comprehension passages, verbal reasoning patterns, puzzles, data sufficiency problems, and workplace communication scenarios using critical thinking, analytical reasoning, and interpretation skills.<br>**CO5 (Evaluate – L5):** Technical Evaluation, Decision-Making & Workplace Effectiveness<br>Evaluate agent frameworks, deployment strategies, authentication workflows, quantitative approaches, logical arguments, communication effectiveness, team collaboration practices, LinkedIn profiling strategies, and decision-making processes for performance, scalability, accuracy, and professional impact.<br>**CO6 (Create – L6):** Integrated Technical Solutions & Employability Development<br>Design and develop production-ready technical solutions, capstone projects, full stack applications, multi-agent AI systems, technical documents, corporate presentations, debate responses, and professional communication deliverables by integrating software development, analytical aptitude, logical reasoning, verbal ability, and employability skills. |

| | | |
|---|---|---|
| 8 | **Course Description** | This course is an industry-oriented and practice-based course designed to develop students' technical competency, quantitative aptitude, logical reasoning, verbal ability, and professional employability skills required for academic excellence, campus placements, and workplace success. The course integrates advanced data structures such as Red-Black Trees, Segment Trees, Tries, DSU, and String Algorithms with Agentic AI/Full Stack Development concepts including LangChain, LangGraph, CrewAI, Node.js, Express.js, MongoDB, REST APIs, authentication systems, and deployment workflows.<br>The course also strengthens quantitative problem-solving, data interpretation, verbal reasoning, reading comprehension, group discussion, presentation, technical writing, LinkedIn profiling, debating, LSRW skills, and workplace communication practices through structured and application-based learning. Students enhance their problem-solving, analytical thinking, computational reasoning, software development, collaboration, decision-making, and communication abilities through technical exercises, mock assessments, collaborative activities, and capstone-oriented practice. The course equips learners with technical, analytical, and professional skills required for real-world, industry-driven, and technology-enabled environments. |
| 9 | **Teaching & Learning Scheme** | Tutorial (T): 90 hrs \| Total: 90 hrs \| Credits: 3 |
| 10 | **Mode of Examination** | CA: 30% \| CE: 30% \| ESE: 40% \| Total: 100 marks |
| 11 | **Textbook** | 1. Quantitative Aptitude for Competitive Examinations – R.S. Aggarwal<br>2. A Modern Approach to Verbal & Non-Verbal Reasoning – R.S. Aggarwal<br>3. Russell, S. & Norvig, P. (2022). Artificial Intelligence: A Modern Approach (4th ed.). Pearson. [Data Science Track]<br>4. Flanagan, D. (2020). JavaScript: The Definitive Guide (7th ed.). O'Reilly Media. [Full Stack Track]<br>5. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). Introduction to Algorithms (4th ed.). MIT Press. [Data Structures – Mandatory] |
| 12 | **References** | 1. Quantitative Aptitude for Competitive Examinations – Abhijit Guha<br>2. How to Prepare for Logical Reasoning for CAT – Arun Sharma<br>3. Word Power Made Easy – Norman Lewis<br>4. English Grammar in Use – Raymond Murphy<br>5. Communication Skills – Sanjay Kumar & Pushp Lata<br>6. Soft Skills – Alex K.<br>7. Harrison, M. (2023). Langchain: Develop LLM Applications with Python. Manning Publications. [Data Science Track]<br>8. Banks, A. & Porcello, E. (2020). Learning React (2nd ed.). O'Reilly Media. [Full Stack Track]<br>9. Sedgewick, R. & Wayne, K. (2011). Algorithms (4th ed.). Addison-Wesley. [Data Structures]<br>10. Okeke, T. (2023). Building REST APIs with Node.js and Express. Apress. [Full Stack Track]<br>11. LangChain Official Documentation – https://docs.langchain.com |

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|---|---|---|
| | | 12. LangGraph Documentation – https://langchain-ai.github.io/langgraph/<br>13. CrewAI Documentation – https://docs.crewai.com<br>14. Node.js Official Documentation – https://nodejs.org/en/docs/<br>15. Express.js Guide – https://expressjs.com/en/guide/<br>16. MongoDB Manual – https://www.mongodb.com/docs/manual/<br>17. LeetCode – Data Structures & Algorithms Practice – https://leetcode.com<br>18. Docker Official Documentation – https://docs.docker.com<br>Online Resources<br>• British Council Learning English<br>• Toastmasters International<br>• IndiaBIX Aptitude & Reasoning<br>• GeeksforGeeks Aptitude Preparation<br>• Newspaper editorials from The Hindu and The Indian Express for reading comprehension, vocabulary building, and critical reasoning practice. |

## 3. Outline Syllabus — Units with CO Mapping

*i All CO mappings refer to COs (CO1–CO6). This is a practical course; all assessment is via CA, CE, and ESE.*

| | Topic / Activity | CO Mapping |
|---|---|---|
| | **Unit 1: Quantitative Aptitude, Generative AI to Agentic AI & Backend Foundations** | |
| **A** | Problem on Ages, Simple Interest, Compound Interest, Partnerships | **CO1** |
| **B** | Profit & Loss – Advanced, Time & Work – Chain Rule & Wages, Time & Work – Advanced | **CO1** |
| **C** | Pipe & Cistern, Boats & Streams, Problems on Trains | **CO1** |
| **D** | Recap and Bridge: Limitations of Static LLMs, Introduction to Agentic AI, Characteristics and Goal-Directed Behavior<br>OR<br>Introduction to Backend Development, Client-Server Architecture, APIs, Runtime Environment, Node.js, Event Loop, Non-Blocking Architecture | **CO2** |
| **E** | Generative AI vs Agentic AI: Key Differences, Planning, Autonomy, Real-World Transition Examples<br>OR<br>npm Workflow, package.json, Dependencies vs Dev Dependencies, Scripts, Project Initialization, Backend Folder Structure | **CO2** |
| **F** | Industry Landscape and Governance: Agentic AI in Healthcare, Finance, Retail, Manufacturing, AI Governance and Safety | **CO2** |

| | | |
|---|---|---|
| | OR<br>File System (fs) Module, Path Module, Environment Variables (.env), Nodemon, Backend Debugging Workflow | |
| **G** | Red-Black Tree Properties, Rotations and Recoloring, Insert and Delete Cases | **CO1** |
| **H** | Segment Tree: Build and Query, Lazy Propagation, Range Update Patterns | **CO1** |
| | **Unit 2: Logical Reasoning, LangChain, Express.js & Trie-Based Systems** | |
| **A** | Puzzles – Floor/Week, Puzzles – Box/Month, Puzzles – Miscellaneous | **CO3** |
| **B** | Deductive Reasoning, Binary Logic, Selection Based on Given Conditions, Visual Flow Chart | **CO2** |
| **C** | Mirror & Water Image, Paper Cutting & Folding, Game-Based Puzzles, Data Sufficiency – Reasoning | **CO4** |
| **D** | LangChain and LCEL: Agents, Tools, Memory, RunnableSequence, RunnableParallel, RunnableLambda OR Express.js Setup, Routing, Request-Response Cycle | **CO1** |
| **E** | Vector Databases and Data Ingestion OR HTTP Methods, Parameters, Response Handling | **CO2** |
| **F** | MCP Fundamentals, Client-Server Setup, Integration OR Middleware, API Design Principles | **CO3** |
| **G** | Trie Insert, Search, startsWith, Compressed Trie, Trie Memory Optimization | **CO1** |
| **H** | Suffix Array Construction, LCP Array, Pattern Matching via Suffix Array | **CO4** |
| | **Unit 3: Data Interpretation, Quantitative Problem Solving, Building AI Agents with LangGraph, MongoDB & Database Integration, Disjoint Set Union** | |
| **A** | Data Interpretation – Caselet Based Analysis, Quantitative Data Evaluation | **CO4** |
| **B** | Mensuration, Set Theory, Permutation & Combination, Probability | **CO3** |
| **C** | Data Sufficiency – Quantitative Aptitude Based, Integrated Quantitative Problem Solving | **CO5** |
| **D** | Introduction to LangGraph: Graph-Based Architectures, Agent State Management, State Schema Design **OR** SQL vs NoSQL Concepts, Databases, Collections, Documents, Introduction to MongoDB, MongoDB Compass, MongoDB Atlas | **CO2** |

| | | |
|---|---|---|
| **E** | Memory and Message Management: State Reducers, Context Trimming, Short-Term and Long-Term Memory **OR** Mongoose, Schemas, Models, Validation, Relationships, Query Methods | **CO3** |
| **F** | Human-in-the-Loop and Real-Time Agents: HITL, Streaming Agents, Tool-Using and Decision-Making Agents **OR** CRUD Operations, Filtering, Sorting, Pagination, Search Functionality, API Query Handling | **CO5** |
| **G** | Union-Find with Path Compression, Union by Rank/Size, Amortized Analysis, DSU Applications: Kruskal's Algorithm, Cycle Detection | **CO6** |
| | **Unit 4: Verbal Ability, Critical Reasoning, Multi-Agent Systems, Authentication, MVC & Secure Backend Design, String Algorithms** | |
| **A** | Reading Comprehension – Company Specific, Skimming & Scanning Techniques, Interpretation & Inference | **CO4** |
| **B** | Parajumbles – Advanced Level, Passage Completion, Cloze Test Techniques | **CO3** |
| **C** | Vocabulary – Company Test Specific, Strong & Weak Arguments, Cause & Effect | **CO5** |
| **D** | Introduction to Multi-Agent Systems: Coordination, Delegation, Parallelism, CrewAI Fundamentals **OR** Error Handling using try/catch, API Response Structure, Async Error Handling, Reusable Utility Functions | **CO2** |
| **E** | CrewAI Architecture Patterns: Sequential and Hierarchical Crews, Task Dependencies, Collaborative Workflows **OR** Password Hashing using bcrypt, JWT Authentication, Token Validation, Signup/Login Flow, Protected Routes, Authentication Middleware, Authorization Basics | **CO3** |
| **F** | MCP Deep Dive and Framework Comparison: LangGraph vs CrewAI vs AutoGen, Agent-to-Agent Communication **OR** MVC Architecture, Routes, Controllers, Models, Services, Utils, API Documentation, README Writing | **CO5** |
| **G** | KMP Algorithm: Failure Function, O(n+m) Pattern Matching, Z-Algorithm, Rabin-Karp Rolling Hash | **CO1** |
| **H** | Manacher's Algorithm for Palindromes, Longest Palindromic Substring O(n), Eertree Concept | **CO1** |
| | **Unit 5: Professional Communication, Employability Skills, Full Stack Integration & Deployment Workflow** | |
| **A** | Group Discussion – Abstract, Team Building & Collaboration, Time, Priority & Stress Management | **CO3** |
| **B** | Art of Networking – Professional LinkedIn Profiling, Culture Sensitization, MUN – Model United Nations | **CO5** |

| | | |
|---|---|---|
| **C** | The Art of Debating & Elocution, Corporate Style Presentation, Introduction to Technical Writing, LSRW 3, Decision Making | **CO4** |
| **D** | AI Observability and Evaluation: Langfuse, LangSmith, Monitoring, Tracing, Prompt Management **OR** Frontend Integration, CORS, API Consumption Workflow, Backend Testing using Postman and Thunder Client | **CO2** |
| **E** | Deployment and Optimization: MLOps for Agents, CI/CD, Cost Optimization, FastAPI, Docker, Serverless Deployment **OR** Git Workflow for Teams, Branching Strategy, Pull Requests, Logging, Security Best Practices, Rate Limiting Basics | **CO5** |
| **F** | Enterprise Integration and Capstone: CRM/ERP Integration, Single-Agent and Multi-Agent Project Development, Final Review **OR** Complete Full Stack Project: Authentication System, CRUD APIs, React Frontend Integration, Protected Routes, Database Integration, State Management, Deployment Workflow, Production Optimization | **CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| 1 | 1.A - Problem on Ages, Simple Interest, Compound Interest, Partnerships | ✓ | ✓ | | | | |
| 2 | 1.B - Profit & Loss – Advanced, Time & Work – Chain Rule & Wages, Time & Work – Advanced | | ✓ | ✓ | | | |
| 3 | 1.C - Pipe & Cistern, Boats & Streams, Problems on Trains | | ✓ | ✓ | ✓ | | |
| 4 | 1.D - Recap and Bridge: Limitations of Static LLMs, Introduction to Agentic AI, Characteristics and Goal-Directed Behavior<br>OR<br>Introduction to Backend Development, Client-Server Architecture, APIs, Runtime Environment, Node.js, Event Loop, Non-Blocking Architecture | ✓ | ✓ | ✓ | | | |
| 5 | 1.E - Generative AI vs Agentic AI: Key Differences, Planning, Autonomy, Real-World Transition Examples<br>OR<br>npm Workflow, package.json, Dependencies vs DevDependencies, Scripts, Project Initialization, Backend Folder Structure | | ✓ | ✓ | ✓ | | |
| 6 | 1.F - Industry Landscape and Governance: Agentic AI in Healthcare, Finance, Retail, Manufacturing, AI Governance and Safety<br>OR | | ✓ | ✓ | ✓ | ✓ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | File System (fs) Module, Path Module, Environment Variables (.env), Nodemon, Backend Debugging Workflow | | | | | | |
| 7 | 1.G - Red-Black Tree Properties, Rotations and Recoloring, Insert and Delete Cases | ✓ | ✓ | ✓ | ✓ | | |
| 8 | 1.H - Segment Tree: Build and Query, Lazy Propagation, Range Update Patterns | | ✓ | ✓ | ✓ | ✓ | |
| 9 | 2.A - Puzzles – Floor/Week, Puzzles – Box/Month, Puzzles – Miscellaneous | | ✓ | ✓ | ✓ | | |
| 10 | 2.B - Deductive Reasoning, Binary Logic, Selection Based on Given Conditions, Visual Flow Chart | | ✓ | ✓ | ✓ | | |
| 11 | 2.C - Mirror & Water Image, Paper Cutting & Folding, Game-Based Puzzles, Data Sufficiency – Reasoning | | ✓ | ✓ | ✓ | ✓ | |
| 12 | 2.D - LangChain and LCEL: Agents, Tools, Memory, RunnableSequence, RunnableParallel, RunnableLambda<br>OR<br>Express.js Setup, Creating Server, Routing, Listening on Ports, Request-Response Cycle, API Structure | ✓ | ✓ | ✓ | | | |
| 13 | 2.E - Vector Databases and Data Ingestion: FAISS, Chroma, Pinecone, Document Loaders, Chunking Strategies<br>OR<br>HTTP Methods (GET, POST, PUT, PATCH, DELETE), Route Parameters, Query Parameters, Request Body, Response Handling, Status Codes | | ✓ | ✓ | ✓ | | |
| 14 | 2.F - Model Context Protocol (MCP): MCP Fundamentals, MCP Client and Server Setup, API and Database Integration<br>OR<br>Middleware, express.json(), Custom Middleware, Error-Handling Middleware, Request Logging, API Design Principles | | ✓ | ✓ | ✓ | ✓ | |
| 15 | 2.G - Trie Insert, Search, startsWith, Compressed Trie, Trie Memory Optimization | ✓ | ✓ | ✓ | ✓ | | |
| 16 | 2.H - Suffix Array Construction, LCP Array, Pattern Matching via Suffix Array | | ✓ | ✓ | ✓ | ✓ | |
| 17 | 3.A - Data Interpretation – Caselet Based Analysis, Quantitative Data Evaluation | | ✓ | ✓ | ✓ | ✓ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18 | 3.B - Mensuration, Set Theory, Permutation & Combination, Probability | | ✓ | ✓ | ✓ | ✓ | |
| 19 | 3.C - Data Sufficiency – Quantitative Aptitude Based, Integrated Quantitative Problem Solving | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 20 | 3.D - Introduction to LangGraph: Graph-Based Architectures, Agent State Management, State Schema Design<br>OR<br>SQL vs NoSQL Concepts, Databases, Collections, Documents, Introduction to MongoDB, MongoDB Compass, MongoDB Atlas | ✓ | ✓ | ✓ | ✓ | | |
| 21 | 3.E - Memory and Message Management: State Reducers, Context Trimming, Short-Term and Long-Term Memory<br>OR<br>Mongoose, Schemas, Models, Validation, Relationships, Query Methods | | ✓ | ✓ | ✓ | ✓ | |
| 22 | 3.F - Human-in-the-Loop and Real-Time Agents: HITL, Streaming Agents, Tool-Using and Decision-Making Agents<br>OR<br>CRUD Operations, Filtering, Sorting, Pagination, Search Functionality, API Query Handling | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 23 | 3.G - Union-Find with Path Compression, Union by Rank/Size, Amortized Analysis, DSU Applications: Kruskal's Algorithm, Cycle Detection | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 24 | 4.A - Reading Comprehension – Company Specific, Skimming & Scanning Techniques, Interpretation & Inference | | ✓ | ✓ | ✓ | | |
| 25 | 4.B - Parajumbles – Advanced Level, Passage Completion, Cloze Test Techniques | | ✓ | ✓ | ✓ | ✓ | |
| 26 | 4.C - Vocabulary – Company Test Specific, Strong & Weak Arguments, Cause & Effect | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 27 | 4.D - Introduction to Multi-Agent Systems: Coordination, Delegation, Parallelism, CrewAI Fundamentals<br>OR<br>Error Handling using try/catch, API Response Structure, Async Error Handling, Reusable Utility Functions | ✓ | ✓ | ✓ | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 28 | 4.E - CrewAI Architecture Patterns: Sequential and Hierarchical Crews, Task Dependencies, Collaborative Workflows<br>OR<br>Password Hashing using bcrypt, JWT Authentication, Token Validation, Signup/Login Flow, Protected Routes, Authentication Middleware, Authorization Basics | | ✓ | ✓ | ✓ | ✓ | |
| 29 | 4.F - MCP Deep Dive and Framework Comparison: LangGraph vs CrewAI vs AutoGen, Agent-to-Agent Communication<br>OR<br>MVC Architecture, Routes, Controllers, Models, Services, Utils, API Documentation, README Writing | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 30 | 4.G - KMP Algorithm: Failure Function, O(n+m) Pattern Matching, Z-Algorithm, Rabin-Karp Rolling Hash | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 31 | 4.H - Manacher's Algorithm for Palindromes, Longest Palindromic Substring O(n), Eertree Concept | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 32 | 5.A - Group Discussion – Abstract, Team Building & Collaboration, Time, Priority & Stress Management | | ✓ | ✓ | ✓ | ✓ | |
| 33 | 5.B - Art of Networking – Professional LinkedIn Profiling, Culture Sensitization, MUN – Model United Nations | | ✓ | ✓ | ✓ | ✓ | |
| 34 | 5.C - The Art of Debating & Elocution, Corporate Style Presentation (Business Review/Sales Review/HR Review), Introduction to Technical Writing, LSRW 3 – Listening, Speaking, Reading & Writing, Decision Making | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 35 | 5.D - AI Observability and Evaluation: Langfuse, LangSmith, Monitoring, Tracing, Prompt Management<br>OR<br>Frontend Integration, CORS, API Consumption Workflow, Backend Testing using Postman and Thunder Client | ✓ | ✓ | ✓ | ✓ | | |
| 36 | 5.E - Deployment and Optimization: MLOps for Agents, CI/CD, Cost Optimization, FastAPI, Docker, Serverless Deployment<br>OR<br>Git Workflow for Teams, Branching Strategy, Pull | | ✓ | ✓ | ✓ | ✓ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Requests, Logging, Security Best Practices, Rate Limiting Basics | | | | | | |
| 37 | 5.F - Enterprise Integration and Capstone: CRM/ERP Integration, Single-Agent and Multi-Agent Project Development, Final Review<br>OR<br>Complete Full Stack Project: Authentication System, CRUD APIs, React Frontend Integration, Protected Routes, Database Integration, State Management, Deployment Workflow, Production Optimization | | ✓ | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

*ℹ Only strong/dominant alignments are mapped. COs span all three domains — Cognitive (L3–L6), Psychomotor (P3–P7), and Affective (A2–A5) — reflecting the skill-based nature of lab and project work.*

| | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **L1** | **L2** | **L3** | **L4** | **L5** | **L6** | **A1** | **A2** | **A3** | **A4** | **A5** | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** | **P7** |
| **CO1** | ✓ | | | | | | | ✓ | | | | | | ✓ | ✓ | | | |
| **CO3** | | | ✓ | | | | | ✓ | ✓ | | | | | | ✓ | ✓ | | |
| **CO4** | | | | ✓ | | | | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | | |
| **CO5** | | | | | ✓ | | | ✓ | ✓ | ✓ | | | | | | ✓ | ✓ | |
| **CO6** | | | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ |
| | *Legend: ✓= Strong / Dominant mapping only.* | | | | | | | | | | | | | | | | | |

## 6. Evaluation Scheme — Overview

| Component | Weightage | Marks | COs & Skill Dimensions Assessed |
|---|---|---|---|
| **Continuous Assessment (CA)** | 30% | **30** | All COs (CO1–CO6) \| Practical Exercises, Aptitude Assignments, Communication Activities, Technical Implementations, Presentations, Group Discussions & Lab Performance |
| **Course Examination (CE)** | 30% | **30** | CO1–CO6 \| Practical Demonstration, Problem Solving, Aptitude & Reasoning Assessment, Technical Tasks, Viva-Voce |

| | | | |
|---|---|---|---|
| **End Semester Examination (ESE)** | 40% | **40** | CO1–CO6 \| Integrated Problem Solving, Technical Implementation, Case Analysis, Project Demonstration, Presentation & Viva |
| **TOTAL** | **100%** | **100** | **All COs assessed through continuous, mid-semester, and end-semester performance evaluation** |

# 7. Continuous Assessment (CA) — 30 Marks

## 7.1 Per-Experiment CA Rubric (3.0 Marks each)

| Criterion | Marks | Skill Dimensions Covered | Marking Guide | CO |
|---|---|---|---|---|
| **Problem Understanding & Solution Planning** | **1.00** | Problem Identification & Analysis. Solution Design, Strategy Formulation & Planning | 1.00: Clear understanding with appropriate approach0.50: Partial understanding0: Inadequate preparation | CO1–CO4 |
| **Technical / Analytical Execution** | **1.00** | Technical Implementation & Application. Analytical Reasoning, Tool Usage & Problem Solving | 1.00: Accurate and complete execution0.50: Minor errors or gaps0: Unable to perform task | CO1–CO5 |
| **Interpretation, Communication & Documentation** | **0.75** | Result Analysis & Interpretation. Reporting, Presentation, Documentation & Communication | 0.75: Comprehensive explanation and documentation0.50: Adequate explanation0.25: Limited evidence0: Not submitted / unable to explain | CO3–CO5 |
| **Professionalism, Collaboration & Ethical Conduct** | **0.25** | Professional Behaviour, Teamwork, Integrity & Continuous Improvement | 0.25: Consistently demonstrated0.10: Partially demonstrated0: Not demonstrated | CO6 |
| **Total** | **3.00** | | | **CO1–CO6** |

## 7.2 Best-N-of-15 Scoring Scheme

| Conducted | Best N Counted | Max Score | Note |
|---|---|---|---|

| | | | |
|---|---|---|---|
| >10 | Best 10 | **30 Marks** | Best 10 of all sessions (3 marks × 10 = 30) |
| < 10 | All attended | **≤ 30 Marks** | Each missed session = zero; cannot be compensated |

## 8. Continuous Evaluation (CE) — 30 Marks

| Section | Marks | Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Sec A: Technical & Analytical Assessment** | **10** | Problem Identification & Analysis. Technical Implementation & Application | CO1, CO2, CO3 | Aptitude, logical reasoning, data interpretation, DSA, Agentic AI/Full Stack practical exercises, and analytical problem-solving tasks requiring application of concepts and techniques. |
| **Sec B: Case Study / Problem-Solving Assessment** | **10** | Analytical Reasoning & Solution Development. Result Interpretation & Evaluation | CO3, CO4, CO5 | Scenario-based technical or workplace case studies requiring analysis, decision-making, interpretation of results, justification of solutions, and structured problem-solving approaches. |
| **Sec C: Group Discussion / Presentation / Viva** | **10** | Communication & Documentation. Solution Planning & Presentation. Professional Behaviour & Collaboration | CO3, CO4, CO5, CO6 | Group discussion, presentation, debate, technical explanation, professional communication exercise, or viva voce. Assessment focuses on communication effectiveness, teamwork, critical thinking, confidence, leadership, professional etiquette, and articulation of ideas. |
| **TOTAL** | **30** | | **CO1–CO6** | **Assessment integrates technical competency, analytical reasoning, communication skills, professional behaviour, teamwork, and problem-solving abilities developed across the course.** |

## 9. End Semester Examination (ESE) — 40 Marks

*ESE is comprehensive — all 5 units and all 6 COs.. Minimum 16/40 required to pass.*

| Section | Marks | Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Sec A: Technical Competency Assessment** | **10** | Technical Implementation & Application. Analytical Reasoning & Solution Development | CO1, CO2, CO3, CO4 | Practical exercises involving aptitude, logical reasoning, advanced data structures, Agentic AI/Full Stack implementation tasks, data interpretation, and technical problem-solving. Students demonstrate application of concepts and appropriate use of tools, techniques, and frameworks. |
| **Sec B: Case Analysis & Decision-Making Assessment** | **20** | Critical Analysis & Evaluation. Interpretation & Judgement. Solution Design & Planning | CO3, CO4, CO5 | Case studies, scenario-based problem solving, analytical reasoning tasks, technical architecture evaluation, workplace simulations, quantitative analysis, communication scenarios, and decision-making exercises. Students justify solutions, evaluate alternatives, and recommend appropriate approaches. |
| **Sec C: Project Demonstration, Presentation & Innovation Assessment** | **10** | Solution Planning & PresentationLS8 — Innovation, Professional Behaviour & Continuous Improvement | CO5, CO6 | Capstone project demonstration, technical presentation, viva voce, group project review, deployment showcase, innovation proposal, or professional communication exercise. Assessment focuses on creativity, solution design, implementation quality, presentation effectiveness, teamwork, leadership, and professional readiness. |
| **TOTAL** | **40** | | **CO1–CO6** | **Comprehensive assessment of technical, analytical, communication, professional, and innovation competencies. Minimum 16/40 marks required to pass. Scaled from a 100-mark examination, if applicable.** |

### 9.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (30) | CE (30) | ESE (40) | Skill Dims | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Apply quantitative aptitude, logical reasoning, and fundamental technical concepts to solve structured problems | ✓ | ✓ | ✓ | Quantitative Aptitude, Logical Reasoning, Analytical Thinking, Problem Solving | PO1, PO2 |
| **CO2** | Demonstrate understanding of advanced data structures, Agentic AI / Full Stack concepts, and analytical techniques | ✓ | ✓ | ✓ | Technical Knowledge, Data Structures, AI/Full Stack Concepts, Analytical Skills | PO1, PO2, PO3 |
| **CO3** | Apply analytical reasoning, data interpretation, communication, and technical problem-solving skills in practical scenarios | ✓ | ✓ | ✓ | Data Interpretation, Critical Thinking, Communication Skills, Technical Problem Solving | PO1, PO2, PO3, PO10 |
| **CO4** | Analyze complex technical and workplace problems using appropriate tools, methods, and structured reasoning approaches | ✓ | ✓ | ✓ | Problem Analysis, Decision Making, Technical Evaluation, Professional Reasoning | PO1, PO2, PO4, PO8 |
| **CO5** | Evaluate alternative solutions, make informed decisions, and demonstrate effective communication and professional interaction skills | ✓ | ✓ | ✓ | Communication Skills, Group Discussion, Presentation Skills, Team Collaboration, Decision Making | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Design, develop, present, and deploy innovative technical solutions while demonstrating teamwork, leadership, and professional readiness | ✓ | ✓ | ✓ | Project Development, Innovation, Leadership, Teamwork, Professional Readiness, Deployment Skills | PO3, PO9, PO10, PO11 |

**PART III COMBINED MAPPINGS & REFERENCE** *CO–PO Matrix, CO–PO Alignment, Bloom's Reference, Attendance & Pass/Fail*

## 10. CO–PO and CO–PSO Mapping Matrix

*Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Column averages computed over non-zero entries only.*

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | – | 1 | – | – | – | – | 1 | – | 2 | 1 | 1 |
| CO2 | 2 | 2 | 3 | – | 2 | – | – | – | – | 1 | – | 2 | 3 | 2 |
| CO3 | 2 | 3 | 2 | 1 | 1 | – | – | – | 1 | 3 | – | 2 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 1 | – | – | 1 | 1 | 2 | – | 2 | 2 | 3 |
| CO5 | 2 | 3 | 1 | 2 | – | – | – | 3 | 3 | 3 | 1 | 2 | 2 | 2 |
| CO6 | 2 | 2 | 3 | 2 | 2 | – | – | 2 | 3 | 3 | 3 | 2 | 3 | 3 |
| Avg | 2.33 | 2.50 | 2.00 | 1.75 | 1.40 | – | – | 2.00 | 2.00 | 2.17 | 2.00 | 2.00 | 2.17 | 2.17 |

## 11. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | M | M | | | | | | | M | | M | | |
| CO2 | M | M | H | | M | | | | | M | | M | H | M |
| CO3 | M | H | M | | | | | | M | H | | M | M | M |
| CO4 | H | H | M | M | | | | M | M | M | | M | M | H |
| CO5 | M | H | | M | | | | H | H | H | M | M | M | M |
| CO6 | M | M | H | M | M | | | M | H | H | H | M | H | H |

*H = High / Primary alignment M = Medium / Secondary alignment Blank = No direct alignment*

## 12. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts L2 — Understand: Explain ideas, concepts, principles L3 — Apply: | A1 — Receiving: Awareness and willingness to participate A2 — Responding: Active participation and engagement A3 — Valuing: | P1 — Perception: Use sensory cues to guide actions P2 — Set: Mental and physical readiness to perform tasks P3 — Guided |

| | | |
|---|---|---|
| Use knowledge to solve new problems L4 — Analyze: Break down information, examine patterns, relationships, and causes L5 — Evaluate: Judge, justify, assess, compare alternatives, and make decisions L6 — Create: Design, develop, integrate, and produce innovative solutions | Demonstrating commitment, responsibility, and appreciation of values A4 — Organizing: Integrating values into personal and professional behaviour A5 — Characterizing: Consistent demonstration of professional ethics, leadership, and lifelong learning attitudes | Response: Perform tasks through guided practice and instruction P4 — Mechanism: Demonstrate proficiency through habitual and confident performance P5 — Complex Overt Response: Execute complex tasks with accuracy and efficiency P6 — Adaptation: Modify skills and approaches for new situations and challenges P7 — Origination: Create innovative methods, solutions, or products independently |

*ℹ OBE Compliance Statement: This is a practical course. All 6 COs span all three domains — Cognitive (L3–L6) as the primary domain, Psychomotor (P3–P6) for implementation and design skills, and Affective (A2–A4) for professional and collaborative conduct — reflecting the skill-based, hands-on nature of laboratory assessment.*

# 13. Attendance Policy & Pass/Fail Criteria

## 13.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Lab / Practical Sessions** | **75%** | All sessions | Debarred from ESE if below threshold |

*⚠ Minimum 75% attendance is mandatory in practical/activity sessions. Non-submission of self-learning tasks, coding activities, analytical exercises, or communication assignments directly impacts internal assessment and is not compensable through external examination performance.*

## 13.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ESE Score** | **≥ 16 / 40** | **MANDATORY** | 40% of ESE marks required; failing ESE means failing the course regardless of CA + CE performance |
| **Overall Total (CA + CE + ESE)** | **≥ 40 / 100** | **Must pass overall** | CA 30 + CE 30 + ESE 40 = 100; 40% overall minimum required |

**_____ — COURSE PLAN — MEASUREMENT ARCHITECTURE**

11 Programme Outcomes → 6 Lab COs (CO1–CO6) → 3 Assessment Instruments →
CO1–CO3: Apply/Analyse → LS1–LS3, LS6 → CA + CE + ESE
CO4–CO5: Analyse/Evaluate → LS3–LS5, LS7 → CA + ESE
CO6: Create → LS7–LS8 → CA + ESE Sec C
**Marks: CA 30 + CE 30 + ESE 40 = Total 100**

| School: SSCSE | | Batch: 2026-2030 | |
|---|---|---|---|
| Program: B Tech | | Current Academic Year: 2028-29 | |
| Branch: CSE-AIML | | Semester: VI | |
| 1 | Course Code | BST2351 | |
| 2 | Course Title | Management for Engineers | |
| 3 | Credits | 3 | |
| 4 | Contact Hours (L-T-P) | 3-0-0 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | The objective of this course is to expose the students to understand the basics of Management Foundations. The students will be given detailed grounding for the theories and cases related to the general management. The aim of the course is to orient the students in theories and practices of Management so as to apply the acquired knowledge in actual business practices. This is a gateway to the real world of management and decision-making. | |
| 6 | Course Outcomes | CO1: Define basic principles and concepts related to management in an organization including the functions, different theories of management and roles they play in an organization.<br>CO2: Explain the primary function Planning with its process. Also, how forecasting is done in organizations with various techniques are used.<br>CO3: Use of organizing by studying different types of organization and also using decentralization and span of control in organizations.<br>CO4: Analyse jobs, recruitment process, manpower planning, job rotation, trainings and rewards in various organizations.<br>CO5: Measure motivation and management control concepts to obtain effective controlling in management system in organizations.<br>CO6: Develop proper system in an organization by using all the functions of management. | |
| 7 | Course Description | This course gives an overview of engineering management and help to understand the various functions of management used in an organization. The focus of the course is the development of individual skills and teamwork. | |
| 8 | Outline syllabus | | CO Mapping |
| | Unit 1 | **Introduction of Management & Organization** | |
| | A | Management-Definition of Management & Organization | CO1, CO6 |

| | | | |
|---|---|---|---|
| | B | Concept, Nature, Scope and Functions of Management, Levels of Management, Management Theories - Taylors principle, Fayol's Principles, Hawthorne Studies, Systems Approach and Contingency Approach to Management. | CO1, CO6 |
| | C | Mintzberg's Managerial Roles, Skills of Manager, Functions of management | CO1, CO6 |
| | Unit 2 | Management Planning Process | CO2, CO6 |
| | A | Planning objectives and characteristics. | CO2, CO6 |
| | B | Hierarchies of planning. | CO2, CO6 |
| | C | The concept and techniques of forecasting. | CO2, CO6 |
| | Unit 3 | Organizing | C03, C06 |
| | A | Meaning, Importance and Principles | C03, C06 |
| | B | Departmentalization, Span of Control | CO3, CO6 |
| | C | Types of Organization, Authority, Delegation of Authority | CO3, CO6 |
| | Unit 4 | Staffing | CO4, C06 |
| | A | Meaning, Job analysis | CO4, C06 |
| | B | Manpower planning, Recruitment, Transfers and Promotions | CO4, CO6 |
| | C | Appraisals, Management Development, Job Rotation, Training, Rewards and Recognition, | CO4, CO6 |
| | Unit 5 | Directing &Controlling | CO5, CO6 |
| | A | Motivation, Co-ordination, Communication, | CO5, CO6 |
| | B | Directing and Management Control, Decision Making, | CO5, CO6 |
| | C | Management by objectives (MBO) the concept and relevance. Objectives and Process of Management Control | CO5, CO6 |
| | Mode of examination | Theory | |
| | Weightage Distribution | CA: 25% / ESE: 75% | |
| | Text book/s* | 1. Principles & practice of Mgmt., L.M. Prasad | |
| | Other References | 1. Management Today, Burton & Thakur<br>2. Principles & Practices of Mgmt., C.B. Gupta<br>3. Understanding Management, Richard L.Daft<br>4. Management, Stoner, Freemand& Gilbert<br>5. Essential of Management, Koontz O' Donnel | |

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| CO2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| CO3 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| CO4 | 0 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 2 |

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 2 |
| CO6 | 1 | 2 | 2 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 3 |
| Avg . PO | 1.0 | 1.5 | 1.8 | - | - | 1.0 | - | 1.0 | 1.0 | 1.0 | 1.5 | - | - | 1.83 |

Strength of Correlation: 11.63

| | | | |
|---|---|---|---|
| **School: SSCSE** | | **Batch :2026-2030** | |
| **Program: B.Tech** | | **Current Academic Year: 2028-29** | |
| **Branch: CSE-AIML** | | **Semester: VI** | |
| **1** | **Course Code** | **CSCR3601** \| **Course Name: Project Based Learning -4** | |
| 2 | Course Title | Project Based Learning -4 (Product Based) | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P) | 0-0-4 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | 1. To align student's skill and interests with a realistic problem or project.<br>2. To understand the significance of problem and its scope.<br>3. Students will make decisions within a framework. | |
| 6 | Course Outcomes | Students will be able to:<br>CO1: Identify and formulate problem statement.<br>CO2: Design relational database schema.<br>CO3: Develop the solution by using different aspects of programming language.<br>CO4: Classify and understand various test techniques for verification and validation of project.<br>CO5: Analyze and make use of modern for solving real word problems.<br>CO6: Develop teamwork and need to engage in life-long learning, along with the ability to communicate effectively with others. | |
| 7 | Course Description | In PBL-4, the students will learn how to define the problem for developing projects, and Design applicable solutions in one or more application domains using software engineering approaches that integrate ethical, social, legal and economic concerns. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | Problem Definition and identification, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any. | CO1,CO4 |
| | **Unit 2** | Use of the relational algebra operations from mathematical set theory (union, intersection, difference, and Cartesian product) and the relational algebra operations developed specifically for relational databases (select (restrict), project, join, and division).. | CO2,CO6 |
| | **Unit 3** | Design; implement project work in any programming language. | CO3 |
| | **Unit 4** | Use of various test tools and techniques for software verification and validation of project | CO4,CO5 |
| | **Unit 5** | Demonstrate and execute Project with the team. | CO6 |
| | | Report should include Abstract, Hardware / Software Requirement, Problem Statement, Design/Algorithm, ER diagrams, Use Case Diagrams, State Diagrams, Sequence Diagrams, Communication Diagrams, and Activity Diagrams, Implementation Detail. Validation Reports.<br>References, Test cases if any.<br>The presentation, report, work done during the term supported by the documentation, forms the basis of assessment. | |

| | | | | | |
|---|---|---|---|---|---|
| | Mode of examination | Lab | | | |
| | Weight age Distribution | | | | |
| | | CA | CE(Viva) | ESE | |
| | | 30% | 30% | 40% | |

**CO and PO Mapping**

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | CO1: Identify and formulate problem statement. | PO1, PO2, PO4, PO6, PO8, PO9, PO10, PO11, PSO1, PSO2, PSO3 |
| 2. | CO2: Design relational database schema. | PO1, PO2, PO3, PO4, PO5, PO7, PO8, PO9, PO11, PSO1, PSO2, PSO3 |
| 3. | CO3: Develop the solution by using different aspects of programming language. | PO1, PO2, PO3, PO4, PO5, PO6, PO8, PO9, PO11, PSO1, PSO2 |
| 4. | CO4: Classify and understand various test techniques for verification and validation of project. | PO1, PO2, PO3, PO4, PO5, PO8, PO9, PO10, PO11, PSO1, PSO2, PSO3 |
| 5. | CO5: Analyze and make use of modern for solving real word problems. | PO1, PO2, PO5, PO6, PO7, PO8, PO9, PSO1, PSO2 |
| 6. | CO6: Develop teamwork and need to engage in life-long learning, along with the ability to communicate effectively with others. | PO2, PO4, PO8, PO9, PO10, PO11, PSO1, PSO3 |

**PO and PSO mapping with level of strength for Course Name Project Based Learning – 4 (Course Code CSCR3601)**

| Cos | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 3 | - | 2 | - | 1 | 1 | 2 | - | 2 | 1 | 2 | 2 | 3 |
| CO 2 | 3 | 2 | 2 | 2 | 2 | - | 1 | 2 | - | 2 | 1 | 2 | 1 | 1 |
| CO 3 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | - | 2 | 1 | 2 | 2 | - |
| CO 4 | 3 | 3 | 2 | 2 | 3 | - | 1 | 2 | - | - | 1 | 2 | 2 | 2 |
| CO 5 | 3 | 2 | - | - | 3 | - | 1 | 2 | - | - | 1 | 2 | 2 | - |
| CO 6 | - | 1 | - | 1 | - | - | 2 | 2 | 3 | 3 | 3 | 1 | - | 1 |
| Avg PO | 3 | 2.2 | 1 | 1.5 | 1.7 | 0.7 | 1.2 | 2 | 1 | 2 | 1 | 2 | 1.5 | 1.2 |

| Semester 7, Credits: 15 | |
|---|---|
| **COURSE CODE** | **COURSE NAME** |
| CSCR4600 | Capstone - 1 |
| CSCR4700 | Summer Internship-II |
| CSCR42** | Program Elective-4 |
| CSCR42** | Program Elective-5 |
| CSCR42** | Program Elective-6 |
| CSCR30** | Open Elective – 2 |

| School: SSCSE | | Batch: 2026-2030 | |
|---|---|---|---|
| Program: B.Tech. | | Current Academic Year: 2029-30 | |
| Branch: CSE-AIML | | Semester: VII | |
| 1 | Course Code | CSCR4600 | |
| 2 | Course Title | Major Project -1 | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P-SL) | 0-0-4-4 | |
| | Course Status | Compulsory | |
| 5 | Course Objective | Project being the student's last activity at the institution, it fulfills a purpose of synthesis of all the knowledge they have acquired throughout the different years. In addition, this knowledge must be used in a particular way, in order to solve a specific problem, which lets student demonstrate their aptitude by applying this knowledge. | |
| 6 | Course Outcomes | Students will be able to:<br>CO1: Identify problem statement in engineering and technology in selected field of interest.<br>CO2: Analyze the gathered information required to develop a project.<br>CO3: Apply prior knowledge of mathematics, computer science and engineering.<br>CO4: Participate in different teams and to focus on getting a working project done on time with each student being held accountable for their part of the project.<br>CO5: Prepare the designs requirements, functional and conceptual design.<br>CO6: Initiate the actual implementation of the project work to produce the deliverables and explain the work in written and oral forms. | |
| 7 | Course Description | The object of Major Project-I is to enable the student to take up investigative study in the broad field of Computer Science & Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. | |
| 8 | **Outline syllabus** | | **CO Mapping** |
| | **Unit 1** | Problem identification, Literature survey/Gather & analyze information from multiple sources | CO1, CO2, CO4, |
| | **Unit 2** | Formulate solution/ Problem Description: Project Planning, Time and Cost Estimation and budgeting, Risk Management, Project scheduling and Planning Tools: Work Breakdown structure/ LRC/ Gantt charts/CPM/PERT Networks.<br>Creating System Requirement Specifications (Functional & Non Functional) | CO1, CO2, CO3 |
| | **Unit 3** | Preparing Design: Data Flow Diagrams & Flow Charts, Use of appropriate tools and techniques for project design | CO3, CO4 |
| | **Unit 4** | Identify and Implement Project Modules. | CO4, CO5 |

| | | | | |
|---|---|---|---|---|
| | **Unit 5** | Use of appropriate tools/technologies for coding the modules | | CO2, CO5, CO6 |
| | | Report on final problem statement, specifications, project schedule, final concept design and project schedule<br>Report and Presentation - Project Modules development | | |
| | Mode of examination | Practical | | |
| | Weight age Distribution | CA | CE(Viva) | ESE |
| | | 30% | 30% | 40% |
| | Text book/s* | | | |
| | Other References | | | |

**CO and PO Mapping**

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | CO1: Identify problem statement in engineering and technology in selected field of interest. | PO2, PO1, PSO1 |
| 2. | CO2: Analyze the gathered information required to develop a project. | PO2, PO4, PSO1, PO1, PO3, PO11, PSO2 |
| 3. | CO3: Apply prior knowledge of mathematics, computer science and engineering. | PO1, PSO1, PO2, PO3, PO5, PSO2 |
| 4. | CO4: Participate in different teams and to focus on getting a working project done on time with each student being held accountable for their part of the project. | PO9, PO10, PO11 |
| 5. | CO5: Prepare the designs requirements, functional and conceptual design. | PO3, PSO1, PO1, PO2, PO4, PO5, PSO2 |
| 6. | CO6: Initiate the actual implementation of the project work to produce the deliverables and explain the work in written and oral forms. | PO3, PO5, PO10, PSO1, PO1, PO2, PO4, PO9, PO11, PSO2 |

**PO and PSO mapping with level of strength for Course Name Major Project -1 (Course Code CSP497)**

| COs \ POs/PSOs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 1 | 1 | – | – | – | – | – | 1 | 1 | 2 | – | – |
| **CO2** | 2 | 3 | 2 | 3 | 1 | – | – | – | – | 1 | 2 | 3 | 2 | – |
| **CO3** | 3 | 2 | 2 | 1 | 2 | – | – | – | – | – | 1 | 3 | 2 | 1 |
| **CO4** | – | 1 | 1 | – | – | – | – | 1 | 3 | 2 | 2 | – | 1 | – |
| **CO5** | 2 | 2 | 3 | 2 | 2 | – | – | – | 1 | 1 | 1 | 3 | 2 | 1 |
| **CO6** | 2 | 2 | 3 | 2 | 3 | – | – | – | 2 | 3 | 2 | 3 | 2 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Avg.** | 2.2 | 2.2 | 2 | 1.8 | 2 | - | - | 1 | 2 | 1.6 | 1.5 | 2.8 | 1.8 | 1 |

**Strength of Correlation: 21.9**
**1.** Addressed to **Slight (Low=1) extent**
**2.** Addressed to **Moderate (Medium=2) extent**
**3.** Addressed to **Substantial (High=3) extent**

| School: SSCSE | | Batch: 2026-2030 | |
|---|---|---|---|
| Program: B Tech | | Current Academic Year: 2029-30 | |
| Branch: CSE-AIML | | Semester: VII | |
| 1 | Course Code | CSCR4700 | |
| 2 | Course Title | **Summer Internship-II** | |
| 3 | Credits | 2 | |
| 4 | Contact Hours (L-T-P-SL) | 0-0-4-0 | |
| | Course Status | UG | |
| 5 | Course Objective | 1. Experience the activities and functions of business professionals.<br>2. Develop and refine oral and written communication skills.<br>3. Identify areas for future knowledge and skill development. | |
| 6 | Course Outcomes | Students will be able to:<br>CO1. Integrate the concepts and strategies of academic study in a real time environment.<br>CO2. Identify, formulate and model problems and find engineering solutions based on a systems approach.<br>CO3. Develop teamwork and apply prior acquired knowledge in problem solving.<br>CO4. Develop communication, interpersonal and other critical skills required for career growth.<br>CO5. Practice engineer's responsibilities, self-understanding, self-discipline and ethical standards.<br>CO6. Explore career alternatives prior to graduation. | |
| 7 | Course Description | An internship experience provides the student with an opportunity to explore career interests while applying knowledge and skills learned in the classroom in a work setting. The experience also helps students gain a clearer sense of what they still need to learn and provides an opportunity to build professional networks. | |
| 8 | Outline syllabus | | CO Mapping |
| | **Unit 1** | Define objectives and conditions for the internship, ensuring students that it is related to the study path carried out at the University | **CO1, CO2** |
| | **Unit 2** | Problem Definition and identification, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any. | **CO2** |
| | **Unit 3** | The internship work plan is drawn up by developing team work and applies prior acquired knowledge in problem solving. | **CO3** |
| | **Unit 4** | Demonstrate and execute Project with the team. Submission of evaluation form and final report completed by the intern. | **CO4** |

| | | | | |
|---|---|---|---|---|
| | **Unit 5** | Final evaluation form completed by the supervisor at the Host Organization and final presentation before departmental committee. | | **CO5, CO6** |
| | Mode of examination | **Practical** | | |
| | Weightage Distribution | CA | CE (Viva) | ETE |
| | | 30% | 30% | 40% |
| | Text book/s* | NA | | |
| | Other References | | | |

## CO and PO Mapping

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | CO1. Integrate the concepts and strategies of academic study in a real time environment. | PO1, PO2, PO9, PO10, PO11, PSO1 |
| 2. | CO2. Identify, formulate and model problems and find engineering solution based on a systems approach. | PO1, PO2, PO3, PO4, PO5, PSO1, PSO2 |
| 3. | CO3. Develop teamwork and apply prior acquired knowledge in problem solving. | PO2, PO3, PO9, PO10, PO11, PSO1 |
| 4. | CO4. Develop communication, interpersonal and other critical skills required for career growth. | PO9, PO10, PO11 |
| 5. | CO5. Practice engineer's responsibilities, self-understanding, self-discipline and ethical standards. | PO6, PO8, PO9, PO10, PO11 |
| 6. | CO6. Explore career alternatives prior to graduation. | PO10, PO11 |

**PO and PSO mapping with level of strength for Course Name Summer Internship-II (CSP398)**

| COs \ POs/PSOs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | – | 1 | 1 | – | – | 2 | 2 | 2 | 2 | 1 | – |
| **CO2** | 2 | 3 | 2 | 2 | 2 | – | – | – | 1 | 1 | 1 | 3 | 2 | 1 |
| **CO3** | 1 | 2 | 2 | 1 | 1 | – | – | – | 3 | 2 | 2 | 2 | 1 | – |
| **CO4** | – | – | – | – | – | 1 | – | 1 | 2 | 3 | 2 | – | – | 1 |
| **CO5** | – | – | – | – | – | 2 | 1 | 3 | 2 | 2 | 2 | – | – | 1 |
| **CO6** | – | – | – | – | – | 1 | – | – | 1 | 2 | 3 | – | 1 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Avg PO attained** | 1.67 | 2.33 | 1.67 | 1.5 | 1.33 | 1.25 | 1 | 2 | 1.83 | 2 | 2 | 2.33 | 1.25 | 1 |

**Strength of Correlation: 23.16**

**1.** Addressed to **Slight (Low=1) extent**

**2.** Addressed to **Moderate (Medium=2) extent**

**3.** Addressed to **Substantial (High=3) extent**

# COURSE PLAN

Cyber Security in Blockchain Technology (CSAI4001)
Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML| Semester VII | Batch 2023–2027.
Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2029-30 |
| **Branch:** | CSE-AIML | **Semester:** | VII |
| **Course Code:** | CSAI4001 | **Course Type:** | Core — Theory Only |

## 2. Course Details

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI4001 |
| 2 | **Course Title** | Cyber Security in Blockchain Technology |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 30 hrs Classroom + 30 hrs Self Learning = 60 hrs total) |

| | | |
|---|---|---|
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | Introduce the fundamental concepts and techniques of Cyber Security in Blockchain Technology.<br>Develop understanding of image processing, feature extraction, and object representation methods.<br>Enable the design and analysis of algorithms for image classification, segmentation, and recognition tasks.<br>Develop the ability to implement Computer Vision models and evaluate their performance in real-world applications. |
| 7 | **Course Outcomes (COs)** | After successful completion of this course, students will be able to:<br>CO1 (Understand – L1/L2): Identify the challenges and understand the fundamental concepts, applications, and components of Cyber Security in Blockchain Technology systems.<br>CO2 (Explore – L2/L3): Explore image representation, image enhancement, filtering, feature extraction, and feature selection techniques used in Computer Vision.<br>CO3 (Apply – L3): Apply image processing and pattern recognition algorithms for object detection, image classification, segmentation, and recognition tasks.<br>CO4 (Analyze – L4/L5): Analyze and evaluate different machine learning and deep learning approaches used in Computer Vision applications.<br>CO5 (Analyze – L4/L5): Analyze various feature matching, clustering, and classification techniques for efficient pattern recognition and decision-making systems.<br>CO6 (Analyze – L2/L4): Understand and analyze real-world applications of Computer Vision such as face recognition, medical image analysis, autonomous systems, and surveillance systems. |
| 8 | **Course Description** | This course introduces the fundamental concepts and techniques of Cyber Security in Blockchain Technology, focusing on image processing, feature extraction, object detection, image classification, and recognition methods. It also covers machine learning and deep learning approaches for analyzing visual data and developing intelligent vision-based applications. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 30 hrs \| Self Learning (SL): 30 hrs \| Total: 60 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Digital Image Processing and Computer Vision"Cengage Learning, 1st Edition, 2008<br>2. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill. |

| | | |
|---|---|---|
| 12 | **References** | 1, Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.<br>2. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992.<br>3. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982. |

## 3. Outline Syllabus with CO Mapping

*All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | Unit 1: Introduction to Cyber Security in Blockchain Technology | |
| **A** | Introduction to Computer Vision and Pattern Recognition; Applications and Challenges; Human Vision vs Computer Vision | **CO1,CO2** |
| **B** | Digital Images and Image Representation; Pixels, Resolution, Color Models (RGB, Gray Scale) | **CO1,CO2** |
| **C** | Basics of Pattern Recognition; Types of Patterns; Recognition Systems and Applications | **CO1,CO2** |
| | **Unit 2: Image Processing Fundamentals** | |
| **A** | Image Enhancement Techniques: Contrast Stretching, Histogram Equalization, Noise Removal | **CO1, CO2** |
| **B** | Image Filtering: Mean Filter, Median Filter, Edge Detection Basics | **CO1, CO2** |
| **C** | Image Transformation Basics: Thresholding, Morphological Operations, Segmentation Introduction | **CO1, CO2** |
| | **Unit 3: Feature Extraction & Pattern Analysis** | |
| **A** | Feature Extraction Concepts; Shape, Color, and Texture Features | **CO1, CO2** |
| **B** | Feature Matching and Similarity Measures; Distance Metrics | **CO1, CO2, CO3, CO4** |
| **C** | Basics of Pattern Classification; Supervised and Unsupervised Learning | **CO1, CO2, CO3, CO4** |

| | | |
|---|---|---|
| | **Unit 4: Object Detection & Recognition** | |
| **A** | Object Detection Fundamentals; Face Detection and Recognition Basics | **CO1, CO2, CO3, CO5** |
| **B** | Image Classification Techniques; K-Nearest Neighbor (KNN), Decision Trees | **CO1, CO2, CO3, CO5** |
| **C** | Introduction to Deep Learning in Vision; Basics of CNN and Transfer Learning | **CO1, CO2, CO3, CO5** |
| | **Unit 5: Applications of Computer Vision** | |
| **A** | Medical Image Analysis and Disease Detection Applications | **CO1, CO2, CO3, CO6** |
| **B** | Applications in Autonomous Vehicles, Surveillance, and Smart Systems | **CO1, CO2, CO3, CO4, CO6** |
| **C** | Case Studies and Mini Projects in Cyber Security in Blockchain Technology | **CO1, CO2, CO3, CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | ✓ | ✓ | ✓ | | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | ✓ | | | | | ✓ | | | | |
| CO4 | | | | ✓ | ✓ | | | | | ✓ | | | | ✓ | | | | |
| CO5 | | | | ✓ | ✓ | | | | ✓ | | | | | ✓ | ✓ | | | |
| CO6 | | ✓ | | ✓ | | | | ✓ | | | | | | | ✓ | | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Cyber Security in Blockchain Technology; Applications and Challenges | UNIT-1 | 4 |
| DD/MM/YY | Human Vision vs Computer Vision; Digital Image Fundamentals | | |
| DD/MM/YY | Image Representation: Pixels, Resolution, Gray Scale and RGB Images | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Basics of Pattern Recognition; Recognition Systems and Applications | | |
| DD/MM/YY | Image Enhancement Techniques: Contrast Stretching and Histogram Equalization | UNIT-2 | 6 |
| DD/MM/YY | Noise Removal Techniques and Image Smoothing Filters | | |
| DD/MM/YY | Image Filtering: Mean, Median and Gaussian Filters | | |
| DD/MM/YY | Edge Detection Basics: Sobel, Prewitt and Canny Operators | | |
| DD/MM/YY | Thresholding and Morphological Operations | | |
| DD/MM/YY | Introduction to Image Segmentation Techniques | | |
| DD/MM/YY | Feature Extraction Concepts; Shape, Color and Texture Features | UNIT-3 | 8 |
| DD/MM/YY | Feature Matching and Similarity Measures | | |
| DD/MM/YY | Distance Metrics and Feature Selection Techniques | | |
| DD/MM/YY | Basics of Pattern Classification; Supervised Learning | | |
| DD/MM/YY | Unsupervised Learning and Clustering Techniques | | |
| DD/MM/YY | K-Nearest Neighbor (KNN) Classification Algorithm | | |
| DD/MM/YY | Decision Trees and Classification Performance Measures | | |
| DD/MM/YY | Case Studies on Pattern Recognition Applications | | |
| DD/MM/YY | Object Detection Fundamentals and Applications | UNIT-4 | 6 |
| DD/MM/YY | Face Detection and Face Recognition Techniques | | |
| DD/MM/YY | Image Classification using Traditional Machine Learning Techniques | | |
| DD/MM/YY | Introduction to Deep Learning and Neural Networks | | |
| DD/MM/YY | Basics of Convolutional Neural Networks (CNNs) | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Transfer Learning Concepts and Pre-trained Models | | |
| DD/MM/YY | Medical Image Analysis and Disease Detection Applications | UNIT-5 | 6 |
| DD/MM/YY | Applications in Autonomous Vehicles and Smart Surveillance | | |
| DD/MM/YY | Object Tracking and Activity Recognition Basics | | |
| DD/MM/YY | Computer Vision Applications in Robotics and Industry | | |
| DD/MM/YY | Mini Project Discussion and Real-World Case Studies | | |
| DD/MM/YY | Revision and Problem Solving Session | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Conceptual Recall & Vision Fundamentals | Recall fundamental concepts of Cyber Security in Blockchain Technology; identify image components, vision systems, and applications | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | Image Processing & Feature Interpretation | Explain image enhancement, filtering, segmentation, and feature extraction techniques; interpret processed image outputs | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |

| | | | | |
|---|---|---|---|---|
| **TS3** | Algorithmic Application & Classification | Apply classification and pattern recognition algorithms such as KNN, clustering, and feature matching techniques to solve problems | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| **TS4** | Vision System Analysis & Performance Evaluation | Analyze the effectiveness of object detection, image classification, and deep learning approaches; compare performance measures | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | Recognition System Analysis & Evaluation | Analyze feature selection, clustering, and recognition models; evaluate classification accuracy and efficiency | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | Real-World Vision Application Evaluation | Analyze real-world Computer Vision applications such as medical imaging, surveillance, autonomous systems, and robotics | CO6 \| L2–L4 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Process Interpretation | TS3 Algorithmic Application | TS4 Performance Evaluation | TS5 Memory System Analysis | TS6 File & Disk Evaluation |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | M | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

## 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| **Real-World Case Study (Report)** | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

## 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Introduction to Computer Vision, applications, image representation, color models | CO1 | TS1 | 5h SL | Report submission + evaluation |
| **Assignment 2** | Image enhancement, filtering, edge detection, segmentation techniques | CO2 | TS2 | 5h SL | Numerical problems on process management |
| **Assignment 3** | Feature extraction, feature matching, similarity measures, classification basics | CO2, CO3 | TS2, TS3 | 5h SL | Numerical computation + comparison |
| **Assignment 4** | KNN classification, clustering, object detection and recognition problems | CO3, CO4 | TS3, TS4 | 5h SL | Step-by-step numerical trace required |
| **Assignment 5** | CNN basics, transfer learning, image classification models | CO3, CO4, CO5 | TS3, TS4, TS5 | 5h SL | Algorithm application + performance analysis |
| **Video Learning Report** | Technical video on Computer Vision applications (medical imaging, surveillance, autonomous systems); self-learning presentation | CO2, CO3 | TS2, TS3 | 9h SL | Report: learning outcomes, key concepts, self-reflection. Presentation: 10 min |

| | | | | | |
|---|---|---|---|---|---|
| **Case Study Report** | Real-world Computer Vision case study (e.g., face recognition, autonomous vehicles, smart surveillance, medical diagnosis) | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Technical depth, data collection, fact finding, comparative analysis |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **10** | TS1 — Conceptual Recall & OS Identification TS2 — Conceptual Explanation & Process Interpretation | **CO1, CO2** | Short-answer: define OS types, explain process states, IPC mechanisms, describe semaphore working, identify scheduling criteria |
| **Section B** | **15** | TS3 — Algorithmic Application TS4 — Algorithmic Analysis & Performance Evaluation | **CO2, CO3, CO4** | Numerical problems: compute Gantt charts, CPU utilization, waiting/turnaround time; apply Banker's Algorithm; compare scheduling algorithms on performance criteria |
| **TOTAL** | **25** | TS1–TS4 | **CO1–CO4** | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1 — Conceptual Recall TS2 — Conceptual Explanation | **CO1, CO2** | Short questions (all units): definitions, OS type identification, process state diagrams, IPC mechanisms, synchronization concepts |
| **Section B** | **25** | TS3 — Algorithmic Application TS4 — Performance Evaluation TS5 — Memory System Analysis | **CO3, CO4, CO5** | Medium questions: scheduling algorithm numericals, deadlock handling, paging/segmentation calculations, page replacement algorithm traces, performance comparisons |

| | | | | |
|---|---|---|---|---|
| **Section C** | **10** | TS5 — Memory System Analysis TS6 — File & Disk Management Evaluation | **CO5, CO6** | Long/evaluation questions: virtual memory analysis, thrashing, disk scheduling comparisons (FCFS/SSTF/SCAN/C-SCAN), file system design, Windows OS case study analysis |
| **TOTAL** | **50** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Identify the challenges and understand the fundamental concepts, applications, and components of Cyber Security in Blockchain Technology systems. | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| **CO2** | Explore image representation, image enhancement, filtering, feature extraction, and feature selection techniques used in Computer Vision. | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| **CO3** | Apply image processing and pattern recognition algorithms for object detection, image classification, segmentation, and recognition tasks. | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Analyze and evaluate different machine learning and deep learning approaches used in Computer Vision applications. | ✓ | ✓ | ✓ | TS4 | PO9, PO10, PO11 |
| **CO5** | Analyze various feature matching, clustering, and classification techniques for efficient pattern recognition and decision-making systems. | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Understand and analyze real-world applications of Computer Vision such as face recognition, medical image analysis, autonomous systems, and surveillance systems. | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | 1 | | | | | | | 3 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | | | | | | | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 2 | | | | 1 | | | 3 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 3 | 3 | | | | 1 | 1 | | 3 | 3 | 2 |
| CO5 | 2 | 3 | 2 | 3 | 3 | | | | | 1 | | 3 | 3 | 2 |
| CO6 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | | 1 | 1 | | 2 | 3 | 2 |
| **Avg** | **2.5** | **2.67** | **2.4** | **2.6** | **2.17** | **1** | **1** | | **1** | **1** | | **2.83** | **2.83** | **2.5** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | H | H | | | | M | M | M | M | H | M | M |
| CO2 | H | M | H | H | | | | M | M | M | M | M | H | M |
| CO3 | H | H | H | H | | | | M | M | M | H | H | M | M |
| CO4 | M | M | M | M | M | | | M | H | H | H | M | M | M |
| CO5 | M | M | H | | | | | H | H | M | M | H | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | H | M | | | | | | | | M | H | M | M | |

## 14. Self-Learning Activities (SL: 30 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Numerical Assignment Writing (5 assignments, problem-based, one per unit focus area)** | 5 assignments × 3 hrs each<br>Total = 15 hrs | CO1–CO4 TS1–TS4 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance |
| 2 | **Technical Video-Based Learning related to the subject (e.g., OS scheduling, deadlock, memory management)** | Video viewing: 3 hrs<br>Report preparation: 3 hrs<br>Presentation: 3 hrs<br>Total = 9 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, algorithms, and personal reflections |
| 3 | **Real-World Case Studies (e.g., Linux/Windows OS internals, Android memory management, cloud OS design)** | Data collection/study: 4 hrs<br>Report preparation: 2 hrs<br>Total = 6 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, and analytical conclusions drawn |
| | **TOTAL Self-Learning Hours** | **30 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

CBT401 — MEASUREMENT ARCHITECTURE SUMMARY
Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)
CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A
CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B
CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C
CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks

# COURSE PLAN

## Industrial IoT 4.0 (CSAI4002)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VII | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2029–30 |
| **Branch:** | CSE-AIML | **Semester:** | VII |
| **Course Code:** | CSAI4002 | **Course Type:** | Core — Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSAI4002** |
| 2 | **Course Title** | **Industrial IoT 4.0** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 30 hrs Classroom + 30 hrs Self Learning = 60 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |

| | | |
|---|---|---|
| 6 | **Course Objectives** | 1. Introduce the concept of Industry 4.0 (Industrial Internet) and its relevance in modern industries.<br>2. Explore real-world applications of Industry 4.0 in the business context.<br>3. Understand how data-driven smartness is leveraged in industrial processes.<br>4. Identify and evaluate the challenges associated with implementing Industry 4.0 technologies. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Define the concept of Industry 4.0<br>CO2 (Explore – L2/L3): Identify design principles under the industry 4.0 umbrella<br>CO3 (Apply – L3): Explain the drivers and features of Servitization and Product Service-System (PSS).<br>CO4 (Analyze – L4/L5): Analyze 5C Cyber Physical System architecture for Industry 4.0<br>CO5 (Analyze – L4/L5): Discuss the impact of digital transformation on transportation and logistics.<br>CO6 (Analyze – L2/L4): Determine the opportunities, challenges brought about by Industry 4.0 to earn the benefits. |
| 8 | **Course Description** | Industry 4.0 refers to fourth generation of industrial activity characterized by smart systems and internet-based solutions. Applicability of 4.0 in transportation, energy and infrastructure is explored, with effects on technology, organization and operations from a systems perspective. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 30 hrs \| Self Learning (SL): 30 hrs \| Total: 60 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | Handbook of Industry 4.0 and SMART Systems by Diego Galar Pascual, Pasquale Daponte, Uday Kumar, CRC Press |
| 12 | **References** | 1. Industry 4.0: Managing The Digital Transformation, Duc Truong Pham, University of Birmingham, Birmingham, UK, Springer<br>2. The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, Springer |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Fundamentals of IoT 4.0** | |
| **A** | Definition of Industry 4.0, Key Paradigm of Industry 4.0, Industry 4.0 Conception: Five Main Components of Networked Production | **CO1** |
| **B** | Framework of Industry 4.0: Conception and Technologies, Nine Pillars of Technological Advancement | **CO1** |

| | | |
|---|---|---|
| C | Macro Perspective of Industry 4.0, Micro Perspective of Industry 4.0, Industry 4.0 Components | CO1 |
| | **Unit 2: Industry 4.0: Design Principles** | |
| A | Interoperability, Virtualization, Decentralization, Real-Time Capability, Service Orientation, Modularity, Impact of Industry 4.0 | CO1, CO2 |
| B | RAMI 4.0 (Reference Architecture Model Industry 4.0), Additional Details of RAMI 4.0: Function of Layers on Vertical Axis, Function of Layers on the Horizontal Left Axis, Hierarchical System Architecture in Industry 4.0 | CO1, CO2 |
| C | Industry 4.0 Component Model: Specification of the Industry 4.0 Component Model | CO1, CO2 |
| | **Unit 3: Servitization and Product Service-System(PSS)** | |
| A | The concept of Servitization, Drivers and Features of Servitization, Current State of Servitization and Impacts from Industry 4.0, Industry 4.0 Services\\ | CO1, CO2, CO3,CO6 |
| B | Product Service-System (PSS), Definition, Features of a PSS: PoPSS, UoPSS, RoPSS | CO1, CO2, CO3, CO6 |
| C | Pervasive Computing, Applications of Pervasive Computing, Pervasive Computing and Internet of Things (IoT) | CO1, CO2, CO3, CO6 |
| | **Unit 4: The Industry 4.0 Architecture and Cyber-Physical Systems** | |
| A | Concept and Characteristics of Cyber-Physical Systems, CPS 5C Level Architecture | CO1, CO2, CO4 |
| B | Implementation of 5C CPS Architecture in Factories, Classification of CPS in Context of Industry 4.0 | CO1, CO2, CO4, CO6 |
| C | IT and OT Convergence in Industrial IoT, Industry 4.0 Principles: Horizontal and Vertical Integration, Basic Functions and Uses of CPS | CO1, CO2, CO4, CO6 |
| | **Unit 5: Industry 4.0 across the Sectors** | |
| A | Introduction, Transportation 4.0: Multimodal Transportation Systems | CO4, CO5, CO6 |
| B | Rail 4.0, Digital Transformation of Railways | CO4, CO5, CO6 |
| C | Logistics 4.0 | CO4, CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 1.C | ✓ | ✓ | ✓ | | | |
| 4 | 2.A | ✓ | ✓ | ✓ | ✓ | | |
| 5 | 2.B | ✓ | ✓ | ✓ | ✓ | | |
| 6 | 2.C | ✓ | ✓ | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 8 | 3.B | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 9 | 3.C | ✓ | ✓ | ✓ | ✓ | | |
| 10 | 4.A | ✓ | ✓ | ✓ | ✓ | | |
| 11 | 4.B | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 12 | 4.C | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 13 | 5.A | ✓ | ✓ | ✓ | ✓ | | |
| 14 | 5.B | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 15 | 5.C | ✓ | ✓ | ✓ | ✓ | | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | ✓ | | | | | | | | | | | |
| CO2 | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | | | | | ✓ | | | | | |
| CO3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | | | | ✓ | | | | | |
| CO4 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | |
| CO5 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | | | ✓ | | | | | |
| CO6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | | | | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be Covered/Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Definition of Industry 4.0; Key Paradigm of Industry 4.0 | UNIT-1 | 4 |
| DD/MM/YY | Industry 4.0 Conception: Five Main Components of Networked Production | | |
| DD/MM/YY | Framework of Industry 4.0: Conception and Technologies | | |
| DD/MM/YY | Nine Pillars of Technological Advancement; Macro and Micro Perspective of Industry 4.0 | | |
| DD/MM/YY | Design Principles: Interoperability, Virtualization, Decentralization | UNIT-2 | 6 |
| DD/MM/YY | Real-Time Capability, Service Orientation, Modularity | | |
| DD/MM/YY | Impact of Industry 4.0 on Industry and Society | | |
| DD/MM/YY | RAMI 4.0 (Reference Architecture Model Industry 4.0) | | |
| DD/MM/YY | Function of Layers on Vertical and Horizontal Axis in RAMI 4.0 | | |
| DD/MM/YY | Industry 4.0 Component Model and Hierarchical System Architecture | | |
| DD/MM/YY | Concept of Servitization and Industry 4.0 Services | UNIT-3 | 7 |
| DD/MM/YY | Drivers and Features of Servitization | | |
| DD/MM/YY | Current State of Servitization and Impact of Industry 4.0 | | |
| DD/MM/YY | Product Service-System (PSS): Definition and Features | | |
| DD/MM/YY | Types of PSS: PoPSS, UoPSS, RoPSS | | |
| DD/MM/YY | Pervasive Computing and Applications | | |
| DD/MM/YY | Pervasive Computing and Internet of Things (IoT) | | |
| DD/MM/YY | Concept and Characteristics of Cyber-Physical Systems (CPS) | UNIT-4 | 7 |
| DD/MM/YY | CPS 5C Level Architecture | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Implementation of 5C CPS Architecture in Smart Factories | | |
| DD/MM/YY | Classification of CPS in Context of Industry 4.0 | | |
| DD/MM/YY | IT and OT Convergence in Industrial IoT | | |
| DD/MM/YY | Horizontal and Vertical Integration | | |
| DD/MM/YY | Basic Functions and Uses of CPS | | |
| DD/MM/YY | Introduction to Transportation 4.0 | UNIT-5 | 6 |
| DD/MM/YY | Multimodal Transportation Systems | | |
| DD/MM/YY | Rail 4.0 and Digital Transformation of Railways | | |
| DD/MM/YY | Smart Transportation Infrastructure and Industry 4.0 Applications | | |
| DD/MM/YY | Logistics 4.0: Concepts, Technologies, and Applications | | |
| DD/MM/YY | Opportunities and Challenges of Industry 4.0 across Sectors | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Fundamentals of Industry 4.0** | Knowledge of Industry 4.0 concepts, paradigms, frameworks, components, and technological pillars | CO1 / L1–L2 | CA \| MTE Sec A \| ETE Sec A |

| | | | | |
|---|---|---|---|---|
| **TS2** | **Industry 4.0 Design Principles and Architecture** | Understanding of interoperability, virtualization, decentralization, RAMI 4.0, and Industry 4.0 component models | CO2 / L2–L4 | CA \| MTE Sec A \| ETE Sec A |
| **TS3** | **Servitization and Product Service-System (PSS)** | Application and analysis of Servitization, PSS models, pervasive computing, and IoT integration | CO3 / L3–L4 | CA \| MTE Sec B \| ETE Sec B |
| **TS4** | **Cyber-Physical Systems and CPS 5C Architecture** | Analytical understanding of CPS concepts, 5C architecture, smart factories, and IT–OT convergence | CO4 / L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | **Industry 4.0 in Transportation and Logistics** | Evaluation of Transportation 4.0, Rail 4.0, digital railway systems, and Logistics 4.0 | CO5 / L4–L5 | ETE Sec B/C |
| **TS6** | **Opportunities and Challenges in Industry 4.0** | Assessment of benefits, implementation challenges, industrial transformation, and strategic opportunities | CO6 / L5–L6 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Process Interpretation | TS3 Algorithmic Application | TS4 Performance Evaluation | TS5 Memory System Analysis | TS6 File & Disk Evaluation |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | M | H | M | M | | |
| CO4 | M | H | M | H | | |
| CO5 | | M | M | H | M | |
| CO6 | M | M | | H | H | M |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| **Real-World Case Study (Report)** | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

## 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Definition of Industry 4.0, Key Paradigm, Five Main Components of Networked Production, Nine Pillars of Technological Advancement | CO1 | TS1 | 5h SL | Understanding of Industry 4.0 concepts, accuracy of explanation, clarity of presentation |
| **Assignment 2** | Industry 4.0 Design Principles: Interoperability, Virtualization, Decentralization, RAMI 4.0 Architecture | CO1,CO2 | TS2 | 5h SL | Interpretation of design principles, architecture explanation, conceptual clarity |
| **Assignment 3** | Servitization, Product Service-System (PSS), Pervasive Computing and IoT Applications | CO2,CO3 | TS3 | 5h SL | Application-oriented analysis, explanation of PSS models, IoT integration understanding |
| **Assignment 4** | Cyber-Physical Systems, CPS 5C Architecture, IT–OT Convergence in Industrial IoT | CO4 | TS4 | 5h SL | Analytical understanding of CPS architecture, industrial implementation, technical correctness |
| **Assignment 5** | Transportation 4.0, Rail 4.0, Logistics 4.0 and Digital Transformation | CO5,C06 | TS5,TS6 | 5h SL | Evaluation of Industry 4.0 applications, critical analysis of opportunities and challenges |
| **Video Learning Report** | Smart Manufacturing, Industry 4.0 Technologies | CO1,CO2,CO6 | TS1,TS2,TS6 | 9h SL | Summary quality, linkage with syllabus |

| | | | | | |
|---|---|---|---|---|---|
| | and Industrial Applications | | | | concepts, analytical observations |
| **Case Study Report** | Case Study on Industry 4.0 Adoption in Smart Factories / Logistics / Transportation Systems | CO3,CO4,C05,C06 | TS3,TS4,TS5,TS6 | 6h SL | Case analysis, practical relevance, evaluation of implementation benefits and challenges |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **10** | TS1— Conceptual Recall,TS2— Conceptual Explanation | CO1,CO2 | Short answer questions covering fundamentals of Industry 4.0, key paradigms, design principles, RAMI 4.0, and conceptual understanding. Focus on definitions, explanations, and basic interpretations. |
| **Section B** | **15** | TS3 — Application of Industry 4.0 Concepts,TS4 — Analytical Evaluation of CPS and Industrial Systems | CO3,CO4 | Descriptive and analytical questions based on Servitization, Product Service-System (PSS), Cyber-Physical Systems, CPS 5C architecture, and IT–OT convergence. Questions should test application, analysis, and evaluation abilities. |
| **TOTAL** | **25** | TS1–TS4 | **CO1–CO4** | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1 — Conceptual Recall<br>TS2 — Conceptual Explanation | **CO1, CO2** | Short questions from all units covering definitions of Industry 4.0, key paradigms, nine technological pillars, design principles, RAMI 4.0 architecture, Industry 4.0 component model, and conceptual explanations of smart manufacturing systems. |

| | | | | |
|---|---|---|---|---|
| **Section B** | **25** | TS3 — Application of Industry 4.0 Concepts TS4 — Analytical Evaluation of CPS and Industrial Systems TS5 — Industrial System and Logistics Analysis | **CO3, CO4, CO5** | Medium/descriptive questions involving Servitization, Product Service-System (PSS), pervasive computing, IoT applications, CPS 5C architecture, IT–OT convergence, smart factories, Transportation 4.0, Rail 4.0, and Logistics 4.0 analysis. |
| **Section C** | **10** | TS5 — Industrial Transformation Analysis TS6 — Evaluation of Industry 4.0 Opportunities and Challenges | **CO5, CO6** | Long analytical/evaluation-based questions on digital transformation in transportation and logistics, implementation challenges of Industry 4.0, benefits of CPS integration, future industrial opportunities, and case-study-based evaluations. |
| **TOTAL** | **50** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Define and understand the fundamental concepts, paradigms, frameworks, and components of Industry 4.0 | ✓ | ✓ | ✓ | TS1 | PO1, PO2 |
| **CO2** | Explain and interpret Industry 4.0 design principles, RAMI 4.0, and Industry 4.0 component architecture | ✓ | ✓ | ✓ | TS2 | PO1, PO2, PO3 |
| **CO3** | Apply Servitization, Product Service-System (PSS), pervasive computing, and IoT concepts in industrial contexts | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Analyze Cyber-Physical Systems, CPS 5C architecture, and IT–OT convergence in smart factories | ✓ | ✓ | ✓ | TS4 | PO1,PO2,PO4,PO5 |
| **CO5** | Evaluate digital transformation in Transportation 4.0, Rail 4.0, and Logistics 4.0 | ✓ | — | ✓ | TS5 | PO1, PO2, PO8,PO10 |
| **CO6** | Assess opportunities, benefits, and implementation challenges of Industry 4.0 technologies | ✓ | — | ✓ | TS6 | PO1, PO2, PO9, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

*Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | - | - | - | 1 | 1 | 1 | 1 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 1 | - | - | 1 | 2 | 1 | 1 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 1 | - | - | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | - | - | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| CO5 | 2 | 3 | 2 | 2 | 1 | - | - | 3 | 3 | 2 | 2 | 2 | 2 | 1 |
| CO6 | 3 | 3 | 2 | 2 | 1 | - | - | 3 | 3 | 3 | 3 | 2 | 2 | 1 |
| Avg | 2.83 | 3.00 | 2.50 | 2.33 | 1.20 | - | - | 2.00 | 2.33 | 1.83 | 1.83 | 2.67 | 2.33 | 1.50 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | M | M | | | | M | | | | H | M | |
| CO2 | H | H | H | M | M | | | M | M | | | H | H | M |
| CO3 | H | H | H | H | M | | | M | M | M | | H | M | M |
| CO4 | H | H | H | H | M | | | M | H | M | | H | H | M |
| CO5 | M | H | M | M | | | | H | H | M | | M | M | |
| CO6 | H | H | M | M | | | | H | H | H | M | M | M | |

## 14. Self-Learning Activities (SL: 30 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Assignment Writing based on Industry 4.0 concepts (5 assignments covering Industry 4.0 fundamentals, RAMI 4.0, Servitization, CPS, Logistics 4.0)** | 5 assignments × 3 hrs each<br>Total = 15 hrs | CO1–CO4 TS1–TS4 | Evaluated based on conceptual understanding, architecture explanation, analytical ability, case examples, and quality of report submission |
| 2 | **Technical Video-Based Learning related to Industry 4.0, Smart Manufacturing, CPS, IoT, Transportation 4.0, and Logistics 4.0** | Video viewing: 3 hrs<br>Report preparation: 3 hrs<br>Presentation: 3 hrs<br>Total = 9 hrs | CO2, CO3,CO4 TS2, TS3,TS4 | Report and presentation evaluated on understanding of Industry 4.0 technologies, interpretation of industrial applications, technical insights, and learning reflections |
| 3 | **Real-World Case Studies on Smart Factories, Rail 4.0, Logistics 4.0, IT–OT Convergence, and Industrial IoT Applications** | Data collection/study: 4 hrs<br>Report preparation: 2 hrs<br>Total = 6 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on practical relevance, analytical depth, industrial case interpretation, opportunities/challenges identified, and quality of conclusions |
| | **TOTAL Self-Learning Hours** | **30 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**CSE 254 — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks

# COURSE PLAN

## LLMs (CSCR3203)

*Sharda School of Computing Science & Engineering | B.Tech CSE-AIML | Semester VII | Batch 2023–2027*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

**PART I**

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE- Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2029–30 |
| **Branch:** | CSE-AIML | **Semester:** | VII |
| **Course Code:** | CSCR3203 | **Course Type:** | Core — Theory Only |

## 2. Course Details

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSCR3203 |
| 2 | **Course Title** | LLMs |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs Classroom + 45 hrs Self Learning = 90 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |

| | | |
|---|---|---|
| 6 | **Course Objectives** | 1. Understand the evolution, architecture, and working principles of large language models, along with their foundations in NLP and deep learning.<br>2. Explore transformer-based architectures, attention mechanisms, and their role in sequence modeling and natural language understanding.<br>3. Apply LLMs to practical tasks such as text generation, code synthesis, and multimodal applications using industry-standard tools and frameworks.<br>4. Analyze the ethical, societal, and regulatory implications of deploying generative models, including issues of bias, hallucination, and responsible AI.<br>5. Evaluate and design innovative solutions by integrating prompt engineering, parameter-efficient adaptation, and workflow toolkits for real-world applications. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Identify the foundational concepts of NLP and Deep Learning, and understand the evolution, types, and training objectives of language models.<br>CO2 (Explore – L2/L3): Explore word representation techniques, tokenization strategies, and transfer learning approaches in NLP, including pretraining and fine-tuning.<br>CO3 (Apply – L3): Apply attention mechanisms and transformer architectures to implement NLP tasks, and experiment with models such as BERT, GPT, and T5.<br>CO4 (Analyze – L4/L5): Analyze the scaling laws, in-context learning capabilities, and efficiency of transformer-based LLMs, interpreting their strengths and limitations.<br>CO5 (Evaluate – L4/L5): Evaluate prompt engineering strategies, workflow integration using APIs and toolkits (OpenAI, Hugging Face, LangChain), and assess their effectiveness in real-world applications.<br>CO6 (Create – L6): Design innovative solutions using LLMs by integrating prompt engineering, decentralized workflows, and ethical frameworks, while addressing bias, hallucination, and regulatory considerations. |
| 8 | **Course Description** | This course provides a comprehensive introduction to the foundations and recent advances in Large Language Models (LLMs). Beginning with core concepts in Natural Language Processing (NLP) and Deep Learning, it explores transformer architectures, attention mechanisms, and prompt engineering strategies. Learners will gain hands-on experience with modern toolkits and parameter-efficient adaptation techniques, while critically examining evaluation methods, bias, and ethical implications. The course equips students with both technical proficiency and responsible AI perspectives, preparing them to design and analyze cutting-edge language technologies. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1.'You Look Like a Thing and I Love You: How AI Works and Why It's Making the World a Weirder Place', Janelle Shane, Publisher: Voracious (Little, Brown), 2019 |
| 12 | **References** | 2. Deep Learning with Python, François Chollet, Manning Publications, Edition: 2nd Edition (2021) |

| | | |
|---|---|---|
| | | 3. Transformers for Natural Language Processing: Build and Train State-of-the-Art Natural Language Processing Models Using the Transformer Architecture, Denis Rothman, Packt Publishing, 2nd Edition (2022). |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Introduction to NLP and Deep Learning** | |
| **A** | Introduction to LLM and recent advances in generative AI | **CO1** |
| **B** | Fundamentals of Natural Language Processing – Statistical vs Neural Language Models; N-grams; Perplexity; Training objectives (causal vs masked). | **CO1** |
| **C** | Basics of Deep Learning – Neural Language Models (CNN, RNN, LSTM, GRU); role in NLP tasks. | **CO1** |
| | **Unit 2: Foundations of LLMs and Attention Mechanism** | |
| **A** | Emergence of LLMs – History and evolution; Word representation techniques (Word2Vec, FastText, GloVe, GPT); Tokenization strategies. | **CO2** |
| **B** | Transfer learning in NLP; Pretraining vs fine-tuning, Sequence-to-Sequence Models | **CO2** |
| **C** | Attention Mechanism-Scaled dot-product attention, self-attention, positional encodings. | **CO2** |
| | **Unit 3: Transformer Architectures** | |
| **A** | Transformer Architecture: Encoder-decoder framework, Comparative study of BERT, GPT, T5, LLaMA. | **CO3, CO4** |
| **B** | Parameter scaling and capabilities – Scaling laws, in-context learning, zero-shot vs few-shot learning. | **CO3, CO4** |
| **C** | Advanced concepts – Handling long sequences, efficiency improvements (sparse attention, retrieval-augmented transformers). | **CO3, CO4** |

| | | |
|---|---|---|
| | **Unit 4: Prompt Engineering and Toolkits** | |
| **A** | Prompt Engineering Basics – Zero-shot, one-shot, few-shot prompts; Formatting; Instruction tuning. | **CO3, CO5, CO6** |
| **B** | APIs and Libraries – Hands-on with OpenAI API, Hugging Face Transformers, Google PaLM; Input-output control. | **CO3, CO5, CO6** |
| **C** | LangChain and Workflow Integration – Agents, Chains, Memory; Connecting LLMs to external tools and data pipelines. | **CO3, CO5, CO6** |
| | **Unit 5: Evaluation, Bias, and Ethics** | |
| **A** | Output Evaluation Metrics- BLEU, ROUGE, perplexity, truthfulness, helpfulness, Human vs automated evaluation. | **CO4, CO5,** |
| **B** | Bias and Hallucination – Failure cases (hallucination, toxicity, social bias); Red-teaming models. | **CO4, CO5,** |
| **C** | Ethical & Regulatory Frameworks – Responsible AI principles; Guidelines by OpenAI, EU AI Act, and global AI ethics frameworks. | **CO4, CO5, CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | ✓ | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | ✓ | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | ✓ |
| 13 | 5.A | | ✓ | ✓ | | ✓ | |
| 14 | 5.B | | | ✓ | ✓ | ✓ | |
| 15 | 5.C | | ✓ | | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | | | | | | | | | | | | | | | ✓ | | |
| CO2 | ✓ | ✓ | | | | | | | | | | | | | | ✓ | | |
| CO3 | | ✓ | ✓ | | | | | | | | | | | ✓ | | | | |
| CO4 | | | ✓ | ✓ | | | | ✓ | | | | | | | | | | |
| CO5 | | | ✓ | ✓ | | | | ✓ | | | | | | | | | | |
| CO6 | ✓ | ✓ | ✓ | | ✓ | | | | | | | | | | | ✓ | | |

*Legend: ✓= Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ *Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 11.*

| Date (DD/MM/YY) | Topics to be Covered / Title | Unit | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to LLMs and recent advances in generative AI | Unit-1 | 10 |
| DD/MM/YY | Evolution of NLP and role of Deep Learning | | |
| DD/MM/YY | Statistical vs Neural Language Models | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | N-grams and Perplexity | | |
| DD/MM/YY | Training objectives – causal vs masked | | |
| DD/MM/YY | Basics of Deep Learning – CNN | | |
| DD/MM/YY | Basics of Deep Learning – RNN | | |
| DD/MM/YY | Basics of Deep Learning – LSTM & GRU | | |
| DD/MM/YY | Recap & Case Study (Unit-1) | | |
| DD/MM/YY | Emergence of LLMs – History and evolution | Unit-2 | 10 |
| DD/MM/YY | Word representation – Word2Vec | | |
| DD/MM/YY | Word representation – FastText | | |
| DD/MM/YY | Word representation – GloVe | | |
| DD/MM/YY | GPT and Tokenization strategies | | |
| DD/MM/YY | Transfer learning – Pretraining vs fine-tuning | | |
| DD/MM/YY | Sequence-to-Sequence Models | | |
| DD/MM/YY | Attention Mechanism – Scaled dot-product | | |
| DD/MM/YY | Self-attention mechanism | | |
| DD/MM/YY | Positional encodings | | |
| DD/MM/YY | Transformer Architecture – Encoder–decoder framework | Unit-3 | 11 |
| DD/MM/YY | Transformer Architecture – BERT | | |
| DD/MM/YY | Transformer Architecture – GPT,T5 | | |
| DD/MM/YY | Transformer Architecture – LLaMA | | |
| DD/MM/YY | Parameter scaling laws | | |
| DD/MM/YY | In-context learning | | |
| DD/MM/YY | Zero-shot vs few-shot learning | | |
| DD/MM/YY | Handling long sequences | | |
| DD/MM/YY | Sparse attention techniques | | |
| DD/MM/YY | Retrieval-augmented transformers | | |
| DD/MM/YY | Implementing Transformer Models | | |
| DD/MM/YY | Prompt Engineering Basics – Zero-shot prompts, One-shot prompts,Few-shot prompts | Unit-4 | 9 |
| DD/MM/YY | Prompt Engineering Examples | | |
| DD/MM/YY | Instruction tuning | | |
| DD/MM/YY | APIs – OpenAI API | | |
| DD/MM/YY | APIs – Hugging Face Transformers | | |
| DD/MM/YY | APIs – Google PaLM | | |
| DD/MM/YY | LangChain – Agents and Chains | | |
| DD/MM/YY | LangChain – Memory | | |
| DD/MM/YY | Workflow Integration – Connecting LLMs to tools and data | | |
| DD/MM/YY | Output Evaluation Metrics – BLEU, ROUGE, Perplexity | Unit-5 | 5 |
| DD/MM/YY | Truthfulness, helpfulness; Human vs automated evaluation | | |
| DD/MM/YY | Bias and Hallucination – Failure cases, Red-teaming models | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Ethical & Regulatory Frameworks – Responsible AI principles | | |
| DD/MM/YY | Guidelines – OpenAI, EU AI Act, Global frameworks | | |
| DD/MM/YY | Case Studies & Future Trends | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| **TS1** | **Conceptual Recall & NLP Foundations** | Recall fundamental NLP and Deep Learning concepts; identify types of language models, training objectives (causal vs masked), and neural architectures (CNN, RNN, LSTM, GRU). | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| **TS2** | **Representation & Transfer Learning Explanation** | Explain word representation techniques (Word2Vec, FastText, GloVe, GPT), tokenization strategies, and transfer learning approaches (pretraining vs fine-tuning, Seq2Seq). | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A/B |
| **TS3** | **Transformer Application & Implementation** | Apply transformer architectures (BERT, GPT, T5, LLaMA) and attention mechanisms to NLP tasks; implement workflows using APIs and libraries (OpenAI, Hugging Face, PaLM). | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B/C |
| **TS4** | **Scaling & Capability Analysis** | Analyze scaling laws, in-context learning, zero/few-shot capabilities; interpret efficiency improvements (sparse attention, retrieval augmentation). | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | **Prompt Engineering & Evaluation** | Evaluate prompt engineering strategies (zero/one/few-shot, instruction tuning), output | CO5 \| L4–L5 | ETE Sec B/C |

| | | | | |
|---|---|---|---|---|
| | | metrics (BLEU, ROUGE, perplexity, truthfulness), and workflow integration effectiveness. | | |
| **TS6** | **Ethics, Bias & Responsible AI Design** | Analyze bias, hallucination, and toxicity in LLMs; evaluate ethical/regulatory frameworks (Responsible AI, EU AI Act); design responsible solutions integrating fairness and compliance. | CO6 \| L2–L4 | ETE Sec A/C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall (NLP Foundations) | TS2 Representation & Transfer Learning | TS3 Transformer Application | TS4 Scaling & Capability Analysis | TS5 Prompt Engineering & Evaluation | TS6 Ethics, Bias & Responsible AI |
|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | | | | |
| **CO2** | **M** | **H** | **M** | | | |
| **CO3** | | **M** | **H** | **M** | | |
| **CO4** | | | **M** | **H** | **M** | |
| **CO5** | | | | **M** | **H** | **M** |
| **CO6** | **M** | | **M** | **M** | **M** | **H** |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| **Real-World Case Study (Report)** | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 concepts: Introduction to LLMs, NLP foundations, training objectives (causal vs masked) | CO1 | TS1 | 6h SL | Report submission + conceptual recall evaluation |
| **Assignment 2** | Word representation (Word2Vec, FastText, GloVe, GPT) and tokenization strategies | CO2 | TS2 | 6h SL | Numerical/analytical problems on embeddings & tokenization |
| **Assignment 3** | Transformer architectures (BERT, GPT, T5, LLaMA) – comparative study and application | CO2, CO3 | TS2, TS3 | 6h SL | Short answer + implementation trace of transformer workflow |
| **Assignment 4** | Scaling laws, in-context learning, zero/few-shot learning – performance analysis | CO3, CO4 | TS3, TS4 | 6h SL | Analytical problem set + trade-off evaluation |
| **Assignment 5** | Prompt engineering strategies (zero/one/few-shot, instruction tuning) and evaluation metrics (BLEU, ROUGE, perplexity) | CO4, CO5 | TS4, TS5 | 6h SL | Algorithm application + performance comparison |
| **Video Learning Report** | Technical video on transformer models or prompt engineering (min 3 hrs); structured report + class presentation | CO2, CO3 | TS2, TS3 | 9h SL | Report: learning outcomes, key concepts, self-reflection. Presentation: 10 min |
| **Case Study Report** | Real-world LLM case study (e.g., GPT-4 deployment, Hugging Face applications, bias/hallucination in production systems); in-depth analysis report | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Technical depth, data collection, fact finding, ethical/regulatory analysis |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **10** | TS1 – Conceptual Recall & NLP Foundations TS2 – Representation & Transfer Learning Explanation | **CO1, CO2** | Short-answer: define NLP concepts, explain training objectives (causal vs masked), describe word representation methods (Word2Vec, FastText, GloVe), |

| | | | | |
|---|---|---|---|---|
| | | | | explain tokenization strategies, interpret transfer learning approaches. |
| **Section B** | **15** | TS3 – Transformer Application & Implementation TS4 – Scaling & Capability Analysis | **CO2, CO3, CO4** | Numerical/analytical problems: trace transformer attention outputs, compute embedding similarities, apply scaling laws to parameter growth, compare zero-shot vs few-shot performance, analyze efficiency improvements (sparse attention, retrieval augmentation). |
| **TOTAL** | **25** | TS1–TS4 | **CO1–CO4** | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Section | Marks | Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|---|---|
| **Section A** | **15** | TS1 – Conceptual Recall & NLP Foundations TS2 – Representation & Transfer Learning Explanation | **CO1, CO2** | Short questions (all units): definitions of NLP concepts, training objectives (causal vs masked), word representation methods (Word2Vec, FastText, GloVe, GPT), tokenization strategies, transfer learning approaches. |
| **Section B** | **25** | TS3 – Transformer Application & Implementation TS4 – Scaling & Capability Analysis TS5 – Prompt Engineering & Evaluation | **CO3, CO4, CO5** | Medium questions: trace transformer attention outputs, apply scaling laws, compare zero/few-shot learning, implement prompt engineering strategies, compute evaluation metrics (BLEU, ROUGE, perplexity), analyze efficiency improvements (sparse attention, retrieval augmentation). |
| **Section C** | **10** | TS5 – Prompt Engineering & Evaluation TS6 – Ethics, Bias & Responsible AI | **CO5, CO6** | Long/evaluation questions: analyze bias and hallucination cases, evaluate ethical/regulatory frameworks (Responsible AI, EU AI Act), discuss prompt engineering failures, design responsible AI solutions, case study analysis of real-world LLM deployment. |
| **TOTAL** | **50** | TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Identify foundational concepts of NLP & Deep Learning; understand evolution, types, and training objectives of LMs | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| CO2 | Explore word representation, tokenization, and transfer learning (pretraining vs fine-tuning) | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| CO3 | Apply attention mechanisms & transformer architectures (BERT, GPT, T5) to NLP tasks | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| CO4 | Analyze scaling laws, in-context learning, and efficiency of LLMs | ✓ | ✓ | ✓ | TS4 | PO9, PO10, PO11 |
| CO5 | Evaluate prompt engineering, workflow integration (APIs, toolkits), and effectiveness in real-world applications | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| CO6 | Design innovative LLM solutions integrating prompt engineering, workflows, and ethical frameworks (bias, hallucination, regulation) | ✓ | — | ✓ | TS6 | PO1, PO2, PO9, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | – | – | – | 2 | 2 | 1 | 2 | 3 | 2 | 2 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 2 | 3 | 3 | – | – | – | 2 | 2 | 2 | 1 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | – | – | – | 1 | 1 | 1 | 3 | 3 | 2 | 1 |
| CO4 | 2 | 2 | 2 | 2 | 1 | – | – | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 3 | – | – | – | – | 3 | 3 | 1 | 2 | 3 | – | – |
| CO6 | 3 | 2 | – | – | – | – | – | 3 | 3 | 2 | 3 | 2 | 2 | 3 |
| **Avg** | **2.67** | **2.33** | **2.80** | **2.75** | **1.00** | **–** | **–** | **2.17** | **2.33** | **1.67** | **2.33** | **2.50** | **2.20** | **2.00** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | H | H | | | | M | M | M | M | H | M | M |
| CO2 | H | M | H | H | | | | M | M | M | M | M | H | M |
| CO3 | H | H | H | H | | | | M | M | M | H | H | M | M |
| CO4 | M | M | M | M | M | | | M | H | H | H | M | M | M |
| | | | | | | | | | | | | | | |
| CO5 | M | M | H | | | | | H | H | M | M | H | | |
| CO6 | H | M | | | | | | H | H | M | H | M | M | H |

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Numerical Assignment Writing (5 assignments, problem-based, one per unit focus area: NLP foundations, word representation, transformers, scaling laws, prompt engineering)** | 5 assignments × 4 hrs each<br>Total = 20 hrs | CO1–CO4 TS1–TS4 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm / models performance |
| 2 | **Technical Video-Based Learning related to the subject (e.g., transformer attention, prompt engineering, LangChain workflows)** | Video viewing: 3 hrs<br>Report preparation: 3 hrs<br>Presentation: 3 hrs<br>Total = 9 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, architectures, workflows, and personal reflections |
| 3 | **Real-World Case Studies (e.g., GPT-4 deployment, Hugging Face applications,** | Data collection/study: 4 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact |

| | | | | |
|---|---|---|---|---|
| | **bias/hallucination in production, ethical frameworks)** | Report preparation: 2 hrs<br>Total = 6 hrs | | finding, ethical/regulatory analysis, and conclusions drawn |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

## 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | **≥ 24 / 60** | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | **≥ 40 / 100** | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**CSE 254 — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks

# COURSE PLAN

## Blockchain with AI(CSAI4004)

*School of Computing Science and Engineering (SSCSE) | B.Tech CSE-AIML | Semester VII | Batch 2023–2027*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Shadra School of Computing Science and Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2029–30 |
| **Branch:** | CSE-AIML | **Semester:** | VII |
| **Course Code:** | CSAI4004 | **Course Type:** | AIML |

## 2. Course Details

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | CSAI4004 |
| 2 | **Course Title** | **Blockchain with AI** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs. Classroom + 45 hrs. Self learning = 90 hrs. total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |

| | | |
|---|---|---|
| 6 | **Course Objectives** | 1. Understand the integration of Blockchain and Artificial Intelligence technologies.<br>2. Study decentralized AI architectures and intelligent blockchain systems.<br>3. Analyze security, privacy, and trust mechanisms in AI-driven blockchain applications<br>4. Apply blockchain techniques for secure AI model sharing and data management |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Understand blockchain and AI integration concepts and architectures.<br>CO2 (Explore – L2/L3): Explain decentralized AI models, smart contracts, and data sharing mechanisms.<br>CO3 (Apply – L3/L4): Analyze blockchain-based AI security, trust, and privacy techniques.<br>CO4 (Analyze – L4/L5): Apply blockchain frameworks for AI model management and automation.<br>CO5 (Analyze – L4/L5): Evaluate intelligent decentralized applications and enterprise AI-blockchain solutions.<br>CO6 (Analyze – L5/L6): Design secure and scalable blockchain-enabled AI solutions for real-world applications. |
| 8 | **Course Description** | This course introduces the integration of Blockchain Technology and Artificial Intelligence (AI) to develop secure, decentralized, transparent, and intelligent systems. The course covers blockchain fundamentals, decentralized AI architectures, smart contracts, federated learning, secure data sharing, privacy-preserving mechanisms, and trust management in AI applications. Students will explore how blockchain enhances AI through data integrity, transparency, auditability, and decentralized decision-making. The course also examines real-world applications in healthcare, finance, IoT, supply chain, and smart cities. By the end of the course, students will be able to analyze, design, and evaluate blockchain-enabled AI solutions for modern distributed environments. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | Stuart Russell & Peter Norvig — Artificial Intelligence: A Modern Approach |
| 12 | **References** | 1.Melanie Swan — Blockchain: Blueprint for a New Economy<br>2.William Stallings — Cryptography and Network Security<br>3.Research Papers on Blockchain and AI Integration |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **UNIT-1: Introduction to Blockchain and AI** | |
| A | Fundamentals of Artificial Intelligence, Machine Learning basics, Introduction to Blockchain Technology | CO1 |
| B | Distributed Ledger Technology, Blockchain Architecture, Centralized vs Decentralized AI Systems | CO1,CO2 |
| C | Need for Blockchain in AI, Intelligent decentralized systems, Real-world overview | CO2 |
| | **UNIT-2: Blockchain Fundamentals for AI** | |
| A | Consensus Mechanisms: PoW, PoS, PBFT | CO2 |
| B | Smart Contracts, Decentralized Applications, Tokenization | CO2 |
| C | Cryptographic techniques, Trust management, Data integrity mechanisms | CO2,CO3 |
| | **Unit 3: Decentralized AI Systems** | |
| A | Federated Learning, Distributed AI Models | CO3 |
| B | AI Model Sharing using Blockchain, Secure Data Exchange | CO3 |
| C | Privacy-preserving AI, Blockchain-enabled collaborative learning | CO3,CO4 |
| | **Unit 4: Security and Privacy in Blockchain AI** | |
| A | Blockchain Security Challenges, AI Security Threats | CO4 |
| B | Identity and Access Management, Secure AI Training | CO4 |
| C | Explainable AI, Trustworthy AI systems, Privacy-preserving mechanisms | CO4,CO5 |
| | **Unit 5: Applications and Future Trends** | |

| | | |
|---|---|---|
| A | Blockchain in Healthcare AI and Smart Cities | CO6 |
| B | AI-based Fraud Detection, Finance and Supply Chain Applications | CO4, CO6 |
| C | Future Trends in Blockchain and AI Integration, Research Challenges | CO1, CO2, CO3, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | | ✓ | ✓ | ✓ | |
| 14 | 5.B | | | ✓ | ✓ | ✓ | |
| 15 | 5.C | | | | ✓ | ✓ | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | | | | | | | ✓ | | | |
| CO4 | | | ✓ | ✓ | ✓ | | | | ✓ | | | | | | | | | |
| CO5 | | | | ✓ | ✓ | | | ✓ | | | | | | | | | | |
| CO6 | | | | ✓ | ✓ | ✓ | | | | | | | | | | | | |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

ℹ *Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 11.*

| Date | Smart Contract Basics | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Course Introduction and Overview of Blockchain and AI | UNIT-1 | 9 |
| DD/MM/YY | Fundamentals of Artificial Intelligence | | |
| DD/MM/YY | Machine Learning Basics and Types | | |
| DD/MM/YY | Introduction to Blockchain Technology | | |
| DD/MM/YY | Distributed Ledger Technology (DLT) | | |
| DD/MM/YY | Blockchain Architecture and Components | | |
| DD/MM/YY | Centralized vs Decentralized AI Systems | | |
| DD/MM/YY | Need for Blockchain in AI | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Intelligent Decentralized Systems and Real-World Applications | | |
| DD/MM/YY | Introduction to Consensus Mechanisms | UNIT-2 | 9 |
| DD/MM/YY | Proof of Work (PoW) | | |
| DD/MM/YY | Proof of Stake (PoS) | | |
| DD/MM/YY | Practical Byzantine Fault Tolerance (PBFT) | | |
| DD/MM/YY | Comparison of Consensus Mechanisms | | |
| DD/MM/YY | Smart Contracts: Concepts and Working | | |
| DD/MM/YY | Decentralized Applications (DApps) | | |
| DD/MM/YY | Tokenization and Blockchain Ecosystems | | |
| DD/MM/YY | Cryptographic Techniques, Trust Management and Data Integrity | | |
| DD/MM/YY | Introduction to Federated Learning | UNIT-3 | 9 |
| DD/MM/YY | Federated Learning Architecture | | |
| DD/MM/YY | Distributed AI Models | | |
| DD/MM/YY | Challenges in Distributed AI Systems | | |
| DD/MM/YY | AI Model Sharing Using Blockchain | | |
| DD/MM/YY | Blockchain-Based Secure Data Exchange | | |
| DD/MM/YY | Privacy-Preserving AI Techniques | | |
| DD/MM/YY | Blockchain-Enabled Collaborative Learning | | |
| DD/MM/YY | Case Studies on Decentralized AI Systems | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Introduction to Blockchain Security Challenges | | |
| DD/MM/YY | Common Blockchain Attacks and Threats | | |
| DD/MM/YY | AI Security Threats and Vulnerabilities | | |
| DD/MM/YY | Identity and Access Management | | |
| DD/MM/YY | Secure AI Training and Model Protection | UNIT-4 | 9 |
| DD/MM/YY | Explainable AI (XAI) Concepts | | |
| DD/MM/YY | Trustworthy AI Systems | | |
| DD/MM/YY | Privacy-Preserving Mechanisms in AI and Blockchain | | |
| DD/MM/YY | Security and Privacy Case Studies | | |
| DD/MM/YY | Blockchain in Healthcare AI | | |
| DD/MM/YY | Blockchain for Smart Cities | | |
| DD/MM/YY | AI-Based Fraud Detection Systems | | |
| DD/MM/YY | Blockchain and AI in Finance | | |
| DD/MM/YY | Blockchain and AI in Supply Chain Management | UNIT-5 | 9 |
| DD/MM/YY | Emerging Applications of Blockchain AI Integration | | |
| DD/MM/YY | Future Trends in Blockchain and AI | | |
| DD/MM/YY | Research Challenges and Opportunities | | |
| DD/MM/YY | Course Review, Recent Developments and Discussion | | |

**PART II**

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Conceptual Understanding | Understanding of Blockchain and AI fundamentals | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | Analytical Reasoning | Analysis of decentralized AI architectures | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | Security and Trust Analysis | Evaluation of blockchain security and privacy | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | Framework Application | Application of blockchain frameworks in AI systems | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| TS5 | Enterprise Evaluation | Assessment of real-world AI–Blockchain systems | CO5 \| L4–L5 | ETE Sec B/C |
| TS6 | Innovation & Design | Design of scalable AI–Blockchain solutions | CO6 \| L2–L4 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Process Interpretation | TS3 Algorithmic Application | TS4 Performance Evaluation | TS5 Memory System Analysis | TS6 File & Disk Evaluation |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| **Real-World Case Study (Report)** | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 Fundamentals & architecture | CO1 | TS1 | 5h SL | Report submission + conceptual understanding |

| | | | | | |
|---|---|---|---|---|---|
| **Assignment 2** | Blockchain mechanisms & smart contracts | CO2 | TS2 | 5h SL | Analytical explanation + architecture interpretation |
| **Assignment 3** | Federated learning & decentralized AI | CO3 | TS3 | 5h SL | Comparative analysis + technical justification |
| **Assignment 4** | Security, privacy, trustworthy AI | CO3, CO4 | TS4, TS5 | 5h SL | Threat analysis + solution evaluation |
| **Assignment 5** | Applications, enterprise solutions, future trends | CO5, CO6 | TS5, TS6 | 5h SL | Case study evaluation + innovation proposal |
| **Video Learning Report** | Technical video analysis on Federated Learning, Blockchain-based AI model sharing, or Smart Contract-enabled AI workflows with report submission and presentation | CO2, CO3 | TS2, TS3 | 9h SL | Presentation + technical interpretation + self-learning outcomes |
| **Case Study Report** | Blockchain-enabled AI applications in Healthcare, Supply Chain, Fraud Detection, Smart Cities, or Secure Data Sharing with solution analysis and scalability evaluation | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Problem identification + framework design + feasibility analysis |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Fundamental Understanding of Blockchain and AI Concepts TS2 — Conceptual Explanation of Smart Contracts, Consensus, and Distributed AI Architectures | **CO1, CO2** | Short-answer and descriptive questions: define blockchain and AI concepts, explain distributed ledger technology, compare centralized vs decentralized AI, describe consensus mechanisms, smart contracts, cryptographic foundations, and trust management |

| | | |
|---|---|---|
| TS3 — Application of Blockchain Frameworks and AI Integration TS4 — Analytical Evaluation of Security, Privacy, and Decentralized AI Systems | **CO2, CO3, CO4** | Analytical and application-oriented questions: analyze federated learning models, explain secure AI model sharing, evaluate blockchain-based privacy mechanisms, compare decentralized AI architectures, discuss identity/access management, and interpret AI-blockchain security scenarios |
| TS1–TS4 | **CO1–CO4** | Covers Units I–III only. CO5 and CO6 assessed in ETE through application-oriented and case-study-based questions. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Conceptual Recall TS2 — Conceptual Understanding and Interpretation | **CO1, CO2** | Short-answer and descriptive questions from all units: definitions of blockchain and AI concepts, distributed ledger models, consensus mechanisms, smart contracts, cryptographic foundations, decentralized AI architectures, and trust management concepts |
| TS3 — Application of Blockchain and AI Frameworks TS4 — Analytical Evaluation of Security and Privacy TS5 — Comparative Analysis of Decentralized Systems | **CO3, CO4, CO5** | Medium and analytical questions: federated learning workflows, blockchain-based AI model sharing, secure data exchange, privacy-preserving AI techniques, AI security threats, identity and access management, explainable AI, and comparison of decentralized AI frameworks |
| TS5 — Enterprise Application Analysis TS6 — Design and Innovation of Secure Blockchain-enabled AI Solutions | **CO5, CO6** | Long-answer and case-study-oriented questions: healthcare AI using blockchain, blockchain in IoT and smart cities, AI-driven fraud detection, supply-chain applications, enterprise blockchain-AI integration, scalability analysis, and future research-oriented solution design |
| TS1–TS6 (all) | **CO1–CO6** | Comprehensive assessment covering all 5 units with progressive evaluation from conceptual understanding to application, analysis, and innovative solution design. Minimum 20/50 required to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Understand blockchain and AI integration concepts and architectures. | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO2** | Explore process management — scheduling, synchronization, deadlocks | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| **CO3** | Implement algorithms in resource allocation and utilization | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Integrate and interpret effectiveness and efficiency of algorithms | ✓ | ✓ | ✓ | TS4 | PO9, PO10, PO11 |
| **CO5** | Analyze memory management and virtual memory techniques | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Understand file & disk management; analyze their efficiency | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | – | – | – | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 3 | 3 | – | – | – | 2 | 2 | 2 | 1 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | – | – | – | 1 | 1 | 1 | 3 | 3 | 2 | 1 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | – | – | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | – | – | – | – | 3 | 3 | 1 | 2 | 3 | – | – |
| **CO6** | 3 | 2 | – | – | – | – | – | – | – | 2 | 3 | 2 | 2 | – |
| **Avg** | **2.67** | **2.33** | **2.80** | **2.75** | **1.00** | **–** | **–** | **2.00** | **2.20** | **1.67** | **2.33** | **2.50** | **2.20** | **1.75** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | H | H | H | H | | | | M | M | M | M | H | M | M |
| CO2 | H | M | H | H | | | | M | M | M | M | M | H | M |
| CO3 | H | H | H | H | | | | M | M | M | H | H | M | M |
| CO4 | M | M | M | M | M | | | M | H | H | H | M | M | M |
| CO5 | M | M | H | | | | | H | H | M | M | H | | |
| CO6 | H | M | | | | | | | | M | H | M | M | |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Numerical Assignment Writing (5 assignments, problem-based, one per unit focus area)** | 5 assignments × 4 hrs each<br>Total = 20 hrs | CO1–CO4 TS1–TS4 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance |
| 2 | **Technical Video-Based Learning related to the subject (e.g., OS scheduling, deadlock, memory management)** | Video viewing: 4 hrs<br>Report preparation: 4 hrs Presentation: 4 hrs Total = 12 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, algorithms, and personal reflections |
| 3 | **Real-World Case Studies (e.g., Linux/Windows OS internals, Android memory management, cloud OS design)** | Data collection/study: 5 hrs Report preparation: 8 hrs Total = 13 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, and analytical conclusions drawn |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (30 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | ≥ 40 / 100 | **Must pass overall** | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**CSE 254 — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A

CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B

CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C

CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks

# COURSE PLAN

## HealthCare Data Analytics (CSDS4200/4301)

School of Computing Science & Engineering (SSCSE) | B.Tech. CSE-AIML | Semester VII | Batch 2026–2030

Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment

**PART I COURSE SYLLABUS** *Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2029–30 |
| **Branch:** | CSE-AIML | **Semester:** | VII |
| **Course Code:** | CSDS4200/4301 | **Course Type:** | Core — Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | XXXX |
| 2 | **Course Title** | HealthCare Data Analytics |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs Classroom + 45 hrs Self Learning = 90 hrs total) |
| 5 | **Course Status** | Core — Theory Only (No Laboratory Component) |

| | | |
|---|---|---|
| 6 | **Course Objectives** | 1. Introduce the landscape of healthcare data, including types, sources, and governance frameworks. 2. Cover statistical and analytical methods applicable to clinical and public health data. 3. Enable evaluation of predictive and machine-learning models used in healthcare settings. 4. Develop the ability to interpret analytical results for clinical decision support and policy formulation. |
| 7 | **Course Outcomes (COs)** | After successful completion of this course, students will be able to: CO1 (Understand – L1/L2): Identify and understand the types, sources, standards (HL7, FHIR, ICD), and governance frameworks of healthcare data. CO2 (Explore – L2/L3): Explore data preprocessing, quality assessment, and statistical methods specific to clinical datasets. CO3 (Apply – L3): Apply descriptive and inferential analytics, including regression and survival analysis, to healthcare data problems. CO4 (Analyze – L4/L5): Analyze predictive modelling techniques such as classification, clustering, and risk-stratification in clinical contexts. CO5 (Analyze – L4/L5): Analyze clinical NLP, medical imaging analytics, and IoT/wearable health data interpretation techniques. CO6 (Evaluate – L2/L4): Evaluate healthcare analytics platforms, ethical/legal considerations (HIPAA, data privacy), and real-world case studies. |
| 8 | **Course Description** | This course introduces the principles and practice of data analytics in the healthcare domain. It covers healthcare data ecosystems, statistical analysis, predictive modelling, NLP for clinical text, and emerging analytics for IoT-enabled health systems, with attention to ethical and regulatory frameworks. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks |
| 11 | **Textbook** | Shortliffe, E.H. & Cimino, J.J. — Biomedical Informatics: Computer Applications in Health Care and Biomedicine (4th Ed.), Springer |
| 12 | **References** | 1. Iyer, B. & Reza, H. — Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley 2. Provost, F. & Fawcett, T. — Data Science for Business, O'Reilly 3. Stroup, D.F. & Thacker, S.B. — Public Health Surveillance, Springer 4. Topol, E.J. — Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Basic Books |

## 3. Outline Syllabus with CO Mapping

ℹ All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Healthcare Data Ecosystem** | |
| **A** | Healthcare data types and sources: EHR, EMR, clinical notes, lab data, imaging, administrative and claims data | **CO1** |

| | | |
|---|---|---|
| B | Healthcare data standards and interoperability: HL7, FHIR, ICD-10/11, SNOMED CT, LOINC, DICOM | CO1 |
| C | Data governance, privacy regulations: HIPAA, GDPR in healthcare; de-identification techniques | CO1 |
| | **Unit 2: Healthcare Data Preprocessing & Statistics** | |
| A | Data quality dimensions: completeness, accuracy, consistency; handling missing data, outliers, and noise in clinical datasets | CO1, CO2 |
| B | Descriptive statistics for healthcare: measures of central tendency, dispersion; survival analysis fundamentals (Kaplan-Meier) | CO1, CO2 |
| C | Inferential statistics: hypothesis testing, t-tests, chi-square, ANOVA, correlation in clinical research contexts | CO1, CO2 |
| | **Unit 3: Predictive & Diagnostic Analytics** | |
| A | Regression analysis for healthcare outcomes: linear, logistic, and Cox proportional hazards models | CO1, CO2, CO3 |
| B | Diagnostic performance metrics: sensitivity, specificity, PPV, NPV, ROC curves, AUC; clinical decision thresholds | CO1, CO2, CO3, CO4 |
| C | Classification techniques in clinical settings: decision trees, random forests, SVM; risk-stratification models | CO1, CO2, CO3, CO4 |
| | **Unit 4: Advanced Analytics & Machine Learning in Healthcare** | |
| A | Clustering methods for patient segmentation: k-means, hierarchical clustering; disease subtype discovery | CO1, CO2, CO3, CO5 |
| B | Deep learning in healthcare: neural networks for clinical prediction; introduction to transfer learning for medical imaging | CO1, CO2, CO3, CO5 |
| C | Clinical Natural Language Processing (NLP): text preprocessing, named-entity recognition, ICD code assignment from clinical notes | CO1, CO2, CO3, CO5 |
| | **Unit 5: Emerging Domains & Ethics in Healthcare Analytics** | |
| A | IoT and wearable health data analytics: remote patient monitoring, sensor data, real-time alert generation | CO1, CO2, CO3, CO6 |
| B | Healthcare analytics platforms: overview of tools (SAS Health, IBM Watson Health, Azure Health Insights); implementation considerations | CO1, CO2, CO3, CO4, CO6 |
| C | Ethical, legal, and social implications (ELSI): algorithmic bias in clinical AI, fairness, accountability, transparency; real-world case studies | CO1, CO2, CO3, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | **1.A** | ✓ | ✓ | | | | |
| 2 | **1.B** | ✓ | ✓ | | | | |
| 3 | **1.C** | | ✓ | | | | |
| 4 | **2.A** | | ✓ | ✓ | | | |
| 5 | **2.B** | | ✓ | ✓ | | | |
| 6 | **2.C** | | | ✓ | ✓ | | |
| 7 | **3.A** | | ✓ | ✓ | | | |
| 8 | **3.B** | | | ✓ | ✓ | | |
| 9 | **3.C** | | | ✓ | ✓ | ✓ | |
| 10 | **4.A** | | ✓ | | | | |
| 11 | **4.B** | | | ✓ | ✓ | | |
| 12 | **4.C** | | | ✓ | ✓ | ✓ | |
| 13 | **5.A** | | ✓ | ✓ | | | |
| 14 | **5.B** | | | ✓ | ✓ | | |
| 15 | **5.C** | | ✓ | ✓ | ✓ | | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for model implementation in CO3. Affective domain appears at A3 (Valuing) for analytical efficiency evaluation in CO4 and CO5.

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO** | **L1** | **L2** | **L3** | **L4** | **L5** | **L6** | **A1** | **A2** | **A3** | **A4** | **A5** | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** | **P7** |
| **CO1** | ✓ | ✓ | | | | | | | | | | | | | | | | |
| **CO2** | | ✓ | ✓ | | | | | | | | | | | | | | | |
| **CO3** | | | ✓ | ✓ | | | | | | | | | | ✓ | | | | |
| **CO4** | | | | ✓ | ✓ | | | | ✓ | | | | | | | | | |
| **CO5** | | | | ✓ | ✓ | | | ✓ | | | | | | | | | | |
| **CO6** | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |

Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (model implementation). Affective (A3) for CO4 and CO5 (valuing analytical performance).

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 14.

| Date | Topics to be Covered / Title | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Healthcare data types: EHR, EMR, clinical notes, imaging, lab, administrative data | UNIT-1 | 9 |
| DD/MM/YY | Healthcare data sources: government health databases, wearable devices, insurance claims | | |
| DD/MM/YY | Data standards: HL7, FHIR — concepts, architecture, and interoperability | | |
| DD/MM/YY | Coding systems: ICD-10/11, SNOMED CT, LOINC, DICOM — structure and use cases | | |
| DD/MM/YY | Data governance frameworks: HIPAA, GDPR in healthcare context | | |
| DD/MM/YY | De-identification techniques: Safe Harbor, Expert Determination, k-anonymity | | |
| DD/MM/YY | Healthcare data ecosystems: integrated health networks, HIE, secondary data use | | |
| DD/MM/YY | Introduction to data warehousing in healthcare; OLAP for clinical analytics | | |
| DD/MM/YY | Overview: Electronic Health Records — architecture, usage, challenges | | |
| DD/MM/YY | Data quality dimensions in healthcare: completeness, accuracy, consistency, timeliness | UNIT-2 | 9 |
| DD/MM/YY | Missing data strategies: imputation techniques for clinical datasets | | |
| DD/MM/YY | Outlier detection in clinical data; noise handling in biosignals | | |
| DD/MM/YY | Descriptive statistics: mean, median, mode, standard deviation for health metrics | | |
| DD/MM/YY | Survival analysis fundamentals: Kaplan-Meier estimator, log-rank test | | |
| DD/MM/YY | Inferential statistics: hypothesis testing; t-test and chi-square for clinical data | | |
| DD/MM/YY | ANOVA, correlation and covariance in clinical research | | |
| DD/MM/YY | Confounding, causality vs. correlation in health data | | |
| DD/MM/YY | Standardization and normalization of healthcare datasets | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Regression analysis: linear regression for health outcome prediction | **UNIT-3** | **9** |
| DD/MM/YY | Logistic regression: binary outcomes in clinical decision making | | |
| DD/MM/YY | Cox proportional hazards model for time-to-event health data | | |
| DD/MM/YY | Diagnostic metrics: sensitivity, specificity, PPV, NPV — clinical interpretation | | |
| DD/MM/YY | ROC curves and AUC; selecting clinical decision thresholds | | |
| DD/MM/YY | Decision trees for clinical classification — CART, ID3 | | |
| DD/MM/YY | Random forests and ensemble methods in healthcare risk modelling | | |
| DD/MM/YY | Support Vector Machines (SVM) for medical diagnosis; model evaluation | | |
| DD/MM/YY | Risk stratification models: readmission, mortality, chronic disease prediction | | |
| DD/MM/YY | Clustering for patient segmentation: k-means algorithm and healthcare applications | **UNIT-4** | **9** |
| DD/MM/YY | Hierarchical clustering; disease subtype discovery and precision medicine | | |
| DD/MM/YY | Introduction to neural networks and deep learning in clinical prediction | | |
| DD/MM/YY | Transfer learning for medical imaging: chest X-ray, retinal image analysis overview | | |
| DD/MM/YY | Clinical NLP: text preprocessing, tokenization, stopword removal for medical text | | |
| DD/MM/YY | Named-entity recognition (NER) in clinical notes; automated ICD code assignment | | |
| DD/MM/YY | Sentiment analysis and readability of patient-reported outcomes (PROs) | | |
| DD/MM/YY | Temporal analytics: longitudinal data analysis, time-series for patient vitals | | |
| DD/MM/YY | Association rule mining for adverse drug event detection | | |
| DD/MM/YY | IoT and wearable health data: sensor types, data acquisition, real-time monitoring | **UNIT-5** | **9** |
| DD/MM/YY | Remote patient monitoring systems: architecture, alert generation, data challenges | | |
| DD/MM/YY | Healthcare analytics platforms: SAS Health, IBM Watson Health overview | | |
| DD/MM/YY | Cloud-based health analytics: Azure Health Insights, AWS HealthLake | | |
| DD/MM/YY | Algorithmic bias in clinical AI: sources, detection, and mitigation strategies | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Fairness, accountability, and transparency in healthcare ML models | | |
| DD/MM/YY | Legal and ethical frameworks for AI in healthcare; informed consent in data analytics | | |
| DD/MM/YY | Case Study I: Predictive readmission model in hospital setting | | |
| DD/MM/YY | Case Study II: NLP-based clinical documentation analytics; course wrap-up | | |

**PART II THEORY ASSESSMENT FRAMEWORK** *Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Conceptual Recall & Healthcare Data Identification** | Recall fundamental healthcare data terminology, types, standards, and governance frameworks; identify the appropriate data source, coding system, or regulatory mechanism for a given scenario | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | **Statistical Interpretation & Data Preprocessing** | Explain data quality issues and preprocessing strategies for clinical datasets; interpret and describe statistical concepts including survival analysis, hypothesis testing, and correlation in healthcare contexts | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | **Analytical Application & Model Implementation** | Apply regression, classification, and clustering algorithms to healthcare data; trace model execution and compute diagnostic performance metrics step-by-step | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | **Predictive Model Analysis & Performance Evaluation** | Analyze the effectiveness and efficiency of predictive models; compare model performance on clinical criteria; evaluate trade-offs between competing approaches for patient risk stratification | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |

| | | | | |
|---|---|---|---|---|
| **TS5** | **Advanced Analytics & Emerging Technology Evaluation** | Analyze NLP pipelines for clinical text, deep learning approaches for medical imaging, and IoT-based health data analytics; evaluate performance and applicability of techniques | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | **Platform Evaluation, Ethics & Case Study Analysis** | Analyze healthcare analytics platforms and tools; evaluate ethical, legal, and fairness dimensions of clinical AI; apply evaluation frameworks to real-world healthcare analytics case studies | CO6 \| L2–L4 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.

| CO | TS1 Conceptual Recall | TS2 Statistical Interpretation | TS3 Analytical Application | TS4 Performance Evaluation | TS5 Advanced Analytics | TS6 Ethics & Platform |
|---|---|---|---|---|---|---|
| **CO1** | **H** | M | | | | |
| **CO2** | M | **H** | M | | | |
| **CO3** | | M | **H** | M | | |
| **CO4** | | | M | **H** | M | |
| **CO5** | | | | M | **H** | M |
| **CO6** | | M | | M | M | **H** |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 9. Continuous Assessment (CA) — 25 Marks

★ CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| Assignments 1–5 (Numerical / Problem-based) | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| Technical Video Learning Report | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| Real-World Case Study (Report) | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |

| TOTAL | — | 25 | CO1–CO6 | TS1–TS6 |
|---|---|---|---|---|

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 concepts: healthcare data types, standards, governance, de-identification | CO1 | TS1 | 6h SL | Report submission + evaluation |
| **Assignment 2** | Data preprocessing, quality dimensions, missing data, descriptive statistics in clinical datasets | CO2 | TS2 | 6h SL | Numerical problems on data quality and statistics |
| **Assignment 3** | Regression and classification algorithms — compute performance metrics; ROC curve interpretation | CO2, CO3 | TS2, TS3 | 6h SL | Numerical computation + comparison |
| **Assignment 4** | Predictive model evaluation — apply risk stratification to given patient dataset; compare classifiers | CO3, CO4 | TS3, TS4 | 6h SL | Step-by-step numerical trace required |
| **Assignment 5** | Clustering for patient segmentation; performance analysis of NLP pipeline on clinical notes | CO3, CO4, CO5 | TS3, TS4, TS5 | 6h SL | Algorithm application + performance analysis |
| **Video Learning Report** | Technical video on healthcare ML, clinical NLP, or medical imaging analytics (min 3 hrs); structured report + class presentation | CO2, CO3 | TS2, TS3 | 9h SL | Report: learning outcomes, key concepts, self-reflection. Presentation: 10 min |
| **Case Study Report** | Real-world healthcare analytics case study (e.g., hospital readmission prediction, COVID-19 data analytics, clinical NLP implementation); in-depth analysis report | CO4, CO5, CO6 | TS4, TS5, TS6 | 6h SL | Technical depth, data collection, fact finding, comparative analysis |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Conceptual Recall & Healthcare Data Identification TS2 — Statistical Interpretation & Data Preprocessing | CO1, CO2 | Short-answer: define healthcare data standards, explain data quality dimensions, describe missing data strategies, interpret Kaplan-Meier curve, identify appropriate statistical test for clinical scenario |
| TS3 — Analytical Application & Model Implementation TS4 — | CO2, CO3, CO4 | Numerical problems: compute regression coefficients, evaluate classification model using confusion matrix, calculate |

| | | |
|---|---|---|
| Predictive Model Analysis & Performance Evaluation | | sensitivity/specificity/AUC; compare model performance on given dataset; apply risk stratification logic |
| TS1–TS4 | CO1–CO4 | Units 1–3 only. CO5 and CO6 assessed in ETE only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 24/60 required to pass.

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Conceptual Recall TS2 — Statistical Interpretation | CO1, CO2 | Short questions (all units): definitions, healthcare data types, standard identification, data quality issues, descriptive statistics, survival analysis interpretation, hypothesis testing selection |
| TS3 — Analytical Application TS4 — Performance Evaluation TS5 — Advanced Analytics Evaluation | CO3, CO4, CO5 | Medium questions: regression computations, classification model evaluation, ROC/AUC analysis, clustering trace, NLP pipeline explanation, deep learning concept application; performance comparison of models |
| TS5 — Advanced Analytics Evaluation TS6 — Platform, Ethics & Case Study | CO5, CO6 | Long/evaluation questions: IoT health data interpretation, platform comparison (SAS vs. IBM Watson), algorithmic bias analysis, HIPAA compliance scenario, end-to-end healthcare case study evaluation |
| TS1–TS6 (all) | CO1–CO6 | Scaled from 100 mark to 60 marks. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Understand healthcare data types, standards, sources, and governance | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| CO2 | Explore data preprocessing and statistical analysis for clinical datasets | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| CO3 | Apply regression, classification, and clustering algorithms to healthcare data | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO4** | Analyze predictive models for clinical decision support and risk stratification | ✓ | ✓ | ✓ | **TS4** | PO9, PO10, PO11 |
| **CO5** | Analyze NLP, deep learning, and IoT-based health analytics techniques | ✓ | — | ✓ | **TS5** | PO1, PO2, PO8, PO9, PO10 |
| **CO6** | Evaluate analytics platforms, ethics, and real-world case studies | ✓ | — | ✓ | **TS6** | PO1, PO2, PO10, PO11 |

⚠ CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.

**PART III COMBINED MAPPINGS & REFERENCE** *CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

**PART III COMBINED MAPPINGS & REFERENCE** *CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only.

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **3** | **3** | – | – | – | 2 | 2 | 1 | 2 | **3** | 2 | 2 |
| **CO2** | **3** | 2 | **3** | **3** | – | – | – | 2 | 2 | 2 | 1 | 2 | **3** | 2 |
| **CO3** | **3** | **3** | **3** | **3** | – | – | – | 1 | 1 | 1 | **3** | **3** | 2 | 1 |
| **CO4** | 2 | 2 | 2 | 2 | 1 | – | – | 2 | **3** | **3** | **3** | 2 | 2 | 2 |
| **CO5** | 2 | 2 | **3** | – | – | – | – | **3** | **3** | 1 | 2 | **3** | – | – |
| **CO6** | **3** | 2 | – | – | – | – | – | – | – | 2 | **3** | 2 | 2 | – |
| **Avg** | **2.67** | **2.33** | **2.80** | **2.75** | **1.00** | **–** | **–** | **2.00** | **2.20** | **1.67** | **2.33** | **2.50** | **2.20** | **1.75** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **H** | **H** | **H** | **H** | | | | M | M | M | M | **H** | M | M |
| **CO2** | **H** | M | **H** | **H** | | | | M | M | M | M | M | **H** | M |
| **CO3** | **H** | **H** | **H** | **H** | | | | M | M | M | **H** | **H** | M | M |
| **CO4** | M | M | M | M | M | | | M | **H** | **H** | **H** | M | M | M |
| **CO5** | M | M | **H** | | | | | **H** | **H** | M | M | **H** | | |
| **CO6** | **H** | M | | | | | | | | M | **H** | M | M | |

H = High / Primary alignment  M = Medium / Secondary alignment  Blank = No direct alignment

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 1 | **Numerical Assignment Writing (5 assignments, problem-based, one per unit focus area)** | 5 assignments × 4 hrs each Total = 20 hrs | CO1–CO4 TS1–TS4 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of model performance |
| 2 | **Technical Video-Based Learning related to the subject (e.g., healthcare AI, clinical NLP, predictive analytics case)** | Video viewing: 4 hrs Report preparation: 4 hrs Presentation: 3 hrs Total = 11 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, algorithms, and personal reflections |
| 3 | **Real-World Case Studies (e.g., hospital readmission prediction, COVID-19 analytics dashboard, clinical NLP deployment, wearable health monitoring)** | Data collection/study: 10 hrs Report preparation: 4 hrs Total = 14 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, and analytical conclusions drawn |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts L2 — Understand: Explain ideas, concepts, and principles L3 — Apply: Use knowledge to solve problems in new situations L4 — Analyze: Break down information, examine relationships L5 — Evaluate: Judge, justify, assess, and make decisions L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend A2 — Responding: Active participation and reaction A3 — Valuing: Commitment and assigning value to content A4 — Organizing: Integrating values into a personal system A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity P2 — Set: Mental, physical readiness to act P3 — Guided Response: Practice through imitation/trial P4 — Mechanism: Habitual correct performance P5 — Complex Overt Response: Skilled performance P6 — Adaptation: Modify skills for special situations P7 — Origination: Create new solution patterns |

★ OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (model implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of analytical and model performance.

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |

| | | | |
|---|---|---|---|
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

⚠ Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | ≥ **40 / 100** | Must pass overall | CA 25 + MTE 25 + ETE 50 = 100; 40% overall minimum required |

**Course Code — HealthCare Data Analytics**

Theory-Only Course | 6 COs (CO1–CO6) |3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

**CA 25 marks + MTE 25 marks + ETE 50 marks = Total 100 marks**

# COURSE PLAN

## Smart Contract (CSAI4003)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VI | Batch 2023–2027*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2029–30 |
| **Branch:** | CSE-AIML | **Semester:** | VII |
| **Course Code:** | CSAI4003 | **Course Type:** | Core — Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSAI4003** |
| 2 | **Course Title** | **Smart Contracts Using Ethereum** |
| 3 | **Credits** | 3 |

| | | |
|---|---|---|
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs Classroom + 45 hrs Self Learning = 90 hrs total) |
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | The objective of the course is to introduce fundamental concepts in Smart Contracts using Ethereum with a practical approach in understanding them. To visualize the scope of smart contracts and Ethereum its role in futuristic development. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Apply – L1/L2/L3): Develop smart contract, solidarity, Ethereum based application.<br>CO2 (Explore – L2/L3): Compare bitcoin, Ethereum, Hyperledger and various cryptocurrencies concept.<br>CO3 (Apply – L2/L3): Discuss decentralization and crowdfunding systems.<br>CO4 (Analyze – L4/L5): Explain smart contracts, their technical capabilities, practical applications, limitations and security constraints.<br>CO5 (Analyze – L4/L5): Discuss the most prominent smart contract platform and Ethereum.<br>CO6 (Analyze – L2/L4): Improve other smart contract problems. |
| 8 | **Course Description** | The fundamental concepts in Smart Contracts using Ethereum with a practical approach in understanding them have been discussed. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | • Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder Princeton University Press 2016<br>• Mastering Bitcoin by Andreas Antonopoulos, O'Reilly Publishing 2014 978-0691171692 |
| 12 | **References** | 1. Ethereum White Paper Vitalik Buterin Online 2014.<br>2. Ethereum Documentation (https://ethereum.org/en/developers/docs/)<br>3. Solidity Documentation (https://docs.soliditylang.org/)<br>4. Mastering Bitcoin Andreas M. Antonopoulos O'Reilly Media 2014 ISBN: 9781449374044<br>5. Mastering Ethereum Andreas M. Antonopoulos, Gavin Wood O'Reilly Media 2018 ISBN: 9781491971949<br>6. Blockchain Basics Daniel Drescher Apress Publishing 2017 ISBN: 9781484226032<br>7. Introducing Ethereum and Solidity Chris Dannen Apress Publishing 2017 ISBN: 9781484225349<br>8. Hyperledger Fabric Documentation (https://hyperledger-fabric.readthedocs.io/) |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: INTRODUCTION TO SMART CONTRACTS** | |
| **A** | Smart Contract Basics: Why Smart Contracts? Contract lifecycle, | **CO1, CO2** |
| **B** | Solidity: Structure, Basic Data Types & Statements | **CO1, CO2** |
| **C** | Contract lifecycle, distinction between a payment system and a decentralized applications platform | **CO1, CO2** |
| | **Unit 2: ETHEREUM** | |
| **A** | Ethereum – Introduction, Multitude of clients in Ethereum | **CO1, CO2, CO3** |
| **B** | Production and test networks in Ethereum, Public, private and development deployments | **CO1, CO2, CO3** |
| **C** | Comparing Bitcoin and Ethereum, Ethereum sub-protocols | **CO1, CO2, CO3** |
| | **Unit 3: SOLIDITY** | |
| **A** | Demonstration of smart contract, Introduction to Solidity, Solidity in depth, Building blocks , Contract lifecycle, | **CO1, CO2, CO3, CO4** |
| **B** | Solidity for Contract Writing, Developing, Compiling and Deploying My Contract | **CO1, CO2, CO3, CO4** |
| **C** | Interacting with the Contract, Limitations of Remix | **CO1, CO2, CO3, CO4** |
| | **Unit 4: DECENTRALIZATION** | |
| **A** | Decentralized Autonomous Organization (DAO), Decentralized Applications | **CO3, CO4, CO5** |
| **B** | A Central Bank or Your Own Coin, A Crowdfunding System | **CO3, CO4, CO5** |
| **C** | State, Merkle Patricia Tree, Client Applications, Objects of smart contracts | **CO3, CO4, CO5** |
| | **Unit 5: USE AND APPLICATION OF SMART CONTRACTS** | |
| **A** | Examples of using smart contracts, Time Elements in developing smart contracts | **CO4, CO5, CO6** |
| **B** | Features of smart contracts: Autonomy, Trust, Savings, Safety, Efficiency | **CO4, CO5, CO6** |

| | | |
|---|---|---|
| C | Other smart contract platforms, Quality of decentralized applications, Code patterns, Discussion of future prospects | CO4, CO5, CO6 |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | ✓ | | | | |
| 7 | 3.A | | | ✓ | ✓ | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | ✓ | | |
| 14 | 5.B | | | ✓ | ✓ | ✓ | |
| 15 | 5.C | | ✓ | ✓ | ✓ | | |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | | ✓ | ✓ | | | | | | ✓ | | | | | | | | |
| CO3 | | ✓ | ✓ | | | | ✓ | | | | | | | | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | |
| CO5 | | | | ✓ | ✓ | | ✓ | ✓ | | | | | | | | | |
| CO6 | | ✓ | | ✓ | | | | | | | ✓ | | | | | | |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

*Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 11.*

| Date | Smart Contract Basics | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Smart Contract Basics | UNIT-1 | 9 |
| DD/MM/YY | Why Smart Contracts? | | |
| DD/MM/YY | Contract lifecycle | | |
| DD/MM/YY | History of Solidity | | |
| DD/MM/YY | Structure of Solidity | | |
| DD/MM/YY | Basic Data Types & Statements | | |
| DD/MM/YY | Contract lifecycle | | |
| DD/MM/YY | payment system | | |
| DD/MM/YY | distinction between a payment system and a decentralized applications platform | | |
| DD/MM/YY | Ethereum – Introduction | UNIT-2 | 9 |
| DD/MM/YY | Multitude of clients in Ethereum | | |
| DD/MM/YY | Multitude of clients in Ethereum | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Production and test networks in Ethereum | | |
| DD/MM/YY | Production and test networks in Ethereum | | |
| DD/MM/YY | Public, private and development deployments | | |
| DD/MM/YY | Comparing Bitcoin and Ethereum | | |
| DD/MM/YY | Ethereum sub-protocols | | |
| DD/MM/YY | Ethereum sub-protocols | | |
| DD/MM/YY | Demonstration of smart contract | UNIT-3 | 9 |
| DD/MM/YY | Solidity in depth | | |
| DD/MM/YY | Building blocks, Contract lifecycle | | |
| DD/MM/YY | Solidity for Contract Writing | | |
| DD/MM/YY | Developing, Compiling and Deploying My Contract | | |
| DD/MM/YY | Interacting with the Contract | | |
| DD/MM/YY | Interacting with the Contract | | |
| DD/MM/YY | Interacting with the Contract | | |
| DD/MM/YY | Limitations of Remix | | |
| DD/MM/YY | Decentralized Autonomous Organization (DAO) | UNIT-4 | 9 |
| DD/MM/YY | Decentralized Applications | | |
| DD/MM/YY | A Central Bank or Your Own Coin | | |
| DD/MM/YY | A Crowdfunding System, State | | |
| DD/MM/YY | Merkle Patricia Tree | | |
| DD/MM/YY | Client Applications | | |
| DD/MM/YY | Objects of smart contracts | | |
| DD/MM/YY | Objects of smart contracts | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Objects of smart contracts | | |
| DD/MM/YY | Examples of using smart contracts | UNIT-5 | 9 |
| DD/MM/YY | Examples of using smart contracts | | |
| DD/MM/YY | Time Elements in developing smart contracts | | |
| DD/MM/YY | Features of smart contracts: Autonomy, Trust, Savings, Safety, Efficiency | | |
| DD/MM/YY | Other smart contract platforms | | |
| DD/MM/YY | Quality of decentralized applications | | |
| DD/MM/YY | Code patterns | | |
| DD/MM/YY | Discussion of future prospects | | |
| DD/MM/YY | Discussion of future prospects | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Smart Contract Fundamentals & Conceptual Recall** | Recall fundamental concepts of smart contracts, Ethereum architecture, Solidity basics, contract lifecycle, and decentralized application terminology; identify appropriate blockchain platforms and components for given scenarios | CO1 \| L1–L3 | CA \| MTE Sec A \| ETE Sec A |

| | | | | |
|---|---|---|---|---|
| **TS2** | **Ethereum Platform Understanding & Comparative Interpretation** | Explain Ethereum ecosystem concepts including Ethereum clients, networks, deployments, sub-protocols, and compare Bitcoin, Ethereum, and other blockchain platforms; interpret decentralized platform working mechanisms | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| **TS3** | **Smart Contract Development & Solidity Application** | Apply Solidity programming concepts for writing, compiling, deploying, and interacting with smart contracts; demonstrate contract creation and execution using Ethereum tools and platforms | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| **TS4** | **Smart Contract Analysis & Security Evaluation** | Analyze smart contract architecture, technical capabilities, limitations, Remix constraints, and security considerations; evaluate efficiency, reliability, and performance of decentralized applications | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | **Decentralization & Blockchain System Evaluation** | Analyze decentralized systems including DAO, crowdfunding systems, client applications, Merkle Patricia Tree, and smart contract objects; evaluate effectiveness and practical implementation challenges | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | **Smart Contract Platforms & Future Application Analysis** | Analyze other smart contract platforms, decentralized application quality, code patterns, future prospects, and practical applications of blockchain technologies; evaluate comparative advantages and real-world use cases | CO6 \| L2–L4 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Smart Contract Fundamentals & Conceptual Recall | TS2 Ethereum Platform Understanding & Comparative Interpretation | TS3 Smart Contract Development & Solidity Application | TS4 Smart Contract Analysis & Security Evaluation | TS5 Decentralization & Blockchain System Evaluation | TS6 Smart Contract Platforms & Future Application Analysis |
|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | | | | |
| **CO2** | **M** | **H** | **M** | | | |
| **CO3** | | **M** | **H** | **M** | | |
| **CO4** | | | **M** | **H** | **M** | |
| **CO5** | | | | **M** | **H** | **M** |
| **CO6** | | **M** | | **M** | **M** | **H** |

H = High / Primary alignment M = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 assignments | **10** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5,TS6 |
| **Assessments 1–2 (Theory / Application-based)** | **2 Assessments (Assessment 1 (10 Marks) + Assessment 2 (5 Marks))** | **15** | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2 concepts: Smart contract basics, Solidity structure, contract lifecycle | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Report submission + conceptual evaluation |
| **Assignment 2** | Unit 3, 4 and Unit 5 : Ethereum concepts: Ethereum clients, networks, deployments, Bitcoin vs Ethereum comparison | CO1,CO2,CO3, CO4, CO5,CO6 | TS1,TS2,TS3,TS4,TS5,TS6 | 5h SL | Comparative analysis + conceptual explanation |

### 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2 concepts: Smart contract basics, Solidity structure, contract lifecycle | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Report submission + conceptual evaluation |

| | | | | | |
|---|---|---|---|---|---|
| **Assessment 2** | Unit 3 and Unit 4: Ethereum concepts: Ethereum clients, networks, deployments, Bitcoin vs Ethereum comparison | CO1,CO2,CO3, CO4, CO5 | TS1,TS2,TS3,TS4,TS5 | 5h SL | Comparative analysis + conceptual explanation |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–2)

ℹ *MTE covers Units 1–2 (CO1, CO2, CO3) and CO1-CO6 are assessed in ETE only. MTE maps to TS1–TS3.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Smart Contract Fundamentals & Conceptual Recall<br>TS2 — Ethereum Platform Understanding & Comparative Interpretation | **CO1, CO2** | Short-answer: define smart contracts, explain Ethereum architecture, describe Solidity basics, explain contract lifecycle, compare Bitcoin and Ethereum, identify blockchain deployment types |
| TS3 — Smart Contract Development & Solidity Application | **CO3** | Application/theory-based questions: write Solidity code snippets, explain smart contract deployment steps, analyze Remix limitations, evaluate security constraints, compare decentralized application approaches |
| TS1–TS4 | **CO1–CO3** | Units 1–2 only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|

| | | |
|---|---|---|
| TS1 — Smart Contract Fundamentals & Conceptual Recall<br>TS2 — Ethereum Platform Understanding & Comparative Interpretation | **CO1, CO2** | Short questions (all units): definitions of smart contracts, Ethereum concepts, Solidity basics, blockchain terminology, Ethereum client identification, Bitcoin vs Ethereum comparison, decentralized application concepts |
| TS3 — Smart Contract Development & Solidity Application<br>TS4 — Smart Contract Analysis & Security Evaluation<br>TS5 — Decentralization & Blockchain System Evaluation | **CO3, CO4, CO5** | Medium questions: Solidity code writing, smart contract deployment process, Remix IDE limitations, DAO analysis, crowdfunding systems, Merkle Patricia Tree explanation, decentralized application evaluation, security and performance comparisons |
| TS5 — Decentralization & Blockchain System Evaluation<br>TS6 — Smart Contract Platforms & Future Application Analysis | **CO5, CO6** | Long/evaluation questions: analysis of decentralized applications, comparison of smart contract platforms, evaluation of code patterns, blockchain case study analysis, future prospects of Ethereum and smart contracts |
| TS1–TS6 (all) | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| **CO1** | Develop smart contract, Solidity, and Ethereum-based applications | ✓ | ✓ | ✓ | TS1 | PO1, PO2, PO3, PO4 |
| **CO2** | Compare Bitcoin, Ethereum, Hyperledger, and various cryptocurrency concepts | ✓ | ✓ | ✓ | TS2 | PO1, PO3, PO4 |
| **CO3** | Discuss decentralization and crowdfunding systems | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| **CO4** | Explain smart contracts, their technical capabilities, practical applications, limitations, and security constraints | ✓ | — | ✓ | TS4 | PO9, PO10, PO11 |
| **CO5** | Discuss the most prominent smart contract platform and Ethereum | ✓ | — | ✓ | TS5 | PO1, PO2, PO8, PO9, PO10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **CO6** | Improve other smart contract problems | ✓ | — | ✓ | TS6 | PO1, PO2, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | - | – | 3 | 1 | 1 | - | - | 1 | 1 | 2 | 1 |
| **CO2** | 2 | 3 | 1 | 2 | 2 | – | - | - | - | 1 | - | 1 | 2 | 2 |
| **CO3** | 1 | 2 | 3 | 3 | 2 | – | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| **CO4** | 2 | 1 | 2 | 2 | - | – | 1 | 1 | 1 | 1 | - | 1 | 3 | 2 |
| **CO5** | 3 | 2 | 3 | – | – | – | - | - | 2 | 1 | 1 | 1 | 2 | 1 |
| **CO6** | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 2 | 1 |
| **Avg** | **2** | **2** | **2.2** | 1.3 | **1.00** | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | **2.2** | **1.3** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | | M | | | H | | | | | | | M | |
| CO2 | M | H | | M | M | | | | | | | | M | M |
| CO3 | | M | H | H | M | | | | | | | | M | |
| CO4 | M | | M | M | | | | | | | | | H | M |
| CO5 | H | M | H | | | | | | M | | | | M | |
| CO6 | M | H | M | | M | M | | | | | | | M | |
| Avg | 2 | 2 | 2.2 | 1.3 | 1.00 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | 2.2 | 1.3 |

H = High / Primary alignment M = Medium / Secondary alignment *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Assignment Writing (5 assignments, theory/application-based, one per unit focus area)** | 5 assignments × 4 hrs each Total = 20 hrs | CO1–CO4 TS1–TS4 | Evaluated based on assignment submission, conceptual understanding, Solidity application, comparative analysis, and explanation of smart contract concepts |
| 2 | **Technical Video-Based Learning related to the subject (e.g., Ethereum, Solidity, DAO, decentralized applications, smart contract deployment)** | Video viewing: 4 hrs Report preparation: 4 hrs Presentation: 4 hrs Total = 12 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, Ethereum workflow, Solidity programming concepts, and personal reflections |
| 3 | **Real-World Case Studies (e.g., Ethereum applications, DAO systems, crowdfunding platforms, DeFi applications, smart contract security incidents)** | Data collection/study: 5 hrs Report preparation: 8 hrs Total = 13 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, analytical conclusions, and comparative evaluation of blockchain applications |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|

| | | |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **ETE Score** | ≥ 24 / 60 | **MANDATORY** | 40% of ETE paper required; failing ETE means failing the course regardless of CA + MTE |
| **Overall Total (CA + MTE + ETE)** | ≥ 40 / 100 | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**CBT302 — MEASUREMENT ARCHITECTURE SUMMARY**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

# COURSE PLAN

## Digital Watermarking and Steganography (CSCF4202)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VIII | Batch 2023–2027*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE - Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2029–30 |
| **Branch:** | CSE-AIML | **Semester:** | VIII |
| **Course Code:** | CSCF4202 | **Course Type:** | Program Elective - Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSCF4202** |
| 2 | **Course Title** | **Digital Watermarking and Steganography** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs. Classroom + 45 hrs. Self learning = 90 hrs. total) |

| | | |
|---|---|---|
| 5 | **Course Status** | **Core - Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | The objective of this course is to provide students with fundamental and advanced concepts of digital watermarking and steganography for secure multimedia communication, copyright protection, information hiding, authentication, and cyber security applications. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Understand the fundamentals of information hiding, digital watermarking, steganography, multimedia security, and related attacks.<br>CO2 (Apply – L2/L3) : Apply spatial and transform domain watermarking techniques for digital image, audio, and video security applications.<br>CO3 (Apply – L3): Implement steganographic methods and data hiding algorithms for secure communication systems.<br>CO4 (Analyze – L4/L5): Analyze watermarking robustness, perceptual transparency, steganographic security, and multimedia attack models.<br>CO5 (Evaluate – L4/L5): Evaluate different watermarking and steganography algorithms using performance metrics and security parameters.<br>CO6 (Create – L5/L6): Design secure multimedia authentication and copyright protection systems using advanced watermarking and steganographic approaches. |
| 8 | **Course Description** | This course covers principles of digital watermarking and steganography, spatial and transform domain techniques, multimedia security, information hiding, attack analysis, steganalysis, reversible watermarking, video and audio watermarking, and real-world secure communication applications. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | ● Digital Watermarking and Steganography, Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Morgan Kaufmann Publishers (Elsevier), Second Edition, 2008.<br>● Digital Watermarking and Steganography: Fundamentals and Techniques, Frank Y. Shih, CRC Press / Taylor & Francis Group, Second Edition, 2017.<br>● Information Hiding: Steganography and Watermarking, Attacks and Countermeasures, Neil F. Johnson, Zoran Duric, Sushil Jajodia, Springer Publications, 2001.<br>● Information Hiding Techniques for Steganography and Digital Watermarking, Stefan Katzenbeisser, Fabien A. P. Petitcolas, Artech House Publishers, 2000. |

| | | |
|---|---|---|
| 12 | **References** | 1.Disappearing Cryptography: Information Hiding, Steganography & Watermarking, Peter Wayner, Morgan Kaufmann Publishers, Third Edition, 2009.<br><br>2. Multimedia Security: Steganography and Digital Watermarking Techniques for Protection of Intellectual Property , Chun-Shien Lu, Idea Group Publishing, 2005.<br><br>3. Data Hiding with Deep Learning: A Survey Unifying Digital Watermarking and Steganography, Zihan Wang, Olivia Byrnes, Hu Wang, Ruoxi Sun, Congbo Ma, Huaming Chen, Qi Wu, Minhui Xue, arXiv / Research Survey, 2021.<br><br>4. FastStamp: Accelerating Neural Steganography and Digital Watermarking of Images on FPGAs, Shehzeen Hussain, Nojan Sheybani, Paarth Neekhara, Xinqiao Zhang, Javier Duarte, Farinaz Koushanfar, IEEE/ArXiv Research Publication, 2022.<br><br>5. Image Steganography: Protection of Digital Properties against Eavesdropping, Ramita Maharjan, Ajay Kumar Shrestha, Rejina Basnet, Research Publication, 2019.<br><br>6. StegoAppDB: A Steganography Apps Forensics Image Database , Jennifer Newman, Li Lin, Wenhao Chen, Stephanie Reinders, Yangxiao Wang, Min Wu, Yong Guan, Research Publication, 2019.<br>1. |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: INTRODUCTION TO DIGITAL WATERMARKING AND STEGANOGRAPHY** | |
| A | **Fundamentals of Information Hiding, Need for Multimedia Security, Applications of Watermarking and Steganography** | **CO1** |
| B | **Watermarking Properties: Robustness, Transparency, Capacity, Security** | **CO1** |
| C | **Types of Watermarking and Steganography, Threats and Attacks on Multimedia Systems** | **CO1** |
| | **Unit 2: DIGITAL WATERMARKING TECHNIQUES** | |
| A | **A Spatial Domain Watermarking Techniques: LSB, Correlation-Based Methods** | **CO2, CO3** |
| B | **B Transform Domain Watermarking: DCT, DWT, DFT Based Watermarking** | **CO2, CO3** |
| C | **C Image, Audio, and Video Watermarking Systems** | **CO2, CO3** |

| | | |
|---|---|---|
| | **Unit 3: STEGANOGRAPHY AND DATA HIDING** | |
| **A** | **A Text, Image, Audio, and Video Steganography Techniques** | **CO3, CO4** |
| **B** | **B Steganographic Algorithms and Secure Data Embedding Methods** | **CO3, CO4** |
| **C** | **C Steganalysis, Detection Methods, and Security Issues** | **CO3, CO4** |
| | **Unit 4: WATERMARKING ANALYSIS AND SECURITY** | |
| **A** | **A Watermark Attacks: Geometric, Compression, Filtering, Noise Attacks** | **CO4, CO5** |
| **B** | **B Performance Evaluation Metrics: PSNR, MSE, SSIM, NC** | **CO4, CO5** |
| **C** | **C Reversible Watermarking and Fragile Watermarking Techniques** | **CO4, CO5** |
| | **Unit 5: ADVANCED APPLICATIONS AND EMERGING TRENDS** | |
| **A** | **A Copyright Protection and Ownership Verification Systems** | **CO5, CO6** |
| **B** | **B Medical Image Watermarking, Biometric Security, Cloud Multimedia Security** | **CO5, CO6** |
| **C** | **C AI-Based Watermarking, Blockchain-Based Authentication, Future Research Directions** | **CO5, CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | | ✓ | ✓ | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | ✓ | ✓ | ✓ | | |
| 7 | 3.A | | ✓ | ✓ | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 3.B | | ✓ | ✓ | ✓ | | |
| 9 | 3.C | | ✓ | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | ✓ | ✓ | ✓ | |
| 11 | 4.B | | ✓ | ✓ | ✓ | ✓ | |
| 12 | 4.C | | ✓ | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | ✓ | ✓ | |
| 14 | 5.B | | ✓ | ✓ | ✓ | ✓ | |
| 15 | 5.C | | ✓ | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | ✓ | ✓ | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | ✓ | | | | | | ✓ | | | | |
| CO3 | | ✓ | ✓ | | | | | ✓ | | | | | | | | | | |
| CO4 | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | | ✓ | | | |
| CO5 | | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | | | | | ✓ | | | |
| CO6 | | ✓ | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | | | | | | | |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

*Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 11.*

| Date | Smart Contract Basics | UNIT | |
|---|---|---|---|

| | | | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Information Hiding and Multimedia Security | UNIT-1 | 9 |
| DD/MM/YY | Need for Digital Watermarking and Steganography | | |
| DD/MM/YY | Applications of Watermarking and Steganography | | |
| DD/MM/YY | Watermarking Properties: Robustness and Transparency | | |
| DD/MM/YY | Watermarking Capacity and Security Requirements | | |
| DD/MM/YY | Types of Watermarking Techniques | | |
| DD/MM/YY | Types of Steganography Techniques | | |
| DD/MM/YY | Threats and Attacks on Multimedia Systems | | |
| DD/MM/YY | Comparative Analysis of Watermarking and Steganography | | |
| DD/MM/YY | Introduction to Spatial Domain Watermarking | UNIT-2 | 9 |
| DD/MM/YY | Least Significant Bit (LSB) Watermarking | | |
| DD/MM/YY | Correlation-Based Watermarking Methods | | |
| DD/MM/YY | Introduction to Transform Domain Techniques | | |
| DD/MM/YY | Discrete Cosine Transform (DCT) Watermarking | | |
| DD/MM/YY | Discrete Wavelet Transform (DWT) Watermarking | | |
| DD/MM/YY | Discrete Fourier Transform (DFT) Watermarking | | |
| DD/MM/YY | Audio Watermarking Systems | | |
| DD/MM/YY | Video Watermarking Systems | | |
| DD/MM/YY | Introduction to Steganography | UNIT-3 | 9 |
| DD/MM/YY | Text Steganography Techniques | | |
| DD/MM/YY | Image Steganography Techniques | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Audio and Video Steganography | | |
| DD/MM/YY | Secure Data Embedding Algorithms | | |
| DD/MM/YY | Advanced Data Hiding Techniques | | |
| DD/MM/YY | Introduction to Steganalysis | | |
| DD/MM/YY | Detection and Extraction Methods | | |
| DD/MM/YY | Security Issues in Steganographic Systems | | |
| DD/MM/YY | Introduction to Watermark Attacks | UNIT-4 | 9 |
| DD/MM/YY | Geometric Attacks on Watermarked Media | | |
| DD/MM/YY | Compression and Filtering Attacks | | |
| DD/MM/YY | Noise and Signal Processing Attacks | | |
| DD/MM/YY | Watermark Robustness Analysis | | |
| DD/MM/YY | Performance Evaluation Metrics: MSE and PSNR | | |
| DD/MM/YY | Structural Similarity Index (SSIM) and NC | | |
| DD/MM/YY | Reversible Watermarking Techniques | | |
| DD/MM/YY | Fragile Watermarking and Authentication Systems | | |
| DD/MM/YY | Copyright Protection and Ownership Verification | UNIT-5 | 9 |
| DD/MM/YY | Multimedia Authentication Systems | | |
| DD/MM/YY | Medical Image Watermarking | | |
| DD/MM/YY | Biometric Security Applications | | |
| DD/MM/YY | Cloud Multimedia Security | | |
| DD/MM/YY | AI-Based Watermarking Techniques | | |
| DD/MM/YY | Blockchain-Based Multimedia Authentication | | |
| DD/MM/YY | Future Trends in Watermarking and Steganography | | |

| DD/MM/YY | Case Studies and Research Challenges | | |
|---|---|---|---|

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

*Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Fundamentals of Multimedia Security | Understanding of information hiding, watermarking concepts, steganography principles, and multimedia security requirements | CO1 \| L1–L2 | TS1 |
| TS2 | Watermarking Technique Application | Application of spatial and transform domain watermarking algorithms for multimedia security | CO2 \| L2–L3 | TS2 |
| TS3 | Steganography and Data Hiding | Implementation and analysis of secure data embedding and steganographic systems | CO3 \| L3 | TS3 |
| TS4 | Security and Attack Analysis | Analysis of attacks, robustness, transparency, and steganalysis methods | CO4 \| L4–L5 | TS4 |
| TS5 | Performance Evaluation and Optimization | Evaluation of watermarking quality, performance metrics, and algorithm effectiveness | CO5 \| L4–L5 | TS5 |
| TS6 | Advanced Secure Multimedia System Design | Design of secure multimedia authentication and copyright protection systems | CO6 \| L5–L6 | TS6 |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Smart Contract Fundamentals & Conceptual Recall | TS2 Ethereum Platform Understanding & Comparative Interpretation | TS3 Smart Contract Development & Solidity Application | TS4 Smart Contract Analysis & Security Evaluation | TS5 Decentralization & Blockchain System Evaluation | TS6 Smart Contract Platforms & Future Application Analysis |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | M | M | H | M |
| CO6 | | | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) - 25 Marks

*CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study - mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 assignments | **10** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4, |
| **Assessments 1–2 (Theory / Application-based)** | **2 Assessments (Assessment 1 (10 Marks) + Assessment 2 (5 Marks))** | **15** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5,TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2 concepts: Fundamentals of multimedia security, watermarking properties, spatial and transform domain watermarking techniques | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Report submission, conceptual understanding, implementation approach, and comparative analysis of watermarking methods |
| **Assignment 2** | Unit 3, Unit 4, and Unit 5 concepts: Steganography, watermark attacks, steganalysis, copyright protection, AI-based watermarking applications | CO3, CO4, CO5,CO6 | TS3,TS4,TS5,TS6 | 5h SL | Technical analysis, case-study evaluation, performance metric comparison, and secure multimedia system design approach explanation |

### 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2 concepts: Information hiding fundamentals, multimedia security, watermarking properties, spatial and transform domain watermarking techniques | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Conceptual understanding, technical explanation, algorithm analysis, and implementation-based problem solving |
| **Assessment 2** | Unit 3 and Unit 4 concepts: Steganography techniques, secure data embedding, watermark attacks, steganalysis, and watermark performance evaluation metrics | CO3, CO4, CO5 | TS3,TS4,TS5 | 5h SL | Comparative analysis, security evaluation, attack analysis, performance metric interpretation, and case-study-based assessment |

## 10. Mid Term Examination (MTE) - 15 Marks (Units 1–2)

*MTE covers Units 1–2 and CO1-CO6 are assessed in ETE. MTE maps to TS1–TS3.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1- Fundamentals of Multimedia Security | CO1 | Short-answer questions on multimedia security concepts, watermarking fundamentals, and steganography basics |
| TS2 - Watermarking Technique Application | CO2 | Questions on spatial and transform domain watermarking methods |
| TS3 - Steganography and Data Hiding | CO3 | Application-based questions on data embedding and watermarking implementation |
| TS1–TS4 | **CO1–CO3** | Units 1–2 only. |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

*ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 40/100 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1–TS2 | CO1, CO2 | Conceptual and application-based questions on watermarking fundamentals and multimedia security |
| TS3–TS4 | CO3, CO4 | Questions on steganographic methods, security analysis, attacks, and steganalysis |
| TS5 | CO5 | Evaluation of watermarking techniques using performance metrics and robustness analysis |
| TS6 | CO6 | Long questions on designing secure multimedia systems and advanced watermarking applications |
| TS1–TS6 (all) | **CO1–CO6** | Scaled from 100 mark to 60 marks. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Understand multimedia security, information hiding, and watermarking fundamentals | ✓ | ✓ | ✓ | TS1 | PO1, PO5 |
| CO2 | Apply spatial and transform domain watermarking techniques for secure multimedia systems | ✓ | ✓ | ✓ | TS2 | PO2, PO3, PO5 |
| CO3 | Implement steganographic methods and secure data hiding algorithms | ✓ | ✓ | ✓ | TS3 | PO2, PO3, PO4 |
| CO4 | Analyze watermark robustness, steganographic security, and multimedia attack models | ✓ | — | ✓ | TS4 | PO2, PO3, PO4 |
| CO5 | Evaluate watermarking and steganography techniques using performance metrics and security parameters | ✓ | — | ✓ | TS5 | PO2, PO3, PO4, PO5, PO8 |
| CO6 | Design secure multimedia authentication and copyright protection systems using advanced techniques | ✓ | — | ✓ | TS6 | PO1, PO2, PO3, PO4, PO7, PO8 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | - | – | 3 | 1 | 1 | - | - | 1 | 1 | 2 | 1 |
| CO2 | 2 | 3 | 1 | 2 | 2 | – | - | - | - | 1 | - | 1 | 2 | 2 |
| CO3 | 1 | 2 | 3 | 3 | 2 | – | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO4 | 2 | 1 | 2 | 2 | - | – | 1 | 1 | 1 | 1 | - | 1 | 3 | 2 |
| CO5 | 3 | 2 | 3 | – | – | – | - | - | 2 | 1 | 1 | 1 | 2 | 1 |
| CO6 | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 2 | 1 |
| Avg | 2 | 2 | 2.2 | 1.3 | 1.00 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | 2.2 | 1.3 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | H | | | | H | M | M | | | | | | | |
| CO 2 | M | H | M | M | M | M | | M | | M | | M | M | M |
| CO 3 | | H | H | M | | M | | H | | H | M | H | M | M |
| CO 4 | | H | H | H | | M | | H | M | H | M | H | H | M |
| CO 5 | M | H | H | M | M | | | M | M | M | M | M | M | H |
| CO 6 | H | M | H | H | M | | M | M | M | H | H | M | M | H |
| Avg | 1.8 | 2.5 | 2.5 | 2.2 | 1.8 | 0.8 | 1.3 | 2.2 | 1.5 | 2.33 | 1.83 | 2.17 | 2.17 | 1.3 |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 1 | **Assignment Writing (5 assignments, theory/application-based, one for each unit covering watermarking, steganography, attacks, and multimedia security techniques)** | **5 assignments × 4 hrs each Total = 20 hrs** | **CO1–CO4 TS1–TS4** | **Evaluated based on conceptual understanding, implementation approach, algorithm comparison, technical explanation, and report submission** |
| 2 | **Technical Video-Based Learning related to the subject (e.g., Digital Watermarking, Steganography Tools, Multimedia Security, AI-Based Watermarking, Copyright Protection Systems)** | **Video viewing: 4 hrs Report preparation: 4 hrs Presentation: 4 hrs Total = 12 hrs** | **CO2, CO3, CO4 TS2, TS3, TS4** | **Report + Presentation based on video learning outcomes; must include technical analysis, watermarking workflow, attack analysis, and secure multimedia communication concepts** |
| 3 | **Real-World Case Studies (e.g., Copyright Protection Systems, Medical Image Watermarking, Biometric Authentication, Blockchain-Based Multimedia Security, Deepfake Protection)** | **Data collection/study: 5 hrs Report preparation: 8 hrs Total = 13 hrs** | **CO4, CO5, CO6 TS4, TS5, TS6** | **Evaluated based on technical depth, comparative analysis, security evaluation, performance metric analysis, innovative design approach, and practical implementation feasibility** |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

*Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | ≥ 40 / 100 | **Must pass overall** | CA 25 + MTE 15 + ETE 60 = 100; 40% overall minimum required |

**Code - Digital Watermarking and Steganography Summary**

*Theory-Only Course | 6 COs (CO1–CO6) | 2 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A

CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B

CO5–CO6: Evaluate/Create → TS5, TS6 → CA + ETE Sec B/C

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

# COURSE PLAN

## Robotics and Intelligent Systems (CSAD4217)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VII | Batch 2026–2030*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech. | **Current Academic Year:** | 2029–30 |
| **Branch:** | CSE-AIML | **Semester:** | VII |
| **Course Code:** | CSAD4217 | **Course Type:** | Core - Theory Only |

## 2. Course Details

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | **CSA061** |
| 2 | **Course Title** | **Robotics and Intelligent Systems** |
| 3 | **Credits** | 3 |

| | | |
|---|---|---|
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs. Classroom + 45 hrs. Self learning = 90 hrs. total) |
| 5 | **Course Status** | **Core - Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | The objective of this course is to introduce students to the principles, architectures, and intelligent methodologies used in modern robotic systems. The course explores robot kinematics, motion planning, sensors, actuators, control systems, and intelligent decision-making techniques including machine learning and multi-agent systems. Students will learn how robotic systems perceive, analyze, and interact with dynamic environments using computational intelligence and optimization techniques. Through practical exposure to simulation tools, intelligent control methods, and autonomous robotics concepts, learners will develop the ability to design, analyze, and evaluate robotic solutions for real-world applications in manufacturing, healthcare, autonomous systems, and smart environments. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Remember – L1)<br>Recall the fundamental concepts, architectures, classifications, and components of robotic and intelligent systems.<br><br>CO2 (Understand – L2)<br>Explain robot motion, kinematics, sensors, actuators, and control mechanisms used in robotic systems.<br><br>CO3 (Apply – L3)<br>Apply transformation, path planning, optimization, and control techniques for autonomous robotic operations.<br><br>CO4 (Analyze – L4)<br>Analyze robotic perception, localization, navigation, and intelligent decision-making using probabilistic and AI-based methods.<br><br>CO5 (Evaluate – L5)<br>Evaluate machine learning, stochastic control, and multi-agent approaches for intelligent robotic applications.<br><br>CO6 (Create – L6)<br>Design intelligent robotic solutions integrating sensing, control, optimization, and autonomous decision-making for real-world problems. |
| 8 | **Course Description** | This course provides a comprehensive introduction to robotics and intelligent systems with emphasis on robot motion, sensing, control, and intelligent decision-making. It covers mobile robots, robotic transformations, path planning, sensors, actuators, optimization, machine learning, stochastic control, and multi-agent systems. Students will explore how intelligent algorithms enable robots to perceive environments, adapt to uncertainty, and perform autonomous operations. The course also introduces practical applications of robotics in industrial automation, healthcare, autonomous vehicles, and smart systems while providing exposure to simulation and intelligent robotic frameworks. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1. J. J. Craig, Introduction to Robotics, Pearson Education.<br>2. Gregory Dudek & Michael Jenkin, Computational Principles of Mobile Robotics. |

| | | |
|---|---|---|
| 12 | **References** | 1. M. Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems.<br>2. Robin Murphy, Introduction to AI Robotics.<br>3. Siegwart, Nourbakhsh & Scaramuzza, Introduction to Autonomous Mobile Robots. |

## 3. Outline Syllabus with CO Mapping

*All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: INTRODUCTION TO ROBOTICS AND INTELLIGENT SYSTEMS** | |
| **A** | Introduction to robotics, classification of robots, robot architectures, applications of robotics and intelligent systems | **CO1** |
| **B** | Mobile robots, position and orientation, translational and rotational dynamics | **CO1, CO2** |
| **C** | Flying robots, swimming robots, articulated robots, robot locomotion and configurations | **CO1, CO2** |
| | **Unit 2: ROBOT KINEMATICS, TRANSFORMATIONS AND CONTROL** | |
| **A** | Spatial transformations, coordinate representation, homogeneous transformations, forward and inverse kinematics | **CO1, CO2, CO3** |
| **B** | Path planning, trajectory generation, motion planning algorithms | **CO1, CO2, CO3** |
| **C** | Dynamic systems, feedback control systems, PID control and robot motion control | **CO1, CO2, CO3** |
| | **Unit 3: SENSORS, ACTUATORS AND OPTIMIZATION** | |
| **A** | Robot sensors, perception systems, actuators and embedded robotic interfaces | **CO1, CO2, CO3, CO4** |
| **B** | Numerical optimization techniques, robotic system optimization and intelligent control | **CO1, CO2, CO3, CO4** |
| **C** | Dynamic optimal control, localization, mapping and navigation techniques | **CO1, CO2, CO3, CO4** |

| | | |
|---|---|---|
| | **Unit 4: INTELLIGENT SYSTEMS AND MACHINE LEARNING** | |
| **A** | Probability, statistics and uncertainty handling in robotics | **CO3, CO4, CO5** |
| **B** | Machine learning techniques for robotics and intelligent decision making | **CO3, CO4, CO5** |
| **C** | Neural networks, intelligent perception and adaptive robotic systems | **CO3, CO4, CO5** |
| | **Unit 5: AUTONOMOUS ROBOTICS AND MULTI-AGENT SYSTEMS** | |
| **A** | State estimation, stochastic control and adaptive robotic behavior | **CO4, CO5, CO6** |
| **B** | Parameter estimation, reinforcement learning and autonomous robotic systems | **CO4, CO5, CO6** |
| **C** | Task planning, swarm robotics and multi-agent intelligent systems | **CO4, CO5, CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | ✓ | ✓ | | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | ✓ | ✓ | | | |
| 7 | 3.A | | ✓ | ✓ | ✓ | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | | |
| 10 | 4.A | | ✓ | ✓ | ✓ | | |
| 11 | 4.B | | | ✓ | ✓ | ✓ | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | | ✓ | ✓ | ✓ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | 5.B | | | ✓ | ✓ | ✓ | ✓ |
| 15 | 5.C | | | ✓ | ✓ | ✓ | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | ✓ | ✓ | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | ✓ | ✓ | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | ✓ | | | | | ✓ | ✓ | | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | | | | |
| CO5 | | | | ✓ | ✓ | | | | ✓ | ✓ | | | | ✓ | | | | |
| CO6 | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | ✓ |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 45 Lectures / 45 Hours)

ℹ *Total classroom contact: 45 hours across 5 units. Self-Learning activities (45 hrs) are structured separately in Section 11.*

| Date | Smart Contract Basics | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Robotics | UNIT-1 | 9 |
| DD/MM/YY | Classification of Robots | | |
| DD/MM/YY | Robot Architectures | | |
| DD/MM/YY | Applications of Robotics and Intelligent Systems | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Mobile Robots | | |
| DD/MM/YY | Position and Orientation | | |
| DD/MM/YY | Translational Dynamics | | |
| DD/MM/YY | Rotational Dynamics | | |
| DD/MM/YY | Flying, Swimming and Articulated Robots | | |
| DD/MM/YY | Spatial Transformations | UNIT-2 | 9 |
| DD/MM/YY | Coordinate Representation | | |
| DD/MM/YY | Homogeneous Transformations | | |
| DD/MM/YY | Forward Kinematics | | |
| DD/MM/YY | Inverse Kinematics | | |
| DD/MM/YY | Path Planning Algorithms | | |
| DD/MM/YY | Trajectory Generation | | |
| DD/MM/YY | Feedback Control Systems | | |
| DD/MM/YY | PID Control and Robot Motion Control | | |
| DD/MM/YY | Robot Sensors | UNIT-3 | 9 |
| DD/MM/YY | Robotic Perception Systems | | |
| DD/MM/YY | Actuators and Embedded Interfaces | | |
| DD/MM/YY | Numerical Optimization | | |
| DD/MM/YY | Optimization in Robotic Systems | | |
| DD/MM/YY | Dynamic Optimal Control | | |
| DD/MM/YY | Localization Techniques | | |
| DD/MM/YY | Mapping and Navigation | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Intelligent Navigation Systems | | |
| DD/MM/YY | Probability and Statistics in Robotics | UNIT-4 | 9 |
| DD/MM/YY | Uncertainty Handling in Robotics | | |
| DD/MM/YY | Machine Learning for Robotics | | |
| DD/MM/YY | Intelligent Decision Making | | |
| DD/MM/YY | Neural Networks in Robotics | | |
| DD/MM/YY | Adaptive Robotic Systems | | |
| DD/MM/YY | Intelligent Perception Models | | |
| DD/MM/YY | AI-Based Robotic Applications | | |
| DD/MM/YY | Case Studies in Intelligent Robotics | | |
| DD/MM/YY | State Estimation | UNIT-5 | 9 |
| DD/MM/YY | Stochastic Control | | |
| DD/MM/YY | Adaptive Robotic Behavior | | |
| DD/MM/YY | Parameter Estimation | | |
| DD/MM/YY | Reinforcement Learning | | |
| DD/MM/YY | Autonomous Robotic Systems | | |
| DD/MM/YY | Task Planning | | |
| DD/MM/YY | Swarm Robotics | | |
| DD/MM/YY | Multi-Agent Intelligent Systems | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

**THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | Robotics Fundamentals & Conceptual Recall | Recall concepts related to robotics, intelligent systems, robot architectures, classifications, locomotion mechanisms, and applications of robotic systems | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | Robot Motion, Kinematics & Control Understanding | Explain robot kinematics, coordinate transformations, path planning, trajectory generation, feedback control systems, and robot dynamics | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | Robotic System Application & Optimization | Apply robotic transformations, motion planning algorithms, optimization techniques, localization, mapping, and navigation methods in intelligent robotic systems | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |
| TS4 | Intelligent Perception & Analytical Evaluation | Analyze robotic perception, sensing systems, uncertainty handling, intelligent navigation, and AI-driven robotic decision-making techniques | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| TS5 | Machine Learning & Autonomous Robotics Evaluation | Evaluate machine learning models, neural networks, reinforcement learning, stochastic control, and adaptive robotic systems for autonomous applications | CO5 \| L4–L5 | ETE Sec B/C |
| TS6 | Autonomous Multi-Agent System Design & Innovation | Design and analyze intelligent autonomous systems using task planning, swarm robotics, reinforcement learning, and multi-agent intelligent frameworks | CO6 \| L5–L6 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Smart Contract Fundamentals & Conceptual Recall | TS2 Ethereum Platform Understanding & Comparative Interpretation | TS3 Smart Contract Development & Solidity Application | TS4 Smart Contract Analysis & Security Evaluation | TS5 Decentralization & Blockchain System Evaluation | TS6 Smart Contract Platforms & Future Application Analysis |
|---|---|---|---|---|---|---|
| CO1 | H | M | | | | |
| CO2 | M | H | M | | | |
| CO3 | | M | H | M | | |
| CO4 | | | M | H | M | |
| CO5 | | | | M | H | M |
| CO6 | | M | | M | M | H |

H = High / Primary alignment  M = Medium / Secondary alignment  *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|
| **Assignments 1–2 (Theory / Application-based)** | 2 assignments | **10** | CO1, CO2, CO3, CO4, CO5, CO6 | TS1, TS2, TS3, TS4, TS5,TS6 |
| **Assessments 1–2 (Theory / Application-based)** | **2 Assessments (Assessment 1 (10 Marks) + Assessment 2 (5 Marks))** | **15** | CO1, CO2, CO3, CO4, CO5 | TS1, TS2, TS3, TS4, TS5 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Assignment 1** | Unit 1 and Unit 2 concepts: Robotics fundamentals, robot architectures, kinematics, transformations, motion planning and control systems | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Report submission + conceptual evaluation |
| **Assignment 2** | Unit 3, Unit 4 and Unit 5 concepts: robotic sensing, intelligent systems, machine learning, reinforcement learning and swarm robotics | CO1,CO2,CO3, CO4, CO5,CO6 | TS1,TS2,TS3,TS4,TS5,TS6 | 5h SL | Comparative analysis + conceptual explanation |

### 9.3 Assessment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assessment 1** | Unit 1 and Unit 2 concepts: robot architectures, mobile robots, transformations, kinematics and control systems | CO1, CO2,CO3 | TS1,TS2,TS3 | 5h SL | Report submission + conceptual evaluation |
| **Assessment 2** | Unit 3 and Unit 4 concepts: robotic perception, optimization, intelligent decision making and machine learning approaches | CO1,CO2,CO3, CO4, CO5 | TS1,TS2,TS3,TS4,TS5 | 5h SL | Comparative analysis + conceptual explanation |

## 10. Mid Term Examination (MTE) - 15 Marks (Units 1–2)

*MTE covers Units 1–2 and CO1-CO6 are assessed in ETE. MTE maps to TS1–TS3.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Robotics Fundamentals & Conceptual Recall<br>TS2 — Robot Motion, Kinematics & Control Understanding | CO1<br>CO2 | Short-answer questions: robot classifications, intelligent systems, locomotion methods, robot architectures, applications of robotics.<br>Theory/problem-based questions: coordinate systems, transformations, forward and inverse kinematics, trajectory planning, robot dynamics. |

| | | |
|---|---|---|
| TS3 — Robotic System Application & Optimization<br>TS4-Intelligent Perception & Analytical Evaluation | CO3, CO4 | Application-based questions: path planning, PID control, motion planning algorithms, robotic transformations and optimization techniques.<br>Theory/problem-based questions: Intelligent perception |
| TS1-TS4 | **CO1–CO4** | **Units 1–3 only. CO5 and CO6 assessed in ETE only.** |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

*ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 40/100 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Robotics Fundamentals & Conceptual Recall TS2 — Robot Motion, Kinematics & Control Understanding | CO1, CO2 | Short-answer questions: robotics concepts, locomotion systems, transformations, kinematics, robot motion control, sensing principles |
| TS3 — Robotic System Application & Optimization TS4 — Intelligent Perception & Analytical Evaluation TS5 — Machine Learning & Autonomous Robotics Evaluation | CO3, CO4, CO5 | Medium questions: optimization techniques, localization and mapping, intelligent navigation, machine learning methods, uncertainty handling, robotic perception analysis |
| TS4 — Intelligent Perception & Analytical Evaluation TS5 — Machine Learning & Autonomous Robotics Evaluation | CO4, CO5 | Long analytical questions: reinforcement learning, neural networks, adaptive robotics, intelligent control, probabilistic robotics and autonomous system evaluation |

| | | |
|---|---|---|
| TS6 — Autonomous Multi-Agent System Design & Innovation | CO6 | Design and case-study-based questions on autonomous robots, swarm robotics, task planning and multi-agent intelligent systems |
| TS1–TS6 (all) | CO1–CO6 | Scaled from 100 marks to 60 marks |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (15) | ETE (60) | TS | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Recall robotics fundamentals, architectures and intelligent systems concepts | ✓ | ✓ | ✓ | TS1 | PO1, PO2 |
| CO2 | Explain robot motion, kinematics and control systems | ✓ | ✓ | ✓ | TS2 | PO1, PO2, PO3 |
| CO3 | Apply robotic transformations, optimization and planning algorithms | ✓ | ✓ | ✓ | TS3 | PO1, PO2, PO3, PO4 |
| CO4 | Analyze robotic perception, localization and intelligent decision making | ✓ | — | ✓ | TS4 | PO2, PO4, PO5 |
| CO5 | Evaluate machine learning and autonomous robotic techniques | ✓ | — | ✓ | TS5 | PO1, PO2, PO5 |
| CO6 | Design intelligent and autonomous multi-agent robotic systems | ✓ | — | ✓ | TS6 | PO3, PO4, PO5 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–2 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

## COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | - | – | 3 | 1 | 1 | - | - | 1 | 1 | 2 | 1 |
| CO2 | 2 | 3 | 1 | 2 | 2 | – | - | - | - | 1 | - | 1 | 2 | 2 |
| CO3 | 1 | 2 | 3 | 3 | 2 | – | 1 | 1 | - | 1 | - | 1 | 2 | 1 |
| CO4 | 2 | 1 | 2 | 2 | - | – | 1 | 1 | 1 | 1 | - | 1 | 3 | 2 |
| CO5 | 3 | 2 | 3 | – | – | – | - | - | 2 | 1 | 1 | 1 | 2 | 1 |
| CO6 | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | 2 | 1 |
| Avg | 2 | 2 | 2.2 | 2.2 | 1.00 | 0.8 | 0.9 | 0.7 | 1.0 | 0.7 | 1.5 | 1 | 2.2 | 2.1 |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | M | | M | | | H | | | | | | | M | |
| CO 2 | M | H | | M | M | | | | | | | | M | M |
| CO 3 | | M | H | H | M | | | | | | | | M | |
| CO 4 | M | | M | M | | | | | | | | | H | M |
| CO 5 | H | M | H | | | | | | M | | | | M | |
| CO 6 | M | H | M | | M | M | | | | | | | M | |
| Avg | 2 | 2 | 2.2 | 1.3 | 1.00 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 1 | 2.2 | 1.3 |

H = High / Primary alignment M = Medium / Secondary alignment *Blank = No direct alignment*

## 14. Self-Learning Activities (SL: 45 Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Assignment Writing (5 assignments, theory/application-based, one per unit focus area)** | 5 assignments × 4 hrs each Total = 20 hrs | CO1–CO4 TS1–TS4 | Evaluated based on assignment submission, conceptual understanding, robot kinematics and control analysis, numerical problem solving, optimization techniques, and explanation of robotic system concepts |
| 2 | **Technical Video-Based Learning related to the subject (e.g., Ethereum, Solidity, DAO, decentralized applications, smart contract deployment)** | Video viewing: 4 hrs Report preparation: 4 hrs Presentation: 4 hrs Total = 12 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, robotic workflows, intelligent control mechanisms, navigation systems, and personal reflections |
| 3 | **Real-World Case Studies (e.g., Ethereum applications, DAO systems, crowdfunding platforms, DeFi applications, smart contract security incidents)** | Data collection/study: 5 hrs Report preparation: 8 hrs Total = 13 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, intelligent system analysis, analytical conclusions, and comparative evaluation of autonomous robotic applications |
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (45 hrs) | Incomplete SL affects CA score directly |

*Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | ≥ 40 / 100 | **Must pass overall** | CA 25 + MTE 25 + ETE 5- = 100; 40% overall minimum required |

**CSA061 - Robotics and Intelligent Systems Summary**

*Theory-Only Course | 6 COs (CO1–CO6) | 2 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A

CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B

CO5–CO6: Evaluate/Create → TS5, TS6 → CA + ETE Sec B/C

CA 25 marks + MTE 15 marks + ETE 60 marks = Total 100 marks

# COURSE PLAN

## Social Network Analytics(CSAI4005)

*Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CSE-AIML | Semester VII | Batch 2023-2027*

*Theory-Only Course Plan — All 6 COs (CO1–CO6) | Theory Skill Dimensions TS1–TS6 | CA + MTE + ETE Assessment*

PART I

## COURSE SYLLABUS

*Course Identification, Details, Outcomes, BTL Mapping & Lecture Plan*

## 1. Course Identification

| | | | |
|---|---|---|---|
| **School:** | SSCSE — Sharda School of Computing Science & Engineering | **Batch:** | 2026–2030 |
| **Program:** | B.Tech | **Current Academic Year:** | 2029-30 |
| **Branch:** | CSE-AIML | **Semester:** | VII |
| **Course Code:** | CSAI4005 | **Course Type:** | Elective — Theory Only |

## 2. Course Details

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

| S.No | Attribute | Details |
|---|---|---|
| 1 | **Course Code** | |
| 2 | **Course Title** | **Social Network Analytics** |
| 3 | **Credits** | 3 |
| 4 | **Contact Hours (L-T-P-SL)** | 3-0-0-3 (Theory: 45 hrs Classroom + 45 hrs Self Learning = 90 hrs total) |

| | | |
|---|---|---|
| 5 | **Course Status** | **Core — Theory Only (No Laboratory Component)** |
| 6 | **Course Objectives** | 1. Understand core concepts of social and software networks, including structures, metrics, and graph models.<br>2. Analyze and interpret real-world network data using modern SNA tools and libraries.<br>3. Apply machine learning and graph-based techniques for prediction, classification, and community detection.<br>4. Develop network-driven solutions for real-world applications such as social media analytics, software dependency analysis, and cybersecurity. |
| 7 | **Course Outcomes (COs)** | **After successful completion of this course, students will be able to:**<br>CO1 (Understand – L1/L2): Explain the fundamentals of complex networks, network types, graph structures, and growth models<br>CO2 (Explore – L2/L3): Apply centrality measures, link analysis algorithms and visualization tools to analyze network properties.<br>CO3 (Apply – L3): Perform predictive network analytics including link prediction, diffusion modeling, and anomaly detection.<br>CO4 (Analyze – L4/L5): Implement graph representation learning techniques such as Node2Vec, DeepWalk, and basic GNN models.<br>CO5 (Analyze – L4/L5): Analyze large-scale social network datasets and apply network analytics in real-world applications.<br>CO6 (Analyze – L2/L4): Develop AI/ML-based solutions using network data for ranking, recommendation, and similarity analysis. |
| 8 | **Course Description** | This course introduces the principles of network science and social network analytics, focusing on complex networks, graph measures, link analysis, and predictive behavioral modeling. Students learn network growth models, diffusion dynamics, anomaly detection, and graph representation learning techniques such as Node2Vec and GNNs. The course emphasizes real-world applications, including recommender systems and large-scale network data analytics. |
| 9 | **Teaching & Learning Scheme** | Classroom Instructions (CI): 45 hrs \| Self Learning (SL): 45 hrs \| Total: 90 hrs |
| 10 | **Mode of Examination** | **Theory Only. CA: 25% \| MTE: 15% \| ETE: 60% \| Total: 100 marks** |
| 11 | **Textbook** | 1. Social Network Analysis: Methods and Applications – Stanley Wasserman & Katherine Faust, Cambridge University Press<br>2. Graph Representation Learning – William L. Hamilton, Morgan & Claypool Publishers |
| 12 | **References** | 1.Mining of Massive Datasets – Jure Leskovec, Anand Rajaraman, Jeffrey Ullman<br>2.Networks: An Introduction – Mark Newman, Oxford University Press<br>3.Social Network Analysis, Tanmoy Chakraborty, Wiley, 2021<br>4.Network Science, Albert-Lazzlo Barabasi |

## 3. Outline Syllabus with CO Mapping

ℹ *All CO mappings in this section refer to Theory COs (CO1–CO6). This is a theory-only course; all assessment is via CA, MTE, and ETE.*

| | Topic | CO Mapping |
|---|---|---|
| | **Unit 1: Foundations of Network Science & Social Network Analytics** | |
| **A** | Introduction to Complex Networks, Types of Networks: Social, Biological, Technological | **CO1** |
| **B** | Basic Graph Concepts: Nodes, Edges, Degrees, Paths, Network Growth Models: Random Graphs, Small-World, Scale-Free Models | **CO1** |
| **C** | Network Measures: Centrality, Clustering, Connectivity | **CO1** |
| | **Unit 2: Network Measures, Link Analysis & Visualization** | |
| **A** | Advanced Network Metrics: Betweenness, Closeness, Eigenvector Centrality | **CO2** |
| **B** | Link Analysis Algorithms: PageRank, HITS | **CO2** |
| **C** | Graph Visualization Techniques & Tools | **CO2** |
| | **Unit 3: Predictive & Behavioral Analytics on Networks** | |
| **A** | Link Prediction Models: Similarity-based, Probabilistic, ML-based | **CO3** |
| **B** | Network Dynamics: Cascading Behavior, Influence Spread, Diffusion Models, Network Effects: Virality, Information Spread, Contagion Models | **CO3** |
| **C** | Robustness, Fragility & Anomaly Detection in Networks | **CO3** |
| | **Unit 4: Graph Representation Learning & Deep Learning for Networks** | |
| **A** | Introduction to Deep Learning for Graphs, Representation Learning Concepts | **CO4** |
| **B** | Node2Vec, DeepWalk, LINE – Theory & Implementation | **CO4** |
| **C** | Graph Neural Networks (GNNs) – Basics | **CO4** |
| | **Unit 5: Software Network Analytics Applications** | |
| **A** | Large-Scale Network Data Analysis Techniques,<br>Real-World Social Network Datasets | **CO5** |
| **B** | Recommendation Systems Using Social Network Analytics | **CO5** |
| **C** | Web Algorithms: Ranking, Recommendation, Similarity | **CO6** |

## 4. Topic-wise Bloom's Taxonomy Level Mapping

| S.No | Topic | L1 Remember | L2 Understand | L3 Apply | L4 Analyze | L5 Evaluate | L6 Create |
|---|---|---|---|---|---|---|---|
| 1 | 1.A | ✓ | ✓ | | | | |
| 2 | 1.B | ✓ | ✓ | | | | |
| 3 | 1.C | | ✓ | ✓ | | | |
| 4 | 2.A | | ✓ | ✓ | | | |
| 5 | 2.B | | ✓ | ✓ | | | |
| 6 | 2.C | | | ✓ | ✓ | | |
| 7 | 3.A | ✓ | ✓ | | | | |
| 8 | 3.B | | | ✓ | ✓ | | |
| 9 | 3.C | | | ✓ | ✓ | ✓ | |
| 10 | 4.A | | ✓ | | | | |
| 11 | 4.B | | | ✓ | ✓ | | |
| 12 | 4.C | | | ✓ | ✓ | ✓ | |
| 13 | 5.A | | ✓ | ✓ | | | |
| 14 | 5.B | | | ✓ | ✓ | | |
| 15 | 5.C | | | | | | ✓ |

## 5. CO vs Bloom's Taxonomy — All Three Domains

ℹ *Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm implementation in CO3. Affective domain appears at A3 (Valuing) for efficiency analysis in CO4 and CO5.*

| CO | Cognitive Domain (L1–L6) | | | | | | Affective (A1–A5) | | | | | Psychomotor (P1–P7) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | L1 | L2 | L3 | L4 | L5 | L6 | A1 | A2 | A3 | A4 | A5 | P1 | P2 | P3 | P4 | P5 | P6 | P7 |
| CO1 | ✓ | ✓ | | | | | | | | | | | | | | | | |
| CO2 | | ✓ | ✓ | | | | | | | | | | | | | | | |
| CO3 | | | ✓ | ✓ | | | | | | | | | | | ✓ | | | |
| CO4 | | | | ✓ | ✓ | | | | ✓ | | | | | | | | | |
| CO5 | | | | ✓ | ✓ | | | ✓ | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | | ✓ | ✓ | ✓ | | | | | | | | | | | | | | |

*Legend: ✓ = Strong / Dominant mapping. Theory-only course: Cognitive domain is primary. Psychomotor (P3) limited to CO3 (algorithm implementation). Affective (A3) for CO4 and CO5 (valuing efficiency).*

## 6. Lecture Plan Outline (Theory — 30 Lectures / 30 Hours)

ℹ *Total classroom contact: 30 hours across 5 units. Self-Learning activities (30 hrs) are structured separately in Section 11.*

| Date | Topics to be covered | UNIT | Total Lectures |
|---|---|---|---|
| DD/MM/YY | Introduction to Network Science and Social Network Analytics ,Introduction to Complex Networks | Unit-1 | 11 |
| DD/MM/YY | Types of Networks: Social, Biological and Technological | | |
| DD/MM/YY | Graph Concepts: Nodes, Edges, Degrees and Paths | | |
| DD/MM/YY | Graph Connectivity and Components | | |
| DD/MM/YY | Random Graph Models | | |
| DD/MM/YY | Small-World Network Models | | |
| DD/MM/YY | Scale-Free Network Models | | |
| DD/MM/YY | Introduction to Network Measures-Centrality Measures,Clustering Coefficient | | |
| DD/MM/YY | Connectivity Measures and Applications | | |
| DD/MM/YY | Unit 1 Revision and Numerical Problems | | |
| DD/MM/YY | Introduction to Advanced Network Metrics | | |
| DD/MM/YY | Betweenness, Closeness, Eigenvector Centrality | Unit -2 | 10 |
| DD/MM/YY | Comparative Study of Centrality Measures | | |
| DD/MM/YY | Introduction to Link Analysis | | |
| DD/MM/YY | PageRank Algorithm | | |
| DD/MM/YY | HITS Algorithm | | |

| | | | |
|---|---|---|---|
| DD/MM/YY | Comparison of PageRank and HITS | | |
| DD/MM/YY | Graph Visualization Basics | | |
| DD/MM/YY | Graph Visualization Techniques and Tools | | |
| DD/MM/YY | Unit 2 Revision and Case Studies | | |
| DD/MM/YY | Introduction to Predictive Analytics on Networks | | |
| DD/MM/YY | Similarity-Based Link Prediction Models | unit 3 | 10 |
| DD/MM/YY | Probabilistic Link Prediction Models | | |
| DD/MM/YY | Machine Learning-Based Link Prediction | | |
| DD/MM/YY | Cascading Behavior in Networks | | |
| DD/MM/YY | Influence Spread and Diffusion Models | | |
| DD/MM/YY | Virality and Information Spread | | |
| DD/MM/YY | Contagion Models and Network Effects | | |
| DD/MM/YY | Robustness, Fragility and Anomaly Detection | | |
| DD/MM/YY | Unit 3 Revision and Applications | | |
| DD/MM/YY | Introduction to Graph Representation Learning | | |
| DD/MM/YY | Deep Learning for Graphs | unit 4 | 7 |
| DD/MM/YY | Representation Learning Concepts | | |
| DD/MM/YY | DeepWalk and Node2Vec – Theory & Implementation | | |
| DD/MM/YY | LINE – Theory & Implementation | | |
| DD/MM/YY | Graph Neural Networks (GNNs) – Basics | | |
| DD/MM/YY | Unit 4 Revision and Applications | | |
| DD/MM/YY | Large-Scale Network Data Analysis Techniques | | |
| DD/MM/YY | Real-World Social Network Datasets | Unit 5 | 7 |

| | | | |
|---|---|---|---|
| DD/MM/YY | Recommendation Systems Using Social Network Analytics | | |
| DD/MM/YY | Recommendation Systems Using Social Network Analytics | | |
| DD/MM/YY | Web Algorithms: Ranking, Recommendation | | |
| DD/MM/YY | Web Algorithms: Similarity | | |
| DD/MM/YY | Unit 5 Revision and Applications | | |
| DD/MM/YY | Introduction to Network Science and Social Network Analytics | | |

PART II

# THEORY ASSESSMENT FRAMEWORK

*Theory Skill Dimensions, CO × TS Mapping, CA / MTE / ETE Structure*

## 7. Theory Skill Dimensions (TS1–TS6)

📘 **THEORY-ONLY COURSE — All 6 COs (CO1–CO6) are assessed exclusively via Continuous Assessment (CA), MTE, and ETE. No laboratory component.**

★ *Six Theory Skill Dimensions — one per Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is being measured in each section of the CA, MTE, and ETE, providing a clear NBA-auditable assessment rationale.*

| ID | Dimension | What is Measured | CO / BTL | Assessment |
|---|---|---|---|---|
| TS1 | **Conceptual Understanding & Network Interpretation** | Explain graph concepts, network growth models, centrality measures, clustering, connectivity, and link analysis techniques; interpret network structures and relationships | CO1 \| L1–L2 | CA \| MTE Sec A \| ETE Sec A |
| TS2 | **Algorithmic Application & Network Analytics** | Apply PageRank, HITS, link prediction methods, diffusion models, and graph visualization techniques to analyze network behavior and information flow | CO2 \| L2–L3 | CA \| MTE Sec A \| ETE Sec A |
| TS3 | **Predictive Analysis & Performance Evaluation** | Analyze influence spread, virality, cascading behavior, robustness, fragility, and anomaly detection in networks; evaluate effectiveness of predictive models and analytical methods | CO3 \| L3 | CA \| MTE Sec B \| ETE Sec B |

| | | | | |
|---|---|---|---|---|
| **TS4** | **Graph Representation Learning & Deep Learning Evaluation** | Analyze representation learning techniques including DeepWalk, Node2Vec, LINE, and Graph Neural Networks (GNNs); evaluate embedding quality and model performance for network tasks | CO4 \| L4–L5 | MTE Sec B \| ETE Sec B |
| **TS5** | **Social Network Applications & Recommendation Evaluation** | Analyze large-scale social network datasets, recommendation systems, and web algorithms for ranking, similarity, and recommendation; evaluate applicability in real-world case studies | CO5 \| L4–L5 | ETE Sec B/C |
| **TS6** | **Conceptual Understanding & Network Interpretation** | Explain graph concepts, network growth models, centrality measures, clustering, connectivity, and link analysis techniques; interpret network structures and relationships | CO6 \| L2–L4 | ETE Sec C |

## 8. CO × Theory Skill Dimension Mapping (6 COs × 6 Dimensions)

ℹ *Each CO maps primarily to one TS dimension (H) with adjacent dimensions receiving secondary mapping (M), reflecting the progressive Bloom's structure of this course.*

| CO | TS1 Conceptual Recall | TS2 Algorithmic Application & Network Analytics | TS3 Performance Evaluation | TS4 Graph Representation Learning & Deep Learning Evaluation | TS5 Recommendation Evaluation | TS6 Network Interpretation |
|---|---|---|---|---|---|---|
| **CO1** | **H** | **M** | | | | |
| **CO2** | **M** | **H** | **M** | | | |
| **CO3** | | **M** | **H** | **M** | | |
| **CO4** | | | **M** | **H** | **M** | |
| **CO5** | | | | **M** | **H** | **M** |
| **CO6** | | | | **M** | **M** | **H** |

**H** = High / Primary alignment **M** = Medium / Secondary alignment *Blank = No direct alignment*

## 9. Continuous Assessment (CA) — 25 Marks

★ *CA is formative and covers COs progressively as the syllabus is taught. It includes numerical-based assignments, a technical video learning report, and a real-world case study — mirroring TS1 through TS6.*

### 9.1 CA Component Breakdown (Sample)

| Component | Quantum | Marks | COs Assessed | Skill Dimensions |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Assignments 1–5 (Numerical / Problem-based)** | 5 assignments | **15** | CO1, CO2, CO3, CO4 | TS1, TS2, TS3, TS4 |
| **Technical Video Learning Report** | 1 Report + Presentation | **5** | CO2, CO3 | TS2, TS3 |
| **Real-World Case Study (Report)** | 1 Report | **5** | CO4, CO5, CO6 | TS4, TS5, TS6 |
| **TOTAL** | — | **25** | CO1–CO6 | TS1–TS6 |

### 9.2 Assignment-wise CO & TS Mapping

| Item | Topic / Focus | COs | TS Dims | SL Hours | Evaluation Criteria |
|---|---|---|---|---|---|
| **Assignment 1** | **Unit 1 concepts: complex networks, graph concepts, network types and growth models** | **CO1** | **TS1** | **5h SL** | **Report submission + conceptual understanding evaluation** |
| **Assignment 2** | **Network measures: centrality, clustering, connectivity and interpretation of network structures** | **CO2** | **TS2** | **5h SL** | **Problem-solving and analytical interpretation** |
| **Assignment 3** | **Link analysis algorithms: PageRank and HITS implementation and comparison** | **CO2, CO3** | **TS2, TS3** | **5h SL** | **Algorithm execution + comparative analysis** |
| **Assignment 4** | **Link prediction and diffusion models: similarity-based, probabilistic and ML approaches** | **CO3, CO4** | **TS3, TS4** | **5h SL** | **Model application + analytical evaluation** |
| **Assignment 5** | **Graph representation learning and GNN basics: DeepWalk, Node2Vec, LINE** | **CO4, CO5** | **TS4, TS5** | **5h SL** | **Embedding implementation + performance analysis** |
| **Video Learning Report** | **Technical video on social network analytics, graph mining, GNNs or recommendation systems (min 3 hrs); structured report + class presentation** | **CO2, CO3** | **TS2, TS3** | **9h SL** | **Report: learning outcomes, key concepts, self-reflection. Presentation: 10 min** |
| **Case Study Report** | **Real-world case study on social media analytics, recommendation systems, influence spread, or web ranking algorithms** | **CO4, CO5, CO6** | **TS4, TS5, TS6** | **6h SL** | **Technical depth, dataset analysis, comparative study and practical relevance** |

## 10. Mid Term Examination (MTE) — 15 Marks (Units 1–3)

ℹ *MTE covers Units 1–3 (CO1, CO2, CO3, CO4). CO5 and CO6 are assessed in ETE only. MTE maps to TS1–TS4.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Conceptual Recall & Network Identification TS2 — Conceptual Understanding & Network Interpretation | **CO1, CO2** | Short-answer questions: define complex networks, explain graph concepts, identify network types, describe centrality measures, clustering, connectivity, PageRank and HITS concepts |
| TS3 — Algorithmic Application & Network Analytics TS4 — Predictive Analysis & Performance Evaluation | **CO2, CO3, CO4** | Analytical and numerical problems: compute centrality measures, apply PageRank/HITS algorithms, analyze link prediction models, evaluate diffusion and influence spread models, compare network analysis techniques |
| **TS1–TS4** | **CO1–CO4** | **Units 1–3 only. CO5 and CO6 assessed in ETE only.** |

## 11. End Term Examination (ETE) — 60 Marks (All Units, All COs)

ℹ *ETE is comprehensive — all 5 units and all 6 COs. Full progression from TS1 (recall) through TS6 (evaluation). Minimum 20/50 required to pass.*

| Theory Skill Dimensions | COs Assessed | Question Type & Guidance |
|---|---|---|
| TS1 — Conceptual Recall & Network Identification TS2 — Conceptual Understanding & Network Interpretation | **CO1, CO2** | Short questions (all units): definitions of complex networks, graph concepts, network models, centrality measures, clustering, connectivity, PageRank, HITS, and graph visualization concepts |
| TS3 — Algorithmic Application & Network Analytics TS4 — Predictive Analysis & Performance Evaluation TS5 — Graph Representation Learning & Deep Learning Evaluation | **CO3, CO4, CO5** | Medium questions: computation of centrality metrics, PageRank/HITS implementation, link prediction models, diffusion and contagion analysis, Node2Vec/DeepWalk concepts, graph embedding and GNN-based analysis |
| TS5 — Graph Representation Learning & Deep Learning Evaluation TS6 — Social Network Applications & Recommendation Evaluation | **CO5, CO6** | Long/evaluation questions: analysis of recommendation systems, large-scale network datasets, web ranking algorithms, similarity measures, real-world social network case studies, and comparative evaluation of graph learning models |
| **TS1–TS6 (all)** | **CO1–CO6** | Scaled from 100-mark paper if needed. Minimum 20/50 to pass. |

### 11.1 CO-wise Assessment Instrument Summary

| CO | CO Statement (Short) | CA (25) | MTE (25) | ETE (50) | TS | PO Primary |
|---|---|---|---|---|---|---|
| CO1 | Explain the fundamentals of complex networks, network types, graph structures, and growth models. | ✓ | ✓ | ✓ | TS1 | PO1, PO2 |
| CO2 | Apply centrality measures, link analysis algorithms, and visualization tools to analyze network properties | ✓ | ✓ | ✓ | TS2 | PO1, PO2, PO3, PO4, PO5 |
| CO3 | Perform predictive network analytics including link prediction, diffusion modeling, and anomaly detection. | ✓ | ✓ | ✓ | TS3 | PO2, PO4 |
| CO4 | Implement graph representation learning techniques such as Node2Vec, DeepWalk, and basic GNN models. | ✓ | ✓ | ✓ | TS4 | PO3, PO4, PO5 |
| CO5 | Analyze large-scale social network datasets and apply network analytics in real-world applications. | ✓ | – | ✓ | TS5 | PO2, PO4, PO5, PO9, PO10 |
| CO6 | : Develop AI/ML-based solutions using network data for ranking, recommendation, and similarity analysis. | ✓ | – | ✓ | TS6 | PO2, PO3, PO5, PO9, PO10, PO11 |

⚠ *CO5 and CO6 are NOT assessed in MTE (only Units 1–3 are covered at mid-semester). They are assessed in CA (self-learning activities) and ETE.*

PART III

# COMBINED MAPPINGS & REFERENCE

*CO–PO Matrix, CO–PO Alignment, Self-Learning Activities, Bloom's Reference, Attendance & Pass/Fail*

## 12. CO–PO and CO–PSO Mapping Matrix (Original Framework)

ℹ *Strength Scale: 3 = Substantial (High) | 2 = Moderate | 1 = Slight (Low) | – = Not Applicable. Averages computed over non-zero entries only. PO framework as per the original course design.*

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 1 | 1 | 1 | - | - | - | 1 | - | 3 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 1 | - | - | 1 | 1 | 1 | 3 | 3 | 3 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO3** | 2 | 3 | 2 | 3 | 2 | 1 | - | - | 1 | 1 | 1 | 2 | 3 | 2 |
| **CO4** | 2 | 2 | 3 | 3 | 3 | 1 | - | - | 1 | 1 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 3 | 1 | - | - | 2 | 2 | 2 | 2 | 3 | 2 |
| **CO6** | 1 | 3 | 3 | 2 | 3 | 1 | - | 1 | 3 | 3 | 3 | 1 | 3 | 1 |
| **Avg** | **2.17** | **2.67** | **2.17** | **2.3** | **2.3** | **1** | **0** | **0.17** | **1.3** | **1.5** | **1.5** | **2.17** | **2.67** | **2.17** |

## 13. CO × PO Alignment Map (H/M Indicators — All 6 COs)

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1- | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | H | M | | | | | | | | | | H | M | H |
| **CO2** | H | H | M | M | M | | | | | | | H | H | H |
| **CO3** | M | H | M | H | M | | | | | | | M | H | M |
| **CO4** | M | M | H | H | H | | | | | | M | M | M | M |
| **CO5** | M | H | M | H | H | | | | M | M | M | M | H | M |
| **CO6** | | H | H | M | H | | | | H | H | H | | H | |

## 14. Self-Learning Activities (SL: 3- Hours)

| S.No | Activity | Hours | COs / TS | Evaluation Criteria |
|---|---|---|---|---|
| 1 | **Numerical Assignment Writing (5 assignments, problem-based, one per unit focus area)** | 5 assignments × 4hrs each<br>Total = 20hrs | CO1–CO4 TS1–TS4 | Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance |
| 2 | **Technical Video-Based Learning related to the subject (e.g., OS scheduling, deadlock, memory management)** | Video viewing: 4 hrs<br>Report preparation: 4 hrs Presentation: 4 hrs Total = 12 hrs | CO2, CO3 TS2, TS3 | Report + Presentation based on video learning outcomes; must capture key concepts, algorithms, and personal reflections |
| 3 | **Real-World Case Studies (e.g., Linux/Windows OS internals, Android memory management, cloud OS design)** | Data collection/study: 5 hrs Report preparation: 8 hrs<br>Total = 13 hrs | CO4, CO5, CO6 TS4, TS5, TS6 | Evaluated based on in-depth study, technical depth, data collected, fact finding, and analytical conclusions drawn |

| | | | | |
|---|---|---|---|---|
| | **TOTAL Self-Learning Hours** | **45 hours** | CO1–CO6 | All activities are compulsory. Submission deadlines communicated at the start of the semester. |

## 15. Bloom's Taxonomy — Domain Level Reference

| Cognitive Domain (6 Levels) | Affective Domain (5 Levels) | Psychomotor Domain — Simpson (7 Levels) |
|---|---|---|
| L1 — Remember: Recall facts, definitions, basic concepts<br>L2 — Understand: Explain ideas, concepts, and principles<br>L3 — Apply: Use knowledge to solve problems in new situations<br>L4 — Analyze: Break down information, examine relationships<br>L5 — Evaluate: Judge, justify, assess, and make decisions<br>L6 — Create: Design, develop, and produce new artefacts | A1 — Receiving: Awareness and willingness to attend<br>A2 — Responding: Active participation and reaction<br>A3 — Valuing: Commitment and assigning value to content<br>A4 — Organizing: Integrating values into a personal system<br>A5 — Characterizing: Internalized value system | P1 — Perception: Sensory cues guide motor activity<br>P2 — Set: Mental, physical readiness to act<br>P3 — Guided Response: Practice through imitation/trial<br>P4 — Mechanism: Habitual correct performance<br>P5 — Complex Overt Response: Skilled performance<br>P6 — Adaptation: Modify skills for special situations<br>P7 — Origination: Create new solution patterns |

★ *OBE Compliance Statement: This is a theory-only course. All 6 COs are mapped primarily to the Cognitive domain (L1–L5). Psychomotor domain (P3) appears only for CO3 (algorithm implementation as mental tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of algorithmic efficiency.*

## 16. Attendance Policy & Pass / Fail Criteria

### 16.1 Attendance Policy

| Component | Minimum | Applicable To | Consequence |
|---|---|---|---|
| **Theory Classes** | **75%** | All lecture sessions | Debarred from ETE if below threshold |
| **Self-Learning / Assignment Submission** | **All activities** | SL activities (3- hrs) | Incomplete SL affects CA score directly |

⚠ *Theory attendance must meet 75% minimum. Missing SL activities (assignments, video report, case study) directly impacts CA marks and is not compensable by exam performance.*

### 16.2 Pass / Fail Criteria

| Condition | Threshold | Status | Remarks |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Overall Total (CA + MTE + ETE)** | ≥ 4- / 1-- | **Must pass overall** | CA 25 + MTE 25 + ETE 5- = 1--; 4-% overall minimum required |

**CSE — Social Networks Analytics Summary**

*Theory-Only Course | 6 COs (CO1–CO6) | 3 Assessment Instruments | 6 Theory Skill Dimensions (TS1–TS6)*

**CO1–CO2: Conceptual / Understand → TS1, TS2 → CA + MTE Sec A + ETE Sec A**

**CO3–CO4: Apply / Analyze → TS3, TS4 → CA + MTE Sec B + ETE Sec B**

**CO5–CO6: Analyze / Evaluate → TS5, TS6 → CA + ETE Sec B/C**

CA 25 marks + MTE 25 marks + ETE 5- marks = Total 1-- marks

| Semester 8, Credits: 15 | |
|---|---|
| **COURSE CODE** | **COURSE NAME** |
| CSCR4601 | Capstone - 2 |
| CSCR40** | Open Elective - 3 (Min. 12 weeks MOOCs) |
| CSCR40** | Open Elective - 4 |

| | | | | | |
|---|---|---|---|---|---|
| **School: SSCSE** | | **Batch: 2026-2030** | | | |
| **Program: B.Tech.** | | **Current Academic Year: 209-2030** | | | |
| **Branch: CSE-AIML** | | **Semester: VIII** | | | |
| 1 | Course Code | **CSCR4601** | | | |
| 2 | Course Title | Capstone - 2 | | | |
| 3 | Credits | 10 | | | |
| 4 | Contact Hours (L-T-P) | 0-0-2 | | | |
| | Course Status | Compulsory | | | |
| 5 | Course Objective | 1. To understand the concept of project design after the completion of project planning<br>2. Students making decisions within a framework<br>3. Continuous evaluation of the project<br>4. A final product to be evaluated for quality | | | |
| 6 | Course Outcomes | Students will be able to:<br>CO1: Demonstrate the implementation of the project.<br>CO2: Identify the test procedure for each implemented module.<br>CO3: Deploy and evaluate the modules to verify the required need of the project.<br>CO4: Use different tools for communication, testing and report writing.<br>CO5: Develop the attitude and ethics of a professional engineer.<br>CO6: Demonstrate an ability to present and defend their project work to a panel of experts. | | | |
| 7 | Course Description | The objective of Major Project-II is to enable the student to extend further the development of project till testing and deployment under the guidance of a Supervisor. | | | |
| 8 | Outline syllabus | | | | CO Mapping |
| | **Unit 1** | Complete the implementation of the project. Testing of the modules, Use of appropriate tools/techniques for testing | | | CO1, CO2 |
| | **Unit 2** | Deploy & demonstrate developed modules of the project | | | CO2, CO3 |
| | **Unit 3** | Preparing a Project Report in the standard format for being evaluated by the Supervisor | | | CO4, CO5 |
| | **Unit 4** | Submission of Project and Report to Departmental Committee | | | CO4, CO5, CO6 |
| | **Unit 5** | Final Presentation before Departmental Committee | | | CO6 |
| | Mode of examination | Project | | | |
| | Weight age Distribution | CA | CE(Viva) | ETE | |
| | | 30% | 30% | 40% | |

**CO and PO Mapping**

| S. No. | Course Outcome | Program Outcomes (PO) |
|---|---|---|
| 1. | CO1: Demonstrate the implementation of the project. | PO1, PO2, PO3, PO4, PO5,PO6,PO7, PO8, PO9, PO10, PO11, PSO1,PSO2,PSO3 |
| 2. | CO2: Identify the test procedure for each implemented module. | PO1, PO2, PO3, PO4, PO5,PO6,PO7, PO8, PO9, PO10, PO11,PSO1,PSO2,PSO3 |
| 3. | CO3: Deploy and evaluate the modules to verify the required need of the project. | PO1, PO2, PO3, PO4, PO5,PO6,PO7, PO8, PO9, PO10, PO11, PSO1,PSO2,PSO3 |
| 4. | CO4: Use different tools for communication, testing and report writing. | PO1, PO2, PO3, PO4, PO5,PO6,PO7, PO8, PO9, PO10, PO11, PSO1,PSO2,PSO3 |
| 5. | CO5: Develop the attitude and ethics of a professional engineer. | PO1, PO2, PO3, PO4, PO5,PO6,PO7, PO8, PO9, PO10, PO11, PSO1,PSO2,PSO3 |
| 6. | CO6: Demonstrate an ability to present and defend their project work to a panel of experts. | PO1, PO2, PO3, PO4, PO5,PO6,PO7, PO8, PO9, PO10, PO11,PSO1,PSO2,PSO3 |

**PO and PSO mapping with level of strength for Course Name Major Project -2 (Course Code CSCR4601)**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 3 | 3 |
| CO4 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 |
| CO5 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 |
| CO6 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Avg.** | **1.83** | **2.0** | **2.33** | **2.0** | **2.83** | **2.0** | **2.0** | **2.0** | **2.33** | **2.0** | **1.5** | **1.5** | **2.5** | **2.5** |

**1-Slight (Low) 2-Moderate (Medium) 3-Substantial (High)**