Programme Structure

Sharda School of Computing Science & Engineering

Bachelor of Technology
(Computer Science & Medical Engineering And specialization)

Programme Code: SCS0102

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**

1.2 Vision and Mission of Sharda School of Computing Science & Engineering

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 computer science, artificial intelligence, and biomedical informatics to develop intelligent solutions for disease diagnosis, clinical decision support, medical image analysis, and healthcare data management.
PSO2	Design and develop secure, reliable, and standards-compliant healthcare software, medical information systems, telemedicine platforms, IoT-enabled medical devices, and Electronic Health Record (EHR) solutions.
PSO3	Leverage emerging technologies such as Generative AI, Large Language Models (LLMs), Computer Vision, Edge AI, Digital Twins, and Cybersecurity to develop innovative, ethical, and sustainable healthcare solutions.

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	PSO 1	PSO 2	PSO3
Course Code	Course Name														
CSME1100	Human anatomy and physiology	2.5	2.7	2.3	2.5	2.5	2.0	1.5	2.5	2.0	2.0	1.0	2.2	2.3	2.3
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
PHT1136	Engineering Physics	2.5	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
MTT1117	Foundations of Mathematics	2.67	2.33	2.80	2.75	1.00	–	–	2.00	2.20	1.67	2.33	2.50	2.20	1.75
SKT1100	Professional Communication	1.0	1.83	1.25	1.00	1.00	–	–	2.00	2.17	3.00	2.00	2.17	2.17	2.33
CSCR1300	Programming for Problem Solving	2.5	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
CSCR1507	Digital Prototyping	2.0	2.50	2.40	–	2.00	–	–	2.33	1.67	1.33	2.50	2.00	2.17	2.00
IKT1108	IKS	1.67	1.0	-	1.67	1.0	2.0	1.0	1.6	1.0	1.0	-	1.2	1.0	2.0
Semester-II															
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3

Course Code	Course Name														
EET1101	Basics of Electrical and Electronics Engineering	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
MTT1116	Mathematics - I	2.67	2.33	2.80	2.75	1.00	–	–	2.00	2.20	1.67	2.33	2.50	2.20	1.75
CSCR1302	Application based Programming in Python	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
CSCR1504	Design and Creativity Lab	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
BTT1102	Introduction to Computational Biology	3	1.5	2.0	1.6	1.5	0.83	0.5	1.00	2.3	0	0	2.5	2.1	1.8
CSCR1301	Object Oriented Programming Using Java	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
CVT 1103	Environmental Studies	1.25	2.25	1.4	1.6	2.0	2.0	1.75	1.0	1.5	2.0	2.25	1.75	1.75	2.2
IKT 1105	Human Values and Professional Ethics	1	1	-	1	-	1.5	2	2.17	1	1	1	1	1	-
	Value Added Course														
Semester-III															
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3
Course Code	Course Name														

CSCR2310	Computer Networks	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
MTT1217	Mathematics – II	2.67	3.00	2.50	2.50	1.83	–	–	1.33	1.83	2.00	2.00	1.00	2.67	2.83
CSCR2312	Principles of Operating System	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
CSME2300	Applied AI and ML for health inforamatics	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
SKP2301	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
CSCR2311	Data Structure	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	PSO 1	PSO 2	PSO3
Course Code	Course Name														
CSCR2314	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
CSCR2115	Theory of Computation	2.67	2.50	2.80	2.75	1.00	–	–	2.40	2.60	2.14	2.33	2.00	2.66	2.20

CSCR2117	Introduction to Cloud Computing	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
Program Elective-1															
CSAI2001	System Design - SI (Case Study Based)	2.83	2.83	2.83	3	2.83	2.67	1.83	1.83	2.33	2.33	2	3	3	2.83
CSAI2002	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
CSAI2003	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
SKP2401	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	2.00
CSME2301	Clinical Data Analytics	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
CSCR2601	Project Based Learning (PBL) -2 (Research Methodology Based)	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	PSO 1	PSO 2	PSO3
Course Code	Course Name														
CSME3300	Signal Systems and Medical Engineering	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

CSCR3311	Design and Analysis of Algorithm	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
CSAD2100	Software Engineering and Project Management	2.0	-	2.3	3	1.8	2.5	-	1.00	1.00	3	3	-	-	2.50
Program Elective-2															
CSDS3103	Big Data Analytics	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
CSAI4200	Natural Language Processing	2.34	2.5	1	0.5	2.5	0.34	–	0.67	-	0.5	2.0	2.0	2.0	2.0
CSCF2100	Digital Forensics	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
SKP3501	Communication , coding and 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	PSO 1	PSO 2	PSO3
Course Code	Course Name														

CSME3301	Deep Learning and Reinforcement Learning in Medical data	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
CSME3100	Embeded system and wearable devices	2.83	2.83	2.33	2.60	2.67	1.50	2.00	2.50	1.33	1.33	1.00	2.50	2.83	2.83
CSME3302	Biomedical Instrmentation	2.5	2.7	2.3	2.5	2.5	2.0	1.5	2.5	2.0	2.0	1.0	2.2	2.3	2.3
	Program Elective-3														
CSME3200	AI in drug discovery	2.67	2.33	2.80	2.75	1.00	–	–	2.00	2.20	1.67	2.33	2.50	2.20	1.75
CSME3201	Clinical Decision Support System	2.83	3	2.50	2.50	2	–	–	2.17	2.17	2.17	2.17	2.83	2.67	1.83
CSOT3206	Data Analytics for IoT	2.67	2.33	2.80	2.75	1.00	–	–	2.00	2.20	1.67	2.33	2.50	2.20	1.75
SKP3601	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														
Semester-VII															

Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3
Course Code	Course Name														
	Program Elective-4														
CSME4200	Modelling and simulation of Biomedical system	**2.67**	**2.67**	**2.50**	**2.50**	**2.00**	**1.00**	**1.00**	**1.83**	**1.50**	**2.00**	**1.50**	**2.67**	**2.50**	**1.83**
CSME4201	Blockchain in Medical Data Management	2.5	2.7	2.3	2.5	2.5	2.0	1.5	2.5	2.0	2.0	1.0	2.2	2.3	2.3
CSAI4003	Smart Contract	**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**
	Program Elective-5														
CSME4202	HealthCare Data Analytics	**2.67**	**2.33**	**2.80**	**2.75**	**1.00**	**–**	**–**	**2.00**	**2.20**	**1.67**	**2.33**	**2.50**	**2.20**	**1.75**
CSME4203	Natural Language Processing for Clinical Data	2.34	2.5	1	0.5	2.5	0.34	–	0.67	-	0.5	2.0	2.0	2.0	2.34
CSME4204	Ethical AI in Medicine	2.67	2.83	2.00	1.83	2.16	1.66	1.5	1.16	1.00	1.33	2.33	2.66	2.33	2.00
	Program Elective-6														
CSME4205	Explainable AI in Medicine	2.50	2.50	2.50	2.50	1.00	-	-	1.83	2.00	1.83	1.83	2.67	2.50	1.67
CSME4206	Rehabilitation Engineering	2.5	2.5	2.33	2.17	1.50	1.00	–	2.17	2.17	2.00	2.00	2.50	2.33	1.67
CSME4207	Medical Robotics (surgical robots, rehab robots)	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

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
	Open Elective – 2														
Semester-VIII															
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	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
CSCR40**	Open Elective – 3														
CSCR40**	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	Programming for Problem Solving (4), Digital Prototyping (2), Human anatomy and physiology (3), Fundemental of computing and AI (2) **(11)**		Engineering physics (4),		Professional communication (3)				18	39	First Minor Core is fixed course for each school. VAC Courses include -Environment -Indian Knowledge System -Mulya Pravah VAC/SEC/Multidis/AEC can be taken from NPTEL
II	Application based Programming in Python Lab (4), Design and creativity Lab (2),		Introduction to Computational Biology (2), Human values						21		

	OOP using Java (3) **9**		(2), Basics of EEE (4) and Mathematics 1 (4) **12**								
	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 Network (4), Mathematics – II (3), Principles of OS (3), Applied AI and ML for health inforamatics (4), Project Based Learning (PBL) -1 (Mini-Hackathon Based) (1), Data structures (4) **19**	**0**	**0**	Professional Skills, Data Structures & Web Technologies **3**	**0**	**0**	**0**	**0**	22	84	****Consent to be taken from Students for Apprenticeship by floating name of Industries**

IV	Data Base Management System (4), Theory of computation (3), Introdcution to cloud computing (4),clinical data analytics (4), Project based learning (2) **17**	PE -1 **3**	**0**	**0**	Integrated Professional Communication and Intelligent Computing (3) **3**	**0**	**0**	**0**	23		
	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	Signal systems and medical system processing (4), Design and Analysis of Algorithm (4) , Software Engineering and Project Management (3) , Projetc based learning (2)	PE-2		Community connect (2)	Communica tion, Coding & Career Readiness Skills (3)		Summer Internship-I (2)		23	130	3- Year UG Degree inclusive of optional Apprenticeship

	13	**3**	**0**	**2**	**3**	**0**	**2**	**0**			
VI	Deep Learning and Reinforcement Learning in Medical data (4), Embeded system and wearable devices (3), Biomedical Instrmentation (3), Project Based Learning (PBL) -4 (Product Based) (2), Management for Engineers (3)	Program Elective-3 (3) & Open Elective – 1 (2)			Strategic Professionali sm 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) **2**	Progra m Elective-4 (3), Program Elective-5 (3), Program Elective-6 (3), Open Elective – 2 (2) **11**	**0**	**0**	**0**	**0**	Summ er Interns h ip-II (2) **2**		15	160	***ONLY for students going for Apprenticeship & requires Minor with Major Degree** 4- Year UG Degree (Honours) inclusive of optional Apprenticeship
VIII	Capstone – 2 (10) **10**	Open Elective – 3 (2) Open Electi ve - 4 (min. 12 Week Course) (3) **5**	**0**	**0**	**0**	**0**	**0**	**0**	**15**		

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 (CS & ME)	Credits	Practical/ Theory/Integrated	Type	Total Credits
Sem- 1				**18**
1. Human anatomy and physiology	3	Theory	Core	
2.Fundamentals of Computing and Artificial Intelligence	2	Theory	Core	
3.Engineering Physics	4	Integrated	MDC	
4. Foundations of Mathematics	0	Theory	Core	
5. Programming for Problem Solving	4	Integrated	Core	
6.Digital Prototyping	2	Practical	Practical/Tutorial/Studios	
7. Professional Communication	3	Theory	SEC	
8. IKS	0	Theory	Audit	
Sem – II				**21**
1. Human Values and Professional Ethics	2	Theory	SEC	
2. Basics of Electrical and Electronics Engineering	4	Theory	MDC	
3. Environmental Studies	0	Theory	AECC	
4. Mathematics – I	4	Theory	Core	
5. Application based Programming in Python Lab	4	Integrated	Core	
6. Design and creativity Lab	2	Practical	Practical/Tutorial/Studios	
7. Introduction to Computational Biology	2	Theory	MDC	
8. Object Oriented Programming Using Java	3	Integrated	Core	
9.Value Added Course	0	Theory	VAC	
Sem – III				**22**
1. Computer Network	4	Integrated	Core	
2. Mathematics – II	3	Theory	Core	
3.Principles of Operating System	3	Integrated	Core	
4. Applied AI and ML for health inforamatics	4	Integrated	Core	
5. Professional Skills, Data Structures & Web Technologies	3	Practical	SEC	
6. Project Based Learning (PBL) -1 (Mini-Hackathon Based)	1	Project	Field Projects/RBL	
7. Data Structures	4	Integrated	Core	
Sem – IV				**23**
1.Data Base Management System	4	Integrated	Core	
2.Theory of Computation	3	Theory	Core	
3.Introduction to Cloud Computing	4	Integrated	Core	
4. Program Elective-1	3	Theory	Minor Electives	
5.Integrated Professional Communication and Intelligent Computing	3	Practical	SEC	
6. Clinical Data Analytics	4	Integrated	Core	

7.Project Based Learning (PBL) -2 (AI Applications in Healthcare)	2	Project	Field Projects/RBL	
Sem – V				**23**
1.Signal systems and medical system processing	4	Integrated	Core	
2.Design and Analysis of Algorithm	4	Integrated	Core	
3.Software Engineering and Project Management	3	Theory	Core	
4.Program Elective-2	3	Theory	Minor Electives	
5.Communication, coding and career Readiness skills	3	Practical	SEC	
6.Project Based Learning (PBL) -3 (Hackathon Based)	2	Project	Field Projects/RBL	
7.Community Connect	2	Project	AEC	
8.Summer Internship-I	2	Internship	Internship	
Sem – 6				**23**
1.Deep Learning and Reinforcement Learning in Medical data	4	Integrated	Core	
2.Embeded system and wearable devices	3	Theory	Core	
3.Biomedical Instrmentation	3	Theory	Core	
4. Project Based Learning (PBL) -4 (Product Based)	2	Project	Field Projects/RBL	
5. Management for Engineers	3	Theory	**AEC**	
6. Program Elective-3	3	Theory	Minor Electives	
7. Open Elective – 1	2	MOOC	Minor Electives	
8. Strategic Professionalism and Computational Informatics	3	Practical	**SEC**	
Sem – 7				**15**
1. Capstone – 1	2	Project	Dissertation/Capstone Project	
2. Summer Internship-II	2	Internship	Internship	
3. Program Elective-4	3	Theory	Minor Electives	
4. Program Elective-5	3	Theory	Minor Electives	
5. Program Elective-6	3	Theory	Minor Electives	
6. Open Elective – 2	2	MOOC	Minor Electives	
Sem – 8				**15**
1. Capstone – 2	10	Project	Dissertation/Capstone Project	
2. Open Elective – 3	2	MOOC	Minor Electives	
3. Open Elective - 4 (min. 12 Week Course)	3	MOOC	Minor Electives	

Programme wise Credit Distribution

Programme wise Credit Distribution		
Bachelor of Technology (Computer Science & Medical Engineering)		
4 Year		
Course Category	**No. of Courses**	**Total credits**
Core Courses (CC)	19	67
Multidisciplinary Courses	6	17
Minor Electives	10	27
Dissertation/Capstone Project	2	12
Ability Enhancement Courses (AEC)	3	5
Skill Enhancement Courses (SEC)/ Vocational Courses	6	17
Practical/Tutorials/Studios	2	4
Internship	2	4
Field Projects/RBL	4	7
VAC	1	0
Total	**55**	**160**

B.Tech Computer Science and Medical Engineering specialization in Artificial Intelligence

Programme wise Credit Distribution		
Bachelor of Technology - Computer Science & Medical Engineering specialization in AI		
4 Year		
Course Category	**No. of Courses**	**Total credits**
Core Courses (CC)	24	87
Multidisciplinary Courses	6	17
Minor Electives	10	27
Dissertation/Capstone Project	2	12
Ability Enhancement Courses (AEC)	3	5
Skill Enhancement Courses (SEC)/ Vocational Courses	6	17
Practical/Tutorials/Studios	2	4
Internship	2	4
Field Projects/RBL	4	7
VAC	1	0
Total	**60**	**180**

Course Modules

COURSE PLAN

Human Anatomy and Physiology (CSME1100)

School of Computing Science and Engineering (SSCSE) | B.Tech CS & ME | 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 and Engineering	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026-2027
Branch:	CS & ME	**Semester:**	I
Course Code:	CSME1100	**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**	CSME1100
2	**Course Title**	**Human Anatomy and Physiology**
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 fundamental knowledge of human anatomy and physiology. • Understand the structure and functions of major organ systems. • Correlate physiological processes with biomedical engineering applications. • Introduce students to biomedical signals, healthcare technologies, and AI-driven medical systems. • Prepare students for advanced interdisciplinary courses in healthcare engineering and medical analytics.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Understand – L1/L2): Understand the fundamental concepts of human anatomy, physiology, cellular organization, tissues, and homeostatic mechanisms governing the human body. CO2 (Explore – L2/L3): Explore the structure and physiological functions of musculoskeletal, nervous, cardiovascular, respiratory, digestive, and excretory systems. CO3 (Apply – L3/L4): Apply anatomical and physiological knowledge to interpret body functions, physiological responses, and basic clinical parameters in healthcare systems. CO4 (Analyze – L4/L5): Analyze physiological processes and biomedical signals associated with major organ systems using biomedical instrumentation and healthcare technologies. CO5 (Evaluate – L5/L6): Evaluate the role of wearable devices, biomedical systems, healthcare analytics, and AI-driven medical applications in monitoring human physiological functions. CO6 (Create – L5/L6): Design and interpret healthcare-oriented solutions integrating anatomy, physiology, biomedical engineering concepts, and intelligent healthcare technologies for medical applications.
8	**Course Description**	This course introduces the structural organization and physiological functions of the human body relevant to healthcare and biomedical engineering applications. The course covers major organ systems, cellular functions, physiological processes, and biomedical concepts required for interdisciplinary Computer Science and Medical Engineering students. It also provides insights into biomedical signals, wearable healthcare systems, medical diagnostics, and AI-driven healthcare technologies, enabling students to understand the integration of human physiology with intelligent healthcare and biomedical engineering 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**	1. Hall, J. E., Guyton and Hall Textbook of Medical Physiology, 14th Edition, Elsevier, 2020. 2. Tortora, G. J., & Derrickson, B.,Principles of Anatomy and Physiology, 15th Edition, Wiley, 2017.
12	**References**	1. Marieb, E. N., & Hoehn, K.,Human Anatomy & Physiology, 11th Edition, Pearson Education, 2018. 2. Barrett, K. E., Barman, S. M., Brooks, H. L., & Yuan, J. X.-J.,Ganong's Review of Medical Physiology, 26th Edition, McGraw Hill Education, 2019. 3. Enderle, J., & Bronzino, J.,Introduction to Biomedical Engineering, 3rd Edition, Academic Press, 2012.

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 Human Anatomy and Cell Physiology	
A	Introduction to Human Anatomy and Physiology; Levels of Structural Organization; Homeostasis and Feedback Mechanisms	CO1
B	Structure and Functions of Cells; Cell Membrane Transport; Cellular Communication	CO1
C	Types of Tissues: Epithelial, Connective, Muscular, and Nervous Tissues; Basic Genetics	CO1, CO2
	Unit 2: Musculoskeletal and Nervous Systems	
A	Structure and Classification of Bones; Skeletal Organization; Joints and Body Movements	**CO2**
B	Structure and Physiology of Muscles; Mechanism of Muscle Contraction; Human Locomotion	**CO2**
C	Neuron Structure and Functions; Central and Peripheral Nervous Systems; Reflex Action and Synaptic Transmission	**CO2, CO3**
	Unit 3: Cardiovascular and Respiratory Systems	
A	Structure and Functions of the Heart; Cardiac Cycle; Blood Composition and Circulation	**CO2, CO3**
B	Anatomy of Respiratory Organs; Mechanism of Breathing; Gas Exchange and Transport	**CO2, CO3**
C	ECG Fundamentals; Pulse Oximetry; Physiological Monitoring and Biomedical Instrumentation	**CO3, CO4**
	Unit 4: Digestive, Excretory, and Endocrine Systems	
A	Digestive Organs and Functions; Digestion and Absorption Mechanisms; Liver and Pancreas Functions	**CO2, CO3**
B	Kidney Structure and Nephron; Urine Formation; Fluid and Electrolyte Balance	**CO2, CO3**
C	Endocrine Glands and Hormones; Hormonal Regulation; Clinical Diagnostics and Healthcare Analytics	**CO3, CO4, CO5**
	Unit 5: Biomedical Signals, Wearable Systems, and AI in Healthcare	

A	Biomedical Signals: ECG, EEG, EMG; Medical Imaging Overview; Electronic Health Records	**CO4**
B	Wearable Healthcare Devices; Sensors; Neuroanatomy I and II	**CO4, CO5**
C	AI in Healthcare and Medical Diagnostics; Intelligent Healthcare Systems; Ethical Issues in Biomedical Engineering	**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	Topics to be Covered/Title	UNIT	Total Lectures
DD/MM/YY	Introduction to Human Anatomy and Physiology	UNIT-1	9
DD/MM/YY	Levels of Structural Organization		
DD/MM/YY	Homeostasis and Feedback Mechanisms		
DD/MM/YY	Structure and Functions of Cells		
DD/MM/YY	Cell Membrane Transport		
DD/MM/YY	Cellular Communication		
DD/MM/YY	Types of Tissues: Epithelial, Connective		
DD/MM/YY	Muscular, and Nervous Tissues		
DD/MM/YY	Basic Genetics		
DD/MM/YY	Structure and Classification of Bones	UNIT-2	9
DD/MM/YY	Skeletal Organization		
DD/MM/YY	Joints and Body Movements		

DD/MM/YY	Structure and Physiology of Muscles		
DD/MM/YY	Mechanism of Muscle Contraction		
DD/MM/YY	Human Locomotion		
DD/MM/YY	Neuron Structure and Functions		
DD/MM/YY	Central and Peripheral Nervous Systems		
DD/MM/YY	Reflex Action and Synaptic Transmission		
DD/MM/YY	Structure and Functions of the Heart	UNIT-3	9
DD/MM/YY	Cardiac Cycle		
DD/MM/YY	Blood Composition and Circulation		
DD/MM/YY	Anatomy of Respiratory Organs		
DD/MM/YY	Mechanism of Breathing		
DD/MM/YY	Gas Exchange and Transport		
DD/MM/YY	ECG Fundamentals		
DD/MM/YY	Pulse Oximetry		
DD/MM/YY	Physiological Monitoring and Biomedical Instrumentation		
DD/MM/YY	Digestive Organs and Functions	UNIT-4	9
DD/MM/YY	Digestion and Absorption Mechanisms		
DD/MM/YY	Liver and Pancreas Functions		
DD/MM/YY	Kidney Structure and Nephron		
DD/MM/YY	Urine Formation		
DD/MM/YY	Fluid and Electrolyte Balance		
DD/MM/YY	Endocrine Glands and Hormones		
DD/MM/YY	Hormonal Regulation		
DD/MM/YY	Clinical Diagnostics and Healthcare Analytics		
DD/MM/YY	Biomedical Signals: ECG, EEG, EMG	UNIT-5	9
DD/MM/YY	Medical Imaging Overview		

DD/MM/YY	Electronic Health Records		
DD/MM/YY	Wearable Healthcare Devices		
DD/MM/YY	Sensors		
DD/MM/YY	Neuro anatomy I and II		
DD/MM/YY	AI in Healthcare and Medical Diagnostics		
DD/MM/YY	Intelligent Healthcare Systems		
DD/MM/YY	Ethical Issues in Biomedical Engineering		

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	Fundamentals of Human Anatomy and Cell Physiology	Recall and understand the structural organization of the human body, cellular functions, tissue organization, homeostasis, and physiological mechanisms governing body functions	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	Musculoskeletal and Nervous System Understanding	Explain the anatomy and physiological functions of skeletal, muscular, and nervous systems including locomotion, neural communication, and reflex mechanisms	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	Organ System Functionality and Clinical Interpretation	Apply anatomical and physiological knowledge to interpret cardiovascular, respiratory, digestive, and excretory system functions and associated physiological responses	CO3 | L3–L4	CA | MTE Sec B | ETE Sec B

TS4	Biomedical Signal and Physiological Analysis	Analyze physiological parameters and biomedical signals such as ECG, EEG, EMG, pulse oximetry, and monitoring data using biomedical instrumentation concepts	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	Healthcare Technologies and Intelligent Monitoring Systems	Evaluate wearable healthcare devices, physiological monitoring systems, healthcare analytics, remote patient monitoring, and AI-driven healthcare technologies	CO5 | L4–L5	CA | ETE Sec B/C
TS6	Biomedical Engineering Applications and Ethical Healthcare Systems	Analyze intelligent healthcare systems, medical diagnostics, healthcare IoT, ethical considerations, and biomedical engineering applications for real-world healthcare scenarios	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 Understanding	TS2 Mathematical Modelling & Numerical Interpretation	TS3 Computational Simulation & Implementation	TS4 Biomedical Signal Analysis & System Evaluation	TS5 Optimization & Nonlinear System Evaluation	TS6 Healthcare Applications & Biomedical Model 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 2 (Case study / Problem-based)	2 assignments	**10**	CO1, CO2, CO3, CO4, CO5, CO6	TS1, TS2, TS3, TS4, TS5, TS6

Assessment	2 Assessments	**15**	CO2, CO3	TS2, TS3
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	Fundamentals of human anatomy, cell structure, tissue organization, homeostasis, and basic physiological mechanisms	CO1	TS1	4h SL	Report submission + conceptual understanding evaluation
Assignment 2	Musculoskeletal and nervous system anatomy: skeletal structure, muscle physiology, neuron function, reflex action, and neural communication	CO2	TS2	4h SL	Anatomical interpretation + physiological function analysis
Assignment 3	Organ system functionality: cardiovascular, respiratory, digestive, and excretory system physiology with clinical interpretation	CO3	TS3	4h SL	System-level analysis + clinical correlation and interpretation
Assignment 4	Biomedical signal and physiological parameter analysis: ECG, EEG, EMG, pulse rate, respiration rate, and pulse oximetry concepts	CO4	TS4	4h SL	Signal analysis + interpretation of physiological responses
Assignment 5	Healthcare technologies and intelligent monitoring systems: wearable devices, remote health monitoring, healthcare IoT, and AI-enabled diagnostics	CO5	TS5	4h SL	Technology evaluation + healthcare application assessment
Video Learning Report	Technical video learning on human physiology, biomedical instrumentation, physiological signal monitoring, or AI-driven healthcare systems (minimum 3 hrs) with structured report and presentation	CO2, CO3	TS2, TS3	15h SL	Learning outcomes, technical understanding, self-reflection, and presentation quality
Case Study Report	Real-world healthcare and biomedical engineering case study (e.g., ECG interpretation, neurological disorder analysis, wearable health monitoring, smart diagnostic systems, rehabilitation technologies)	CO4, CO5, CO6	TS4, TS5, TS6	10h SL	Technical depth, comparative analysis, research quality, ethical understanding, and application-oriented interpretation

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	**8**	TS1- Fundamentals of Human Anatomy and Cell Physiology	**CO1, CO2, CO3**	Short-answer and conceptual questions on cell structure, tissues, homeostasis, body organization, and basic physiological functions.
		TS2 - Musculoskeletal and Nervous System Understanding		
		TS3 - Organ System Functionality and Clinical Interpretation		
Section B	**7**	TS1- Fundamentals of Human Anatomy and Cell Physiology	**CO1, CO2, CO3, CO4**	Explanatory and diagram-based questions on skeletal system, muscle contraction, neuron structure, reflex action, and nervous system functions. Analytical and case-based questions on cardiovascular system with physiological and clinical interpretation.
		TS2 - Musculoskeletal and Nervous System Understanding		
		TS3 - Organ System Functionality and Clinical Interpretation		
TOTAL	**15**	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	**20**	TS1- Fundamentals of Human Anatomy and Cell Physiology TS2 - Musculoskeletal and Nervous System Understanding	**CO1, CO2**	Short-answer, conceptual, and diagram-based questions on cell structure, tissues, homeostasis, skeletal system, muscles, neurons, and reflex actions.
Section B	**25**	TS3 - Organ System Functionality and Clinical Interpretation TS4 - Biomedical Signal and Physiological Analysis TS5-Healthcare Technologies and Intelligent Monitoring Systems TS6- Biomedical Engineering Applications and Ethical Healthcare Systems	**CO3, CO4, CO5, CO6**	Analytical, explanatory, and application-oriented questions on organ systems, physiological functions, biomedical signals, healthcare technologies, wearable devices, and intelligent healthcare systems.
Section C	**15**	TS3 - Organ System Functionality and Clinical Interpretation TS4 - Biomedical Signal and Physiological Analysis TS5-Healthcare Technologies and Intelligent Monitoring Systems TS6- Biomedical Engineering Applications and Ethical Healthcare Systems	**CO3, CO4, CO5, CO6**	Case-study, clinical interpretation, and problem-solving questions involving physiological disorders, biomedical monitoring, AI-based healthcare applications, and ethical healthcare scenarios.
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 (25)	ETE (50)	TS	PO Primary
CO1	Understand human anatomy, physiology, cells, tissues, and homeostasis.	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Explore the structure and functions of major human body systems.	✔	✔	✔	TS2	PO1, PO3, PO4
CO3	Apply anatomical and physiological concepts to interpret body functions and clinical parameters.	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Analyze physiological processes and biomedical signals using healthcare technologies.	✔	✔	✔	TS4	PO9, PO10, PO11
CO5	Evaluate wearable devices, biomedical systems, and AI-based healthcare applications	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Design healthcare-oriented solutions using anatomy, physiology, and biomedical engineering concepts	✔	—	✔	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						2	1	
CO2	3	2				1						2	2	
CO3	3	3	2	2	1	2						2	2	1
CO4	2	3	2	2	1	2						2	2	1
CO5	2	3	2	2	3	3	1	2				2	3	3
CO6	2	3	3	3	3	3	2	3	2	2	1	3	3	3
Avg	2.5	2.7	2.3	2.5	2.5	2.0	1.5	2.5	2.0	2.0	1.0	2.2	2.3	2.3

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	M											M		
CO2	H	M											M	M	
CO3	H	H	M	M									M	M	
CO4	M	H	M	H	H								M	H	M
CO5	M	H	M	M	H	M		M					M	H	H
CO6	M	H	H	H	H	M	M	H	M	M		M	H	H	H

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

S.No	Activity	Hours	COs / TS	Evaluation Criteria
1	Assignment Writing (5 assignments covering cell biology, tissues, musculoskeletal system, nervous system, organ systems, and physiological mechanisms)	5 assignments × 4 hrs each Total = 20 hrs	CO1–CO3 TS1–TS3	Evaluated based on assignment submission, conceptual understanding, anatomical interpretation, physiological explanation, and clinical relevance
2	Technical Video-Based Learning related to human anatomy, physiological processes, biomedical signals, wearable healthcare devices, and intelligent healthcare systems	Video viewing: 5 hrs Report preparation: 5 hrs Presentation: 5 hrs Total = 15 hrs	CO2, CO3, CO4 TS2, TS3, TS4	Report + Presentation based on understanding of physiological concepts, biomedical technologies, healthcare applications, and self-learning outcomes
3	Real-World Healthcare and Biomedical Case Studies (e.g., ECG interpretation, respiratory disorders, neural disorders, wearable monitoring systems, AI-based healthcare applications)	Data collection/study: 6 hrs Report preparation: 4 hrs Total = 10 hrs	CO4, CO5, CO6 TS4, TS5, TS6	Evaluated based on technical depth, healthcare relevance, analytical interpretation, research quality, biomedical application, and ethical understanding
	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 (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

Human Anatomy and Physiology — 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

Fundamental of Computing and Artificial Intelligence (CSAI1101)

School of Computing Science and Engineering (SSCSE) | B.Tech CS&ME | 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:**	2026–2027
Branch:	CS & ME	**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**	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**	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:** CO1 (Understand – L2) Explain the fundamental concepts of computer systems, including hardware components, data representation techniques, and the evolution of programming languages. CO2 (Apply– L3) Apply visual thinking techniques and problem-solving strategies using tools such as mind maps, flowcharts, and pseudocode to analyze computational problems. CO3 (Apply– L3) Develop algorithms and represent logical solutions using flowcharts, decision tables, and step-by-step execution tracing for given problems. CO4 (Understand – L2) Describe the fundamental concepts, principles, and applications of Artificial Intelligence, including intelligent agents and problem-solving approaches. CO5 (Apply– L3) Apply basic machine learning concepts such as classification and clustering using appropriate algorithms for solving simple real-world problems.

		CO6 (Analyze – L4) 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. 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 2. Dan W. Patterson, Artificial Intelligence & Expert Systems, Pearson Education with Prentice Hall India. Indian Edition. 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	CO2
C	Introduction to Algorithms & Pseudo code: Problem Solving Approach	CO2
	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	CO2, CO3
C	Step-by-step execution tracing: dry runs, state tables, variable tracking, Test cases	CO2, CO3
	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	CO4, CO6
C	AI-based vs traditional problem-solving techniques, Rational agents and intelligent behaviour, Philosophical and practical perspectives of AI systems	CO4, CO6
	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)	CO5, CO6
C	Applications of ML in various domains	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

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	Analysis of AI principles, intelligent agents, AI problem-solving approaches, and real-world AI	CO4 | L4–L5	CA | ETE

	Systems Analysis	applications		
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 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 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 (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

Engineering Physics (PHT1136)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–2027
Branch:	CS & ME	**Semester:**	I
Course Code:	PHT1136	**Course Type:**	Core- Integrated

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:** **THEORY COs — Assessed via MTE + ETE:** 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. 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. CO3 (Apply – L3): Students will show that they have learned the basics of fiber optics, Holography and its applications. CO4 (Analyze – L4): Students will be able to understand the significance and applications of Maxwell's equations. CO5 (Evaluate – L5): Students will be able to know about the short comings of classical physics and will learn various quantum mechanical principles. CO6 (Create – L6): Student will be familiar with the essential concepts of Semiconductors materials technology and their applications in industries. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Student will be able to determine the Energy Band Gap of Semiconductor materials.

		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. 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. 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 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. References: 1. Integrated Electronics- Millman - Halkias, Tata Mc Graw Hill 2. Laser and non-linear optics by B.B. laud, New Age Int. 3. Semiconductor Devices- Kanaan Kano, Pearson Education. 4. Electronics devices and circuit theory by R.L. Boylestad, Pearson. 5. Introduction to Electrodynamics, David J. Griffiths, Pearson Cambridge University Press 6. Fundamentals of Electricity and Magnetism, D. N. Vasudeva, S. Chand & Co. New Delhi 7. Fundamentals of Physics, Halliday, Resnick and Walker, John Wiley. 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	Quantum Mechanics	CO5 | L5	ETE Sec B/C

	Justification			
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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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

	TS 1 Factual Recall	TS 2 Conceptual Expl.	TS 3 Procedural App.	TS 4 Analytical Rsng	TS 5 Compar. Eval.	TS 6 Synthesis & Design	CA 1 : Prob. Def.	CA 2 Exp.Setup	CA 3 Execution	CA 4 Efficiency	CA 5 Output Anal.	CA 6 Doc.Outcome	CA 7 Algo.Design	CA 8 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	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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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 L2 — Understand: Explain ideas, concepts, principles L3 — Apply: Use knowledge to solve new problems L4 — Analyze: Break down information,	A1 — Receiving: Awareness, willingness to attend A2 — Responding: Active participation and reaction A3 — Valuing: Showing commitment, assigning value A4 — Organizing: Integrating values	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

examine patterns L5 — Evaluate: Judge, justify, assess, make decisions L6 — Create: Design, develop, produce new solutions	into personal system A5 — Characterizing: Internalized value system	performance P5 — Complex Overt Response: Skilled performance P6 — Adaptation: Modify skills for special situations 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 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

Foundation of Mathematics (MTT1117)

Sharda School of Engineering & Science (SSES) | MTT 1117 | *Semester I* | *Batch 2026–2027*
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:	SSES — Sharda School of Engineering & Science	Batch:	2026-2030
Program:	B.Tech.	Current Academic Year:	2026-2027
Branch:	CS & ME	Semester:	I
Course Code:	MTT1117	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**	MTT1117
2	**Course Title**	Foundation of Mathematics
3	**Credits**	0
4	**Contact Hours (L-T-P-SL)**	3-0-0 (Theory: 30 hrs Classroom + 30 hrs Self Learning = 60 hrs total)
5	**Course Status**	**Core — Theory Only (No Laboratory Component)**
6	**Course Objectives**	1. To develop understanding of sets, relations, functions, and matrix algebra. 2. To solve systems of linear equations using matrix methods. 3. To introduce concepts of descriptive statistics and data interpretation. 4. To build analytical skills in probability and real-life applications. 5. To enhance logical reasoning and problem-solving abilities in mathematics.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** **Course Outcomes (COs)** **CO1**(Understand – L1/L2)**:** Understand and apply the concepts of sets, relations, and functions, including their properties and operations. **CO2** (Explore – L2/L3)**:** Perform matrix operations and analyze properties of matrices, determinants, inverses, and rank of matrices. **CO3** (Apply – L3)**:** Solve systems of linear equations using Gauss elimination, Gauss-Jordan methods, and Cramer's Rule.

		CO4 (Analyze – L4/L5)**:** Examine vector dependence and independence and apply matrix methods in algebraic problem-solving. **CO5** (Analyze – L4/L5)**:** Analyze and interpret statistical data using tabulation, graphical representation, and measures of central tendency and dispersion. **CO6**(Analyze – L2/L4)**:** Apply probability concepts, conditional probability, and Bayes' theorem to solve real-life problems involving uncertainty and decision-making.
8	**Course Description**	This course introduces fundamental concepts of algebra, statistics, and probability. It covers sets, relations, and functions along with operations and properties. Students learn matrix algebra, determinants, inverses, rank, and methods for solving systems of linear equations. The course also includes descriptive statistics such as measures of central tendency and dispersion, graphical representation of data, and frequency distributions. Probability concepts including conditional probability, Bayes' theorem, and applications in real-life situations are discussed. The course aims to strengthen mathematical reasoning, analytical thinking, and quantitative problem-solving skills essential for higher studies and practical 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**	Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
12	**References**	1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002. 2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. 3. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005. 4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008. 5. 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: Sets, Relations and Functions	
A	Sets and their Representations, types of sets, Venn Diagrams, Operations on Sets, Complement of a Set	**CO1**
B	Cartesian Product of Sets, Relations on sets, Types of Relations, Properties of Relations	**CO1**
C	Functions, Types of functions, Composition of Functions	**CO1**

	Unit 2: Matrices	
A	Introduction of Matrix, Types of Matrices, Operations on Matrices	**CO2, CO3**
B	Transpose of a Matrix, Symmetric and Skew Symmetric Matrices, Invertible Matrices, Determinants	**CO2, CO3**
C	Inverse of a matrix Rank of a matrix, Normal Form, Cramer's Rule	**CO2, CO3**
	Unit 3: Matrices	
A	Consistency of system of linear equations: System of Linear Non-homogeneous, Equations, System of Homogeneous Equations	**CO3, CO4**
B	Gauss elimination and Gauss-Jordan elimination method.	**CO3, CO4**
C	linear dependence and independence of vectors	**CO3, CO4**
	Unit 4: Descriptive Statistics	
A	Introduction, Classification, tabulation, diagrammatic & graphical representation of grouped data, Frequency distributions, cumulative frequency distributions	**CO5, CO6**
B	Measures of central tendency – arithmetic mean, median, quartiles, mode, Their properties, merits, and demerits	**CO5, CO6**
C	Measures of dispersion, range, quartile deviation, mean deviation, standard deviation,and coefficient of variation.	**CO5, CO6**
	Unit 5: Probability	
A	Probability: Introduction, random experiment, outcomes, sample space, events,various definitions of probability, laws of total and compound probability.	**CO5, CO6**
B	Boole's inequality. Conditional probability, independence of events.	**CO5, CO6**
C	Bayes theorem and its applications in real life problems	**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 Sets and Representation of Sets, Types of Sets	UNIT-1	4
DD/MM/YY	Venn Diagrams, Operations on Sets, Complement of Sets		
DD/MM/YY	Cartesian Product of Sets, Relations on Sets, Types and Properties of		

	Relations		
DD/MM/YY	Functions, Types of Functions, Composition of Functions		
DD/MM/YY	Introduction to Matrices and Types of Matrices	UNIT-2	6
DD/MM/YY	Operations on Matrices, Transpose, Symmetric and Skew Symmetric Matrices		
DD/MM/YY	Determinants and Properties of Determinants		
DD/MM/YY	Inverse of a Matrix and Invertible Matrices		
DD/MM/YY	Rank of a Matrix and Normal Form		
DD/MM/YY	Cramer's Rule and Applications		
DD/MM/YY	System of Linear equations: Consistency	UNIT-3	8
DD/MM/YY	System of Linear Non-Homogeneous Equations		
DD/MM/YY	System of Homogeneous Equations		
DD/MM/YY	Consistency of System of Linear Equations		
DD/MM/YY	Gauss Elimination Method		
DD/MM/YY	Gauss–Jordan Elimination Method		
DD/MM/YY	Linear Dependence and Independence of Vectors		
DD/MM/YY	Revision of important topics		
DD/MM/YY	Introduction to Statistics and Classification of Data	UNIT-4	6
DD/MM/YY	Tabulation and Diagrammatic Representation of Data		
DD/MM/YY	Graphical Representation, Frequency and Cumulative Frequency Distribution		
DD/MM/YY	Measures of Central Tendency – Arithmetic Mean		
DD/MM/YY	Median, Quartiles and Mode		
DD/MM/YY	Properties, Merits and Demerits of Central Tendency Measures		
DD/MM/YY	Measures of Dispersion – Range and Quartile Deviation	UNIT-5	6
DD/MM/YY	Mean Deviation, Standard Deviation and Coefficient of Variation		
DD/MM/YY	Introduction to Probability, Random Experiments and Sample Space		

DD/MM/YY	Events, Definitions of Probability, Laws of Probability		
DD/MM/YY	Conditional Probability, Independence of Events, Boole's Inequality		
DD/MM/YY	Bayes' Theorem and Real-Life Applications, Revision 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**	Develop understanding of fundamental concepts of sets, relations, functions, matrices, statistics, and probability.	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	**Analytical Skills**	Analyze mathematical structures, relations, matrix systems, and statistical data logically and systematically.	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	**Problem-Solving Ability**	Apply mathematical techniques to solve algebraic equations, matrix problems, and probability-based situations.	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	**Computational Skills**	Perform accurate calculations involving matrices, determinants, statistical measures, and probability laws.	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	**Data Interpretation Skills**	Interpret and represent data through tables, graphs, frequency distributions, and statistical measures.	CO5 | L4–L5	ETE Sec B/C
TS6	**Application and Reasoning Skills**	Use mathematical and probabilistic reasoning to model and solve real-life and decision-making problems.	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 Understanding	TS2 Analytical Skills	TS3 Problem-Solving Ability	TS4 Computational Skills	TS5 Data Interpretation Skills	TS6 Application and Reasoning Skills
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)	2 assignments	5+5	CO1, CO2, CO3, CO4, CO5, CO6	TS1, TS2, TS3, TS4, TS5, TS6
Assessment	2 Assessments	**10+5**	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 concepts: concepts of sets, relations, functions, matrices	CO1	TS1	6h SL	Assignment submission + evaluation

Assignment 2	Unit 2: Operations on Matrices	CO2	TS2	6h SL	Numerical problems on evaluation of inverse of matrices
Assignment 3	Unit 3: System of Linear equations: Consistency	CO2, CO3	TS2, TS3	6h SL	Numerical computation + comparison
Assignment 4	Unit 4: Introduction to Statistics and Classification of Data	CO3, CO4	TS3, TS4	6h SL	Step-by-step numerical evaluation
Assignment 5	Unit 5: Measures of Dispersion – Range and Quartile Deviation	CO3, CO4, CO5	TS3, TS4, TS5	6h SL	Step-by-step numerical evaluation

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

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	**16**	TS1 - Conceptual Understanding	**CO1, CO2**	Short-answer, numerical problems
Section B	**14**	TS2 - Analytical Skills	**CO1, CO2**	Numerical problems: compute basic operations on matrices
TOTAL	30	TS1–TS2	**CO1–CO2**	Units 1–2 only. CO3, 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 33/100 required to pass.*

Section	Marks	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	40	TS1 — Conceptual understanding, TS2 - Analytical Skills, TS3 - Problem-Solving Ability, TS4 - Computational Skills, TS5 - Data Interpretation Skills, TS6 - Application and Reasoning Skills	**CO1, CO2, CO3, CO4, CO5, CO6**	Short questions (all units): definitions, develop understanding of fundamental concepts of sets, relations, functions, matrices, statistics, and probability, perform accurate calculations involving matrices, determinants, statistical measures, and probability laws.

Section B	18	TS3 - Problem-Solving Ability, TS4 - Computational Skills, TS5 - Data Interpretation Skills	**CO3, CO4, CO5**	Medium questions: statistics, and probability, perform accurate calculations involving matrices, determinants, statistical measures, and probability laws.
Section C	30	TS3 - Problem-Solving Ability, TS4 - Computational Skills, TS5 - Data Interpretation Skills	**CO3, CO4, CO5**	Long/evaluation questions: statistics, and probability, perform accurate calculations involving matrices, determinants, statistical measures, and probability laws.
Section D	12	TS6 - Application and Reasoning Skills	**CO6**	Long/evaluation questions: Bayes' Theorem and Real-Life Applications
TOTAL	100	TS1–TS6 (all)	**CO1–CO6**	Scaled from 100-mark paper. Minimum 33/100 to pass.

11.1 CO-wise Assessment Instrument Summary

CO	CO Statement (Short)	CA (25)	MTE (15)	ETE (60)	TS	PO Primary
CO1	Understand basic concepts, types, structures, services of OS	✔	✔	✔	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	

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 Total = 15 hrs	CO1–CO4 TS1–TS4	Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance
2	Preparation for assessments	Total = 15hrs	CO2, CO3 TS2, TS3	Assessment 1- subjective question paper, Assessment 2 – MCQ
		30 hours	CO1–CO6	All activities are compulsory. Submission deadlines communicated at

	TOTAL Self-Learning Hours			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 (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 15 + ETE 60 = 100; 40% overall minimum required

FM 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

Professional Communication (SKT1100)

School of Engineering & Technology (SET) | B.Tech CS & ME | 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:	SET — School of Engineering & Technology	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–2027
Branch:	CS & ME	**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**	SKT1100
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:** **CO1 (Remember – L1):** Communication Mastery & Presentation Excellence Recall and identify fundamental concepts of professional communication, presentation structure, and essential elements of effective message delivery. **CO2 (Understand – L2):** Public Speaking & Impromptu Communication Confidence Explain the principles of public speaking, including speech organization, audience analysis, and techniques for confident impromptu communication. **CO3 (Apply – L3):** Group Interaction, Debate & Discussion Skills Demonstrate effective communication by actively participating in group discussions, debates, and collaborative interactions using appropriate verbal and non-verbal strategies.

		CO4 (Analyze – L4): LSRW Skill Enhancement & Critical Reading Ability Analyze written and spoken content by applying listening, speaking, reading, and writing (LSRW) skills to interpret, evaluate, and respond critically. **CO5 (Evaluate – L5):** Pronunciation, Voice & Accent Improvement Evaluate speech delivery based on pronunciation, intonation, voice modulation, and accent to enhance clarity and effectiveness in communication. **CO6 (Create – L6):** Verbal Ability & Language Accuracy 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. A comprehensive guide covering professional communication, presentations, writing, and workplace skills.
12	**References**	1. Communication Skills – Sanjay Kumar & Pushp Lata *Widely used in Indian universities; covers LSRW, interpersonal communication, and soft skills.* 2. Soft Skills – Alex K. *Focuses on personality development, communication, and employability skills.* 3. English Grammar in Use – Raymond Murphy *Excellent for grammar, error correction, and verbal ability practice.* 4. Word Power Made Easy – Norman Lewis *Highly effective for vocabulary building and verbal ability.* 5. Online Resources: • British Council Learning English (grammar, listening, speaking practice) • Toastmasters International (public speaking frameworks) • 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	**CO1**

	craft a memorable conclusion	
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	5
DD/MM/YY	Pronunciation – Activity		
DD/MM/YY	Critical & Creative Thinking 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 (Reading, Listening, Writing, Self-branding, Email/Article Writing)	4 Assignments	**5**	CO4, CO6	TS4, TS6
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 interaction with structured written report	CO4, CO5, CO6	TS4, TS5, TS6	6h SL	Critical analysis, interpretation, language accuracy, communication effectiveness, 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	PO12	PSO1	PSO2	PSO3
CO1	1	1		–	–	–	–	1	2	3	1	2	2	1	–
CO2	1	2		–	–	–	–	2	2	3	2	2	2	2	–
CO3	1	2	1	–	–	–	–	3	3	3	2	2	2	2	1
CO4	1	2	2	1	–	–	–	2	2	3	2	2	2	3	1
CO5	1	2	2	–	–	–	–	2	2	3	2	2	2	3–	1
CO6	1	2	2	1	1	–	–	2	2	3	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**	**2.17**	**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	PO12	PSO1	PSO2	PSO3
CO1	**M**	**M**						**M**	**H**	**H**	**M**	**M**	**H**	**M**	
CO2	**M**	**M**						**M**	**H**	**H**	**M**	**M**	**M**	**H**	
CO3	**M**	**M**	**M**					**H**	**H**	**H**	**M**	**M**	**H**	**M**	**M**
CO4	**M**	**M**	**M**	**M**				**M**	**H**	**H**	**H**	**M**	**M**	**H**	**M**
CO5	**M**	**M**	**M**					**M**	**H**	**H**	**M**	**M**	**M**	**H**	**M**
CO6	**M**	**M**	**H**	**M**	**M**			**M**	**H**	**H**	**H**	**H**	**H**	**H**	**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	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 L2 — Understand: Explain communication principles, speaking techniques, public speaking methods, and verbal concepts L3 — Apply: Apply communication strategies, verbal skills, presentation techniques, and group interaction methods in practical situations L4 — Analyze: Analyze written and spoken communication, arguments, reading passages, communication scenarios, and audience responses L5 — Evaluate: Evaluate pronunciation, accent, speech clarity, verbal responses, communication effectiveness, and language accuracy 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 A2 — Responding: Active participation in presentations, discussions, debates, and speaking activities A3 — Valuing: Demonstrate confidence, professionalism, communication ethics, and appreciation for effective communication A4 — Organizing: Integrate communication values, teamwork, professionalism, and collaborative interaction into personal communication style 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 P2 — Set: Mental and physical readiness for speech delivery, public speaking, and communication performance P3 — Guided Response: Practice pronunciation, voice modulation, presentation delivery, and speaking techniques through guided activities P4 — Mechanism: Perform communication tasks, presentations, GDs, and speaking activities with improved fluency and habitual correctness P5 — Complex Overt Response: Demonstrate skilled presentation delivery, debate participation, and fluent communication performance P6 — Adaptation: Modify speaking style, tone, and communication approach according to audience and professional context 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 — 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

Programming for Problem Solving (CSCR1300)

School of Computing Science & Engineering (SSCSE) | B.Tech CS& ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–2027
Branch:	CS & ME	**Semester:**	I
Course Code:	CSCR1300	**Course Type:**	Core- Integrated

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 (PPS)**
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:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Remember – L1): Recall and list fundamental concepts of C programming such as keywords, data types, operators, and syntax. CO2 (Understand – L2): Explain the working of operators, control structures, functions, arrays, and preprocessing directives in C programming. CO3 (Apply – L3): Develop C programs using control statements, functions, arrays, and strings to solve basic computational problems. CO4 (Analyze – L4): Analyze and debug C programs involving pointers, recursion, structures, and dynamic memory allocation. CO5 (Evaluate – L5): Evaluate different programming approaches and optimize C programs using appropriate data structures, file handling, and memory management techniques. CO6 (Create – L6): Design, implement, and demonstrate complete C-based solutions by integrating functions, pointers, structures, and file handling to solve real-world problems.

		LAB COs — Assessed via Laboratory Assessment only: CO7 (Apply – L3): Implement C programs using professional tools (gcc, Linux CLI, debuggers); configure experimental setups; demonstrate system operation; maintain structured lab records. 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. CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible practices; perform skill self-assessment; reflect on learning to cultivate lifelong professional growth. 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. Reference: Balagurusamy, E. — Programming in ANSI C (8th Ed.), McGraw-Hill. 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.
	• Study of Linux Commands
	  ○ Working with Directories
	  ○ Handling Files
	  ○ Understanding of gcc compiler, writing code in C, compiling and executing on Linux Environment.
	• Demonstration and use of different data types, variables, constants, Operators
	• 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. • Identify the suitability of selection statements (if, if-else, conditional operator) and implement programs by applying more suitable form of selection statement. • 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. • Apply Top-Down approach for finding solutions and implement it with the help of functions. • Identify need of manipulating actual parameters and demonstrate call by value and call by reference. • Implementation of recursive functions for various recursively defined problems. • Implementing one dimensional array: Initialization, manipulation, traversing. • Implement programs to search and sort a given array. • Writing some problems based on matrix manipulation. • 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	Linux Environment, Competitive coding platforms (Leetcode, Hackerrank, etc.), Virtual Labs, whiteboards, online compilers, GitHub.	

Used		
Activities	**Objective:** To understand addresses, pointers, dynamic memory allocation, and strings, and apply these concepts for efficient string handling and implementation of string functions. • Demonstration of pointer arithmetic and indirection operator. • Manipulation on strings (extraction, matching, concatenation) • 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. • Implementation of binding heterogeneous/composite information for a single entity using structure. • Implementation of organizing data as Linked node with the help of self-referential structures. • Demonstrate the use of Union in memory sharing. • Creation and manipulation of data stored in a file on auxiliary memory. • 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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification	0.75: Thorough | 0.5: Adequate | 0.25: Partial | 0: Absent	CO8, CO9

		CA8 — Lab record completeness; viva-voce comprehension		
Professional Attitude & Ethical Conduct	**0.25**	CO9 — Documentation ethics, responsible practice 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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 &**	Demonstrate integrity, ethical conduct, and responsible use of tools/data throughout	CO9 | PO7

	Responsibility		

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 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 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

★ *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 Prototyping (CSCR1507)

Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–2027
Branch:	CSE	**Semester:**	I
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: **CO1 (Remember – L1):** Identify and recall basic electronic components, Arduino hardware, and tools. **CO2 (Understand – L2):** Explain working principles of circuits, sensors, and Arduino programs. **CO3 (Apply – L3):** Build and simulate basic circuits using Tinkercad and Arduino. **CO4 (Analyze – L4):** Debug and analyse circuit behavior and Arduino code. **CO5 (Evaluate – L5):** Compare and select appropriate sensors and components for applications. **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). 15 small real-life problems of 1 hour each. Total = 15 hrs. 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 2. Arduino Projects with Tinkercad is a practical guidebook by Johannes Wild 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**
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, optimization, and integration experiments — all assessed under CA and CE.

Week	Session	Experiment	Lab CO	Marks

W1	Session-1.1 DD/MM/YY	Experiment 1: Identification of Components • Identify resistor, LED, capacitor, switch • Read resistor colour codes • Measure values using multimeter	**CO1**	3.0
	Session-1.2 DD/MM/YY	Experiment 2: Basic LED Circuit • LED connection with resistor • Polarity testing • LED brightness variation	**CO1**	
W2	Session-2.1 DD/MM/YY	Experiment 3: Series & Parallel Circuits • Series LED circuit • Parallel LED circuit • Compare brightness	**CO1**	3.0
	Session-2.2 DD/MM/YY	Experiment 4: Switch Controlled Circuit • Push button LED control • Toggle operation • Debouncing concept (basic)	**CO1**	
W3	Session-3.1 DD/MM/YY	Experiment 5: Tinkercad Interface • Create account & workspace • Add components • Simulate simple circuit	**CO1**	3.0
	Session-3.2 DD/MM/YY	Experiment 6: LED Simulation • LED ON/OFF simulation • Multiple LED connections • Error debugging	**CO1**	
W4	Session-4.1 DD/MM/YY	Experiment 7: Buzzer Circuit Simulation • Connect buzzer • Create alarm circuit • Debug faulty wiring	**CO2**	3.0
	Session-4.2 DD/MM/YY	Experiment 8: Switch + LED Simulation • Switch-controlled LED • Multi-switch logic • Troubleshooting	**CO2**	
W5	Session-5.1 DD/MM/YY	Experiment 9: Arduino IDE Setup • Install Arduino IDE • Board selection • Upload first program	**CO3**	3.0
	Session-5.2 DD/MM/YY	Experiment 10: LED Blink Program • Basic blink • Modify delay • Multiple LEDs	**CO3**	
W6	Session-6.1 DD/MM/YY	Experiment 11: LED Pattern Generation • Sequential blinking • Traffic light system • Pattern design	**CO3**	3.0
	Session-6.2 DD/MM/YY	Experiment 12: Buzzer Interfacing • Buzzer ON/OFF • Alarm tone • Conditional buzzer	**CO3**	
W7	Session-7.1 DD/MM/YY	Experiment 13: Push Button Input • Button reading • LED control • Toggle logic	**CO4**	3.0
	Session-7.2 DD/MM/YY	Experiment 14: Multiple Inputs • Two-button control • AND/OR logic • Debugging input issues	**CO4**	
W8	Session-8.1 DD/MM/YY	Experiment 15: Potentiometer Reading	**CO4**	3.0

		• Analog input reading • Display on serial monitor • Mapping values		
	Session-8.2 DD/MM/YY	Experiment 16: PWM Output • Control LED brightness • AnalogWrite usage • Smooth fading	**CO4**	
W9	Session-9.1 DD/MM/YY	Experiment 17: LDR Interface • Read light intensity • Serial output • Calibration	**CO4**	3.0
	Session-9.2 DD/MM/YY	Experiment 18: Automatic Street Light • Threshold-based LED • Day/Night detection • Optimization	**CO4**	
W10	Session-10.1 DD/MM/YY	Experiment 19: Temperature Sensor Interface • Read temperature values • Display on serial monitor • Calibration	**CO5**	3.0
	Session-10.2 DD/MM/YY	Experiment 20: Temperature Alert System • Threshold alert • Buzzer activation • Real-time monitoring	**CO5**	
W11	Session-11.1 DD/MM/YY	Experiment 21: Distance Measurement • Sensor interfacing • Measure distance • Display output	**CO5**	3.0
	Session-11.2 DD/MM/YY	Experiment 22: Obstacle Detection • LED/buzzer alert • Range control • Debugging	**CO5**	
W12	Session-12.1 DD/MM/YY	Experiment 23: Multi-Sensor Integration • Combine LDR + LED • Combine temperature + buzzer • Logic building	**CO6**	3.0
	Session-12.2 DD/MM/YY	Experiment 24: Smart System Prototype • Mini automation system • Multi-output control • Optimization	**CO6**	
W13	Session-13.1 DD/MM/YY	Experiment 25: Smart Lighting System • LDR + PWM control • Energy-efficient lighting • Performance tuning	**CO6**	3.0
	Session-13.2 DD/MM/YY	Experiment 26: Smart Alarm System • Ultrasonic + buzzer • Multi-condition alert • Testing scenarios	**CO6**	
W14	Session-14.1 DD/MM/YY	Experiment 27: Project Design & Planning • Problem identification • Block diagram • Component selection	**CO6**	3.0
	Session-14.2 DD/MM/YY	Experiment 28: Circuit Implementation • Hardware setup • Code development • Integration	**CO6**	
W15	Session-15.1 DD/MM/YY	Experiment 29: Testing & Debugging • Error handling	**CO6**	3.0

		• Performance testing • Optimization		
	Session-15.2 DD/MM/YY	Experiment 30: Final Demonstration • Working prototype • Presentation • 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.

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).

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)

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/flowchart 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

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	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

Branch: CSE, IT, CS& ME		Semester: I	
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). 2. To recognize the vast corpus of knowledge traditions of India and discuss its evolution through multidisciplinary framework. 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)** 4. To highlight the importance of indigenous traditions in resolving contemporary issues in various fields.	
6	Course Outcomes	Students will be able to: CO1: Explain the geographical, literary and philosophical foundations of India and its knowledge traditions. CO2: Explain the key contributions of Indian Mathematics and Astronomy and trace their influence on modern science and computing. CO3: Interpret the contricutions of Metallurgy and Ayurveda, and develop informed perspectives on their contemporary relevance. **SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education)** CO4: Relate the importance of Indian tradition of spirituality and ethics to modern times. CO5: Examine the significance of indigenous knowledge traditions in addressing contemporary challenges in areas such as health, education, environment, society, and sustainable development. 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,	CO1

		Bharat: a land of rare natural endowments	
	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	ETE
		25	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. • Kapoor, K. (2014/2020) *Comparative Literary Theory: An Overview*. New Delhi: D.K. Printworld (P) Limited. • Kapoor, K., Sheshagiri Rao, K.L. (eds.) (2010/2025) *Encyclopedia of Hinduism* (11 vols.). New Delhi: Indian Heritage Research Foundation & Rupa & Co. • Kapoor, K. (2005) *Text and Interpretation: The Indian Tradition*. New Delhi: D.K. Printworld Pvt. Ltd. • Rajani, M.B. and Kumar, V. (2019) '*Title of article*', *Journal of the Society of Architectural Historians*, 78(4), pp. 392–408. • Muhlberger, S. (1998) *Democracy in Ancient India*. World History of Democracy. Available at: https://uts.nipissingu.ca/muhlberger/histdem/indiadem.htm • Kanungo, A.K. and Dussubieux, L. (2022) 'Indigenous glass manufacture in India: an ethnographic approach', *Journal of Glass Studies*, 64, pp. 225–248. • 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. • Bag, A.K. (1997) *History of Technology in India*, Vol. I. New Delhi: Indian National Science Academy. • Dasgupta, S. (1975) *A History of Indian Philosophy*, Vol. I. Delhi: Motilal Banarsidass. • Dutt, M.N. (2018) *The Mahabharata*. 10 vols. Delhi: Parimal Publications. • Jha, A. (2009) *Traditional Knowledge System in India*. New Delhi: [Publisher not specified]. • Joseph, G.G. (2016) *Indian Mathematics: Engaging with the World from Ancient to Modern Times*. London: World Scientific. • Lal, B.B. (1997) *The Earliest Civilization of South Asia*. New Delhi: Aryan Books International. • Mahadevan, B., Bhat, R.V. and Nagendra Pavana, R.N.	

		(2022) *Introduction to Indian Knowledge System*. Delhi: PHI Learning Private Limited. • Pandey, P.C. (n.d.) *Madhya Himalayi Sanskriti mein Gyan, Vigyan evam Paravigyan*. [Publication details not specified]. • Subbarayappa, B.V. and Sarma, K.V. (1985) *Indian Astronomy: A Source Book*. Mumbai: Nehru Centre.

Semester 1	**18 Credits**
Course Code	Course Name
CSME1100	Human anatomy and physiology
CSAI1101	Fundamentals of Computing and Artificial Intelligence
PHT1136	Engineering Physics
MTT1117	Foundations of Mathematics
SKT1100	Professional Communication
CSCR1300	Programming for Problem Solving
CSCR1507	Digital Prototyping
IKT1001	IKS

COURSE PLAN

Basics of Electrical and Electronics Engineering (EET1101)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–2027
Branch:	CS & ME	**Semester:**	II
Course Code:	EET1101	**Course Type:**	Core- Integrated

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**	EET1106
2	**Course Title**	**Basics of Electrical and Electronics Engineering (BEEE)**
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:** **THEORY COs — Assessed via MTE + ETE:** 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. 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. CO4 (Understand – L2): Interpret MOSFET characteristics and explain the role of CMOS technology and IC fabrication concepts. CO5 (Analyze – L4): Simplify and design switching circuits using number systems, logic gates, Boolean algebra, and Karnaugh maps. CO6 (Analyze – L4): Analyze electrical, electronics, and digital logic concepts to design and evaluate basic arithmetic and comparator circuits for engineering applications. **LAB COs — Assessed via Laboratory Assessment only:** 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. 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. CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible practices; perform skill self-assessment; reflect on learning to cultivate lifelong professional growth. 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. 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. 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. 2. S. K. Bhattacharya, "Basic Electrical and Electronics Engineering", Pearson Publication. 3. Robert L Boylestad, "Electronic Devices and Circuit Theory" Pearson Education, 2009 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. • Verification of Ohm's Law, KCL and KVL using measured values. • Perform nodal and mesh analysis for given DC circuits. • Demonstrate Superposition theorem through circuit setup/simulation. • 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 • Observe transformer operation and identify losses. • Calculate efficiency under different loading conditions. • 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.	

	•Plot V–I characteristics of PN junction diode. •Construct rectifier circuits and compute ripple factor. • 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. • Plot MOSFET drain and transfer characteristics using simulation. •Demonstrate CMOS inverter operation. • 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 • Verify logic gate operations using ICs. • Simplify Boolean expressions using K-maps. • 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	**Unit 5**	**6**
DD/MM/YY	1's Complement and 2's Complement, Fundamentals of Logic Gates		
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	CO9/CO10	

		evaluation, final lab submissionntation		

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 **CA2** — Experimental setup, instrument selection, and connections **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 **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) **CA6** — Result interpretation and conclusion **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 **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 &	**1.5**	P1 — SDG mapping; societal relevance P2 — Problem scope and stakeholder	1.5: Comprehensive |	CO8 / PO3,

Problem Scoping		requirements P4 — Innovative solution proposal with alternatives	1.0: Adequate | 0.5: Partial | 0: Absent	PO6
Project Planning & Financial Awareness	**1.5**	P2 — Timeline, milestones, resource planning 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 P6 — Complete project build and integration 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 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 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) 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

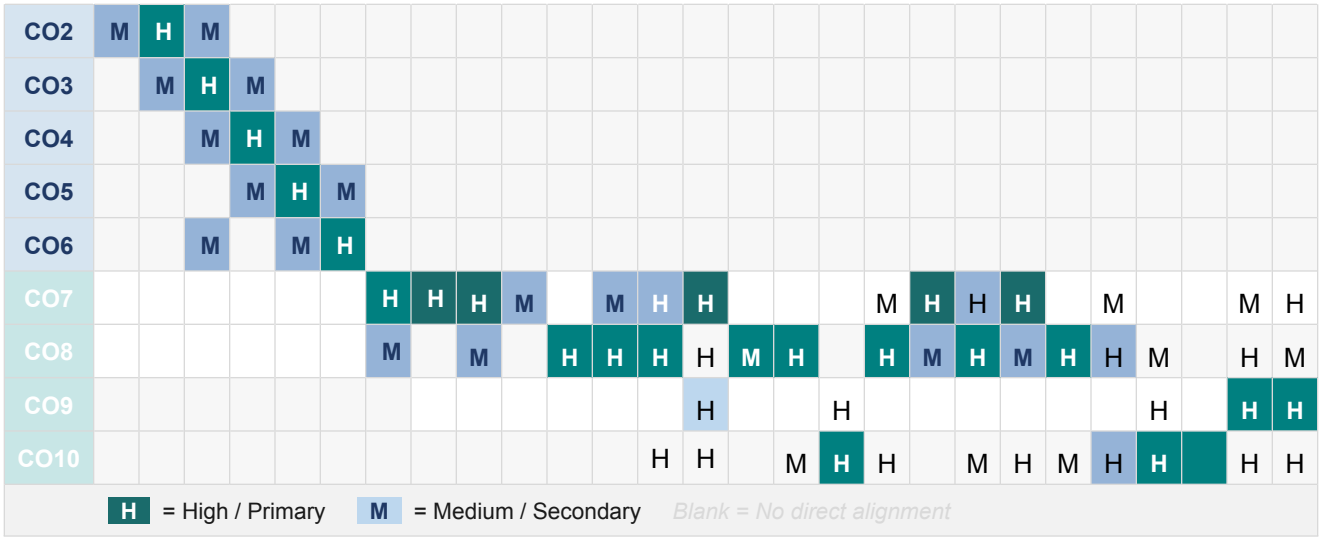
14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

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																									



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 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	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

new solutions		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

BEEE 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

Mathematics-I (MTT1116)

Sharda School of Engineering & Science (SSES) | B.Tech CS & ME | Semester II | Batch 2026 –2031

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:	SSES — Sharda School of Engineering & Science	**Batch:**	2026-2030
Program:	B.Tech	**Current Academic Year:**	2026-2027
Branch:	CS & ME	**Semester:**	II
Course Code:	MTT1116	**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**	MTT 1116
2	**Course Title**	Mathematics I

3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	4-0-0-2 (Theory: 60 hrs Classroom + 30 hrs Self Learning = 90 hrs total)
5	**Course Status**	**Core — Theory Only (No Laboratory Component)**
6	**Course Objectives**	1. To develop understanding of matrices, linear transformations, eigenvalues, eigenvectors, and their applications in solving mathematical problems. 2. To introduce the concepts of vector spaces, basis, dimension, linear mappings, and matrix representations. 3. To familiarize students with inner product spaces, orthogonality, and orthogonalization techniques used in advanced mathematical analysis. 4. To provide knowledge of correlation, regression, and curve fitting techniques for analyzing and interpreting statistical data.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Understand – L1/L2): understand concepts of linear transformations, eigenvalues, eigenvectors, and the Cayley–Hamilton theorem in matrix computations and diagonalization. CO2 (Explore – L2/L3): Analyze vector spaces, subspaces, basis, dimension, rank, and nullity in solving algebraic problems. CO3 (Apply – L3): Represent and interpret linear mappings using matrices and perform change of basis and similarity transformations. CO4 (Analyze – L4/L5): Apply inner product space concepts, orthogonality, and Gram–Schmidt orthogonalization in vector and matrix problems. CO5 (Analyze – L4/L5): Compute and interpret Karl Pearson's and Spearman's correlation coefficients for statistical data analysis. CO6 (Analyze – L2/L4): Apply regression analysis and curve fitting techniques using least square methods to model and analyze data.
8	**Course Description**	This course introduces the fundamental concepts of linear algebra, vector spaces, linear mappings, and statistical techniques including correlation and regression analysis. It develops analytical and problem-solving skills through the study of matrices, eigenvalues, orthogonality, curve fitting, and statistical interpretation, enabling students to apply mathematical methods in scientific and data-oriented contexts.
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. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. 2. Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. Sultan Chand & Sons.
12	**References**	3. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005. 4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010. 5. 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: Linear Algebra basics	
A	Linear Transformation, Characteristics equation, Eigen values and Eigen vectors	**CO1, CO2**
B	Properties of Eigen values and Eigen vectors, Cayley- Hamilton theorem and its applications	**CO1, CO2**
C	Diagonalization, powers of a matrix	**CO1, CO2**
	Unit 2: Vector Spaces	
A	Vector Space: definition, examples of vector spaces, subspaces, linear spans, row space of a matrix	**CO1, CO2**
B	basis and dimension, Application to Matrices, Rank of a Matrix, sums and direct sums, coordinates	**CO3**
C	Linear mappings (Linear transformations), kernel and image of a linear mapping, rank and nullity, Singular and nonsingular linear mappings	**CO3**
	Unit 3: Linear mappings and matrices	
A	Matrix representation of a linear operator, change of basis, Similarity, Matrices and general linear mappings	**CO3, CO4**
B	Inner Product spaces, Cauchy – schwarz inequality, applications, orthogonality, orthogonal sets and bases	**CO3, CO4**
C	Gram- Schmidt orthogonalization process, orthogonal and positive definite matrices	**CO3, CO4**
	Unit 4: Correlation	
A	Concept of Correlation, Definition, Types of Correlation, Basic Properties of Correlation, Covariance and its Properties	**CO5**
B	Karl Pearson's Correlation Coefficient, Computation and Interpretation, Limits of Correlation Coefficient	**CO5**
C	Spearman's Rank Correlation Coefficient, Properties, Numerical Problems, Repeated Ranks	**CO5**

	Unit 5: Regression and Curve Fitting	
A	Concept and Definition of Simple Linear Regression, Equations of Regression Lines, Least Square Method	CO5, CO6
B	Regression Coefficients, Properties of Regression Coefficients, Angle Between Two Regression Lines	CO5, CO6
C	Curve Fitting: Straight Line, Exponential Curve, Algebraic Curve, Parabolic Curve (Quadratic and Cubic)	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: 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 Linear Transformations and Matrix Representation	UNIT-1	12
DD/MM/YY	Introduction to Linear Transformations and Matrix Representation		
DD/MM/YY	Characteristic Equation, Eigenvalues and Eigenvectors		
DD/MM/YY	Characteristic Equation, Eigenvalues and Eigenvectors		
DD/MM/YY	Properties of Eigenvalues and Eigenvectors		
DD/MM/YY	Properties of Eigenvalues and Eigenvectors		
DD/MM/YY	Cayley–Hamilton Theorem and Applications		
DD/MM/YY	Cayley–Hamilton Theorem and Applications		
DD/MM/YY	Cayley–Hamilton Theorem and Applications		
DD/MM/YY	Diagonalization of Matrices		
DD/MM/YY	Powers of a Matrix using Diagonalization		
DD/MM/YY	Powers of a Matrix using Diagonalization		
DD/MM/YY	Definition and Examples of Vector Spaces	UNIT-2	12
DD/MM/YY	Subspaces and Linear Span		

DD/MM/YY	Row Space of a Matrix, Basis and Dimension		
DD/MM/YY	Basis and dimension, Application to Matrices,		
DD/MM/YY	Rank of a Matrix,		
DD/MM/YY	sums and direct sums, coordinates		
DD/MM/YY	Linear mappings (Linear transformations),		
DD/MM/YY	Linear mappings (Linear transformations),		
DD/MM/YY	kernel and image of a linear mapping, rank and nullity,		
DD/MM/YY	kernel and image of a linear mapping, rank and nullity,		
DD/MM/YY	Singular and nonsingular linear mappings		
DD/MM/YY	Singular and nonsingular linear mappings		
DD/MM/YY	Matrix representation of a linear operator		
DD/MM/YY	change of basis, Similarity		
DD/MM/YY	Matrices and general linear mappings		
DD/MM/YY	Matrices and general linear mappings		
DD/MM/YY	Inner Product spaces		
DD/MM/YY	Cauchy – schwarz inequality, applications,		
DD/MM/YY	Orthogonality	UNIT-3	12
DD/MM/YY	orthogonal sets and bases		
DD/MM/YY	Gram- Schmidt orthogonalization process,		
DD/MM/YY	Gram- Schmidt orthogonalization process,		
DD/MM/YY	orthogonal and positive definite matrices		
DD/MM/YY	orthogonal and positive definite matrices		
DD/MM/YY	Concept of Correlation, Definition		
DD/MM/YY	Types of Correlation		
DD/MM/YY	Basic Properties of Correlation	UNIT-4	12
DD/MM/YY	Covariance and its Properties		

DD/MM/YY	Karl Pearson's Correlation Coefficient		
DD/MM/YY	Computation and Interpretation		
DD/MM/YY	Limits of Correlation Coefficient		
DD/MM/YY	Limits of Correlation Coefficient		
DD/MM/YY	Spearman's Rank Correlation Coefficient, Properties		
DD/MM/YY	Spearman's Rank Correlation Coefficient, Properties		
DD/MM/YY	Numerical Problems, Repeated Ranks		
DD/MM/YY	Numerical Problems, Repeated Ranks		
DD/MM/YY	Concept and Definition of Simple Linear Regression	UNIT-5	12
DD/MM/YY	Concept and Definition of Simple Linear Regression		
DD/MM/YY	Equations of Regression Lines		
DD/MM/YY	Regression Coefficients		
DD/MM/YY	Regression Coefficients		
DD/MM/YY	Properties of Regression Coefficients		
DD/MM/YY	Properties of Regression Coefficients		
DD/MM/YY	Angle Between Two Regression Lines		
DD/MM/YY	Angle Between Two Regression Lines		
DD/MM/YY	Curve Fitting: Straight Line, Exponential Curve,		
DD/MM/YY	Algebraic Curve, Parabolic Curve (Quadratic and Cubic)		
DD/MM/YY	Algebraic Curve, Parabolic Curve (Quadratic and Cubic)		

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**	Ability to understand and explain fundamental concepts, definitions, principles, and theorems related to linear algebra, vector spaces, correlation, regression, and curve fitting.	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	**Analytical and Problem-Solving Skills**	Ability to analyze mathematical problems, apply appropriate techniques, and derive logical solutions using algebraic and statistical methods.	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	**Computational Skills**	Ability to perform matrix operations, compute eigenvalues/eigenvectors, correlation coefficients, regression equations, and curve fitting calculations accurately.	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	**Application and Interpretation Skills**	Ability to apply mathematical and statistical concepts to real-life data analysis problems and interpret the obtained results meaningfully.	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	**Logical Reasoning and Critical Thinking**	Ability to develop mathematical reasoning, evaluate relationships among concepts, and justify solutions using logical arguments and proofs.	CO5 | L4–L5	ETE Sec B/C
TS6	**Data Handling and Mathematical Modeling Skills**	Ability to organize, represent, and model data using regression and curve fitting techniques for scientific and analytical applications.	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)	2 assignments	5+5	CO1, CO2, CO3, CO4, CO5, CO6	TS1, TS2, TS3, TS4, TS5, TS6
Assessment	2 Assessments	**10+5**	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	Unit1: Introduction to Linear Transformations and Matrix Representation	CO1	TS1	6h SL	Assignment submission + evaluation
Assignment 2	Unit2: Row Space of a Matrix, Basis and Dimension	CO2	TS2	6h SL	Numerical problems on evaluation of inverse of matrices
Assignment 3	Unit3: Matrix Representation of Linear Operators	CO2, CO3	TS2, TS3	6h SL	Numerical computation + comparison
Assignment 4	Unit4: Concept, Definition and Types of Correlation	CO3, CO4	TS3, TS4	6h SL	Step-by-step numerical evaluation
Assignment 5	Unit5: Introduction to Regression and Regression Lines	CO3, CO4, CO5	TS3, TS4, TS5	6h SL	Step-by-step numerical evaluation

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	**16**	TS1 - Conceptual Understanding	**CO1, CO2**	Short-answer, numerical problems
Section B	**14**	TS2 - Analytical Skills	**CO1, CO2**	Numerical problems: compute basic operations on matrices
TOTAL	30	TS1–TS2	**CO1–CO2**	Units 1–2 only. CO3, 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 20/50 required to pass.*

Section	Marks	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	40	TS1 — Conceptual understanding, TS2 - Analytical Skills, TS3 - Problem-Solving Ability, TS4 - Computational Skills, TS5 - Data Interpretation Skills, TS6 - Application and Reasoning Skills	**CO1, CO2, CO3, CO4, CO5, CO6**	Short questions (all units): linear transformations, eigenvalues, eigenvectors, and the Cayley–Hamilton theorem in matrix computations and diagonalization. vector spaces, subspaces, basis, dimension, rank, and nullity in solving algebraic problems. Karl Pearson's and Spearman's correlation coefficients for statistical data analysis.
Section B	18	TS3 - Problem-Solving Ability, TS4 - Computational Skills, TS5 - Data Interpretation Skills	**CO3, CO4, CO5**	Medium questions: linear mappings using matrices and perform change of basis and similarity transformations. Karl Pearson's and Spearman's correlation coefficients for statistical data analysis
Section C	30	TS3 - Problem-Solving Ability, TS4 - Computational Skills, TS5 - Data Interpretation Skills	**CO3, CO4, CO5**	Long/evaluation questions: Inner product space concepts, orthogonality, and Gram–Schmidt orthogonalization in vector and matrix problems. Karl Pearson's and Spearman's correlation coefficients for statistical data analysis
Section D	12	TS6 - Application and Reasoning Skills	**CO6**	Long/evaluation questions: regression analysis and curve fitting techniques using least square methods to model and analyze data.

TOTAL	100	TS1–TS6 (all)	**CO1–CO6**	Scaled from 100-mark paper. Minimum 20/60 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 of linear transformations, eigenvalues, eigenvectors	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Explore vector spaces, subspaces, basis, dimension, rank, and nullity in solving algebraic problems.	✔	✔	✔	TS2	PO1, PO3, PO4
CO3	Represent and interpret linear mappings using matrices and perform change of basis and similarity transformations	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Apply inner product space concepts,	✔	✔	✔	TS4	PO9, PO10, PO11
CO5	Compute and interpret Karl Pearson's and Spearman's correlation coefficients for statistical data analysis.	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Apply regression analysis and curve fitting techniques using least square methods to model and analyze data.	✔	—	✔	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	

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 Total = 15 hrs	CO1–CO4 TS1–TS4	Evaluated based on the assignment submitted; correctness, steps shown, comparison of algorithm performance
2	**Preparation for assessments**	Total = 15hrs	CO2, CO3 TS2, TS3	Assessment 1- subjective question paper, Assessment 2 - MCQ
	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 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 (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

MTT1116 — 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

Application Based Programming in Python (CSCR1302)

School of Computing Science & Engineering (SSCSE) | B.Tech. CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech.	**Current Academic Year:**	2026–2027
Branch:	CS & ME	**Semester:**	II
Course Code:	CSCR1302	**Course Type:**	Core- Integrated

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**	CSCR1302
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:** **THEORY COs - Assessed via MTE + ETE:** 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. 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. 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. 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. 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. **LAB COs - Assessed via Laboratory Assessment only:** 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. 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 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. 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.
12	**References**	**Reference:** Eric Matthes - Python Crash Course: A Hands-on, Project-based Introduction to Programming, No Starch Press. Reference: Wes McKinney - Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter (3rd Ed.), O'Reilly.

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	Linux Environment, Python 3.8+, Jupyter Notebook, VS Code/PyCharm, Anaconda Distribution, Online Python compilers (Replit, Trinket, Programiz), Competitive	

Used	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.** • Installation and configuration of Python environment and IDEs. • Practice basic Python syntax and program structure with print statements • Implementation of arithmetic, logical, relational operators with precedence demonstration. • 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. • Implementing iterative programs using while, for loops, and nested loop patterns. • Writing programs for mathematical computations (factorial, Fibonacci, sum of series). • Pattern printing programs using nested loops. • 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 • List operations: creation, slicing, appending, extending, sorting, reversing. • Nested list operations and matrix representation using lists. • String manipulation: slicing, methods (split, join, replace, find), immutability. • Tuple operations: packing/unpacking, nested tuples, tuple methods. • Set operations: union, intersection, difference, symmetric difference. • Dictionary operations: key-value pairs, nested dictionaries, dictionary methods. • Data structure comparison programs (list vs tuple vs set performance). • 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. • Function definition with different parameter types (positional, keyword, default). • Lambda functions for one-liner operations and higher-order functions. • Scope resolution: local vs global variables, nonlocal keyword. • Recursive function implementations (factorial, Fibonacci, GCD).	

	• Exception handling: try-except-finally blocks for different exception types. • Custom exception classes and exception propagation. • Function documentation and type hints practice. • 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. • Class creation with attributes, methods, and special methods (__init__, __str__). • Inheritance hierarchies: single, multiple, multilevel inheritance. • Polymorphism demonstration using method overriding and duck typing. • Encapsulation using private attributes (_var, __var) and property decorators. • File operations: reading (r, rb), writing (w, wb), appending (a), with statement. • CSV file handling using csv module. - JSON file operations using json module. • 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. • NumPy array operations: creation, indexing, broadcasting, vectorization. • Pandas DataFrame operations: loading CSV/Excel, filtering, grouping, merging. • Data cleaning: handling missing values, outliers, data type conversion. • Statistical analysis: mean, median, correlation, group statistics. • Matplotlib basic plotting: line, bar, scatter, histogram, pie charts. • Data visualization best practices and customization. • Algorithm implementations: linear search, binary search, bubble/selection/insertion sort. • 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	Unit 4	6
DD/MM/YY	Trace inheritance hierarchies and polymorphism		
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 &	**1.0**	CA1 - Problem definition: attributes,	1.0: Well-defined with design	CO7, CO8

Experimental Design		metrics, success criteria CA2 - Experimental design and tool configuration CA7 - Algorithm/flowchart/solution plan	| 0.5: Partial | 0: Missing	
Code Execution & Computational Efficiency	**1.0**	CA3 - Execution correctness; output matches expected 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 CA6 - Documented outcome with verification 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 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 P2 - Problem scope and stakeholder requirements 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 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 P6 - Complete project build and integration 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 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 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) 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**	Complete peer and self-evaluation rubrics; identify personal skill gaps	CO10 | PO9, PO11

	Presentation & Teamwork		
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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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 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

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 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 C & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–2027
Branch:	CS & ME	**Semester:**	II
Course Code:	CSCR1504	**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**	CSCR1504
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: 1. To equip students with the knowledge and skills to solve complex problems through a human-centered, iterative approach. 2. To focus on fostering creativity, empathy, and collaboration while guiding students through the stages of design thinking to develop impactful solutions. 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: **CO1 (Remember– L1):** Understand the design thinking process. **CO2 (Understand – L2):** Conduct user-centered research **CO3 (Apply– L3):** Develop and evaluate creative ideas. **CO4 (Analyze – L4):** Build and test prototype. **CO5 (Evaluate – L5):** Communicate and pitch innovative solutions. **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.* 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 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**

3. 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 effective "How Might We (HMW)" statements.	CO4 | L4	CA | CE Sec B
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
CO1	H	M						
CO2	H	H						
CO3	M	M	H	M				
CO4		M	M	H	H	M		
CO5			M	H	M	M	H	
CO6			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 LS2 — Problem Definition	1.0: Well-defined with design | 0.5: Partial | 0: Missing	CO1–CO4
Ideation & Solution Development	1	LS3 — Ideation & Creativity 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 —	CO1, CO2	Conduct empathy analysis, identify user problems, apply research techniques,

		Research & Empathy Skills		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	✔	—	✔	LS7, LS8	PO1, PO2,

	actionable plans.					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

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	-	-	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-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

Introduction to Computational Biology (BTT1102)

School of Engineering & Technology (SET) | B.Tech CSE | Semester II | 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:	SET — School of Engineering & Technology	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–2027
Branch:	CSE	**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). 2. It provides computer science students with an understanding of how biology integrates with modern technological advancements. 3. It allows to use of AI in big data analysis, and nanotechnology. 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:** CO1 (Understand – L1/L2): Understand the fundamental principles of biology and their relevance to computational sciences. CO2 (Explore – L2/L3): Analyze the molecular basis of biological systems and their computational modeling. CO3 (Apply – L3): Examine genetic principles and their applications in AI and machine learning. CO4 (Analyze – L4/L5): Explore AI-driven medical and agricultural biotechnologies. CO5 (Analyze – L4/L5): Investigate the role of bioinformatics in modern biology and healthcare. 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. 2. Lesk, A. M. (2019). Introduction to Bioinformatics. Oxford University Press, UK. 3. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, USA. 4. Baldi, P., & Brunak, S. (2001). Bioinformatics: The Machine Learning Approach. MIT Press, USA. 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 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 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	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	1	-	-	-	1	3	-	-	3	3	3	2
CO2	3	-	-	1	-	-	-	-	3	-	-	3	3	3	2
CO3	3	3	3	2	3	-	-	-	2	-	-	2	2	2	1
CO4	3	3	3	2	3	-	-	1	-	-	-	2	2	2	2

CO5	3	-	3	1	-	2	2	2	3	-	-	3	2	-	-
CO6	3	3	3	3	3	3	1	2	3	-	-	2	1	2	-
Avg	**3**	**1.5**	**2.0**	**1.6**	**1.5**	**0.83**	**0.5**	**1.00**	**2.3**	**0**	**0**	**2.5**	**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	PO12	PSO1	PSO2	PSO3
CO1	**H**			**M**				**M**	**H**			**H**	**H**	H	**M**
CO2	**H**			**M**					**H**			**H**	**M**	**H**	**M**
CO3	**H**	**H**	**H**	**M**	H				**M**			**M**	**M**	**M**	**M**
CO4	**H**	**H**	**H**	**M**	**H**			**M**				**M**	**M**	**M**	**M**
CO5	**H**		**H**	M		M	M	**H**	**H**			H	**M**		
CO6	**H**	**H**	**H**	H	H	H	M	M	H			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	**Subjective Assignment Writing (5 assignments, problem-based, one per unit focus area)**	5 assignments × 3 hrs each 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 Report preparation: 3 hrs Presentation: 3 hrs 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 Report preparation: 2 hrs 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 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 (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

ICB 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

Object Oriented Programming Using Java (CSCR1301)

School of Computing Science & Engineering (SSCSE) | B.Tech. CS & ME| 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	**Batch:**	2026–2030
Program:	B.Tech.	**Current Academic Year:**	2026–27
Branch:	CS & ME	**Semester:**	II
Course Code:	CSCR1301	**Course Type:**	Core - Integrated

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**	CSCR1301
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:** **THEORY COs - Assessed via MTE + ETE:** 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. 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. 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. 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. 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. **LAB COs - Assessed via Laboratory Assessment only:** 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. 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. 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. 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. 2. Virtual Labs (NPTEL): Java programming experiments. 3. MOOC course on Java/OOP (SWAYAM/Coursera/NPTEL).
11	**References**	Textbook: Schildt, H. - Java: The Complete Reference (12th Ed.), McGraw-Hill. Reference: Bloch, J. - Effective Java (3rd Ed.), Addison-Wesley. 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. Study of Linux Commands • Install JDK, configure IDE, write and execute "Hello World"; explore basic program structure • Demonstration of different data types with type-conversion examples (implicit/explicit casting) • Programs demonstrating operator precedence and associativity rules • Decision-making programs using if-else, nested if, and switch-case • Implementing iterative constructs using while, do-while, and for loops • 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. • Creating classes and objects to represent real-world entities (Student, Product, Employee) • Implementing various constructor types and demonstrating constructor overloading • Applying method overloading for flexible function creation • Demonstrating static variables, methods, and their use cases • Implementing 1D and 2D arrays: declaration, initialization, traversal • Array operations: linear/binary search, bubble/insertion/selection sort • String manipulation: palindrome check, anagram detection, reversal, substring operations	

	• 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. • Creating class hierarchies demonstrating single and multi-level inheritance • Implementing method overriding and demonstrating dynamic polymorphism • Designing abstract classes for extensible application frameworks • Creating interfaces and implementing multiple inheritance of type • Organising code using packages and demonstrating code-reusability benefits • Implementing encapsulation using access modifiers and getter/setter methods • Creating nested and inner classes for specialised use cases • 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. • Handling runtime errors using appropriate try-catch-finally blocks • Creating custom exceptions for application-specific error handling • Implementing multi-level exception handling in complex programs • Reading data from text files and processing information • Writing data to files in structured formats • Implementing file operations: merging files, sorting file contents, generating file statistics • 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. • Creating and managing multiple threads using Thread class and Runnable interface • Implementing thread priorities and observing JVM scheduling behavior • Demonstrating complete thread lifecycle using appropriate thread methods • Implementing synchronized methods and blocks for race-condition prevention • Solving classic concurrency problems: Producer-Consumer, Dining Philosophers • Implementing inter-thread communication using wait() and notify() • 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 • Install JDK, configure Eclipse/NetBeans • "Hello World" with comments and program structure • Arithmetic operations (+, –, *, /, %) • Scanner class for user input	**CO7**	3.0
	S-1.2	Operator Precedence & Type Conversion • Programs demonstrating operator precedence • Explicit/implicit type casting examples • Programs with mixed data types	**CO7**	
W2	S-2.1	Decision Making - if-else & switch • Grade calculator (marks → A/B/C/D/F) • ATM menu system (balance check, withdraw, deposit) • Simple calculator using switch-case	**CO7**	3.0
	S-2.2	Nested Loops & Patterns • Pyramid, diamond, right-triangle patterns • Floyd's triangle, number patterns • Sum of digits, factorial using loops	**CO7**	
W3	S-3.1	Classes & Objects - Real-World Modelling • Student class (name, rollno, marks, percentage) • Rectangle class (length, breadth, area, perimeter) • BankAccount class (balance, deposit, withdraw)	**CO7, CO8**	3.0

	S-3.2	Constructors & Method Overloading • Constructor overloading in Student class • Copy constructor for Rectangle • Method overloading: add(int), add(double), add(int,int)	**CO7, CO8**	
W4	S-4.1	Arrays - 1D Operations • Declaration, initialisation, traversal • Linear search, frequency count • Largest/smallest element, sum/average	**CO7**	3.0
	S-4.2	Array Algorithms • Bubble, selection, insertion sort • Binary search (sorted array) • Reverse array, duplicate removal	**CO7**	
W5	S-5.1	2D Arrays & Matrix Operations • Matrix addition, subtraction, multiplication • Transpose of matrix • Diagonal elements sum	**CO7**	3.0
	S-5.2	String Manipulation • Palindrome check, anagram detection • Vowel/consonant count, word count • String reversal, substring operations	**CO7**	
W6	S-6.1	Inheritance - Class Hierarchy • Shape hierarchy: Circle, Rectangle extends Shape • Vehicle hierarchy: Car, Bike extends Vehicle • Employee hierarchy: Manager, Developer	**CO7, CO8**	3.0
	S-6.2	Method Overriding & Polymorphism • Override calculateArea(), display() methods • Dynamic method dispatch demonstration • final keyword usage	**CO7, CO8**	
W7	S-7.1	Abstract Classes & Interfaces • Abstract Shape class with abstract methods • Drawable interface implementation • Multiple interface implementation	**CO7, CO8**	3.0
	S-7.2	Object Class Methods • Override toString(), equals(), hashCode() • Compare objects using overridden methods • Lambda expressions and functional interfaces	**CO7, CO8**	
W8	S-8.1	Exception Handling - Basic • Divide by zero, array index out of bounds • NumberFormatException handling • try-catch-finally blocks	**CO7**	3.0
	S-8.2	Advanced Exception Handling • Custom exception: InvalidAgeException • Multiple catch blocks • throw/throws keywords	**CO7**	
W9	S-9.1	File I/O - Byte Streams • FileInputStream/FileOutputStream • Copy file content • Character count in file	**CO7**	3.0
	S-9.2	File I/O - Character Streams • FileReader/FileWriter • Line-by-line reading/writing • Word count from text file	**CO7**	
W10	S-10.1	Advanced File Operations • Student record management (add, search, delete) • CSV file read/write • File merging and sorting file contents	**CO7, CO8**	3.0

	S-10.2	Multithreading - Thread Creation • Thread using Thread class vs. Runnable • Multiple threads execution • Thread naming and priority	**CO7, CO8**	
W11	S-11.1	Thread Lifecycle & Methods • Demonstrate thread states (new, runnable, terminated) • sleep(), join(), yield() methods • Thread interruption	**CO7, CO8**	3.0
	S-11.2	Thread Synchronisation • Synchronised methods/blocks • Race condition demonstration • Atomic counter example	**CO7, CO8**	
W12	S-12.1	Inter-Thread Communication • Producer-Consumer using wait()/notify() • Bounded buffer problem • Thread coordination	**CO7, CO8**	3.0
	S-12.2	Thread Pools & Executors • ExecutorService creation • Fixed thread pool execution • Callable and Future	**CO7, CO8**	
W13	S-13.1	Mini Project - Phase 1: Proposal & Design • Topic selection with SDG alignment • UML class diagram and system design • Project plan and task distribution	**CO8, CO9, CO10**	3.0
	S-13.2	Mini Project - Phase 2: Implementation • Core module coding and unit testing • Code review and refactoring • Version control (Git commits)	**CO8, CO9, CO10**	
W14	S-14.1	Mini Project - Phase 3: Integration & Testing • Full integration of modules • Test cases: edge cases, exception handling • Documentation and README	**CO8, CO9, CO10**	3.0
	S-14.2	Mini Project - Phase 4: Presentation Preparation • Slide deck (problem, design, demo, reflection) • Rehearsal and peer review • Lab record finalisation	**CO8, CO9, CO10**	
W15	S-15.1	Mini Project - Final Presentation & Viva • Team demonstration (10 min) • Individual viva questions • Rubric-based evaluation by faculty	**CO8, CO9, CO10**	3.0
	S-15.2	Lab Examination • One unseen problem (OOP concept) • Code, compile, execute, and document • 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 CA2 - Experimental design and tool configuration 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 CA4 - Efficiency: time/space complexity, optimization	1.0: Correct & efficient | 0.5: Correct, not optimized | 0: Fails	CO7
Output Analysis, Outcome & Lab	**0.75**	CA5 - Output analysis and result interpretation	0.75: Thorough | 0.5: Adequate | 0.25: Partial |	CO8, CO9

Documentation		CA6 - Documented outcome with verification CA8 - Lab record completeness; viva-voce comprehension	0: Absent	
Professional Attitude & Ethical Conduct	**0.25**	CO9 - Documentation ethics, responsible practice 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 P2 - Problem scope and stakeholder requirements 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 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 P6 - Complete project build and integration 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 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 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) 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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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 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

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 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: 2026-2030**
Program: B.Tech.		**Current Academic Year: 2026-2027**
1	Course Code	CVT1103
2	Course Title	Environmental Studies
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 2. Provide students an insight of various causes of natural resource depletion and its conservation 3. Provide knowledge of layers of atmosphere with an insight of role of climatic elements in dispersion of pollutants 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 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 CO3. Study about pollution causes, effects and control and solid waste management CO4. Effect of global warming and ozone layer depletion CO5.Understand sustainable development, resettlement and rehabilitation, impact of population explosion on environment CO6.Understand overall environmental issues and its management

7	Course Description	Environmental Science emphasises on various factors as 1. Importance and scope of environmental science 2. Natural resource conservation 3. Pollution causes, effects and control methods and solid waste management 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. 2. .Howard S. Peavy, Donald R. Rowe, George Tchobanoglous. Environmental engineering Mc Graw-Hill, 1985	
	Other References		

CO-PO Mapping

CO↓ PO →	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	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).

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**
CVT1103	1.25	2.25	1.4	1.6	2.0	2.0	1.75	1.0	1.5	2.0	2.25	1.75	1.75	2.2

School: SSCSE		**Batch : 2025-2029**	
Program: B.Tech.		**Current Academic Year: 2025**	
Branch: CSE		**Semester: II**	
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. 2. Define the principles and ideals, which help in making the judgement of what is more important. 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. 4. Appreciate the importance of harmony in the self, family and the society for mutual fulfilment. 5. Understand the importance of harmony among human beings, other living beings and entire nature for universal equilibrium and mutual co-existence. 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. 2. A.N. Tripathy, 2003, Human Values, New Age International Publishers. 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	-

Semester II	21
Course Code	**Course Name**
EET1101	Basics of Electrical and Electronics Engineering
MTT1116	Mathematics – I
CSCR1302	Application based Programming in Python
CSCR1504	Design and Creativity Lab
BTT1102	Introduction to Computational Biology
CSCR1301	Object Oriented Programming Using Java
CVT 1103	Environmental Studies
IKT 1105	Human Values and Professional Ethics
VAC	Value Added Course

COURSE PLAN

Computer Networks (CSCR2310)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | Semester III | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027–2028
Branch:	CSE	**Semester:**	III
Course Code:	CSCR2310	**Course Type:**	Core – Integrated

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**	CSCR2310
2	**Course Title**	Computer Networks
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	2-0-4-2
5	**Course Status**	Core – Integrated
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:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Understand – L2): Demonstrate networking fundamentals and differentiate the working of OSI and TCP/IP models. CO2 (Analyze – L4): Investigate error control, flow control, and MAC protocols for reliable communication. CO3 (Apply – L3): Apply IP addressing, subnetting, routing, and congestion control techniques. CO4 (Analyze – L4): Examine transport layer services, TCP/UDP protocols, and congestion control mechanisms. CO5 (Understand – L2):

		Describe connection management and application layer protocols. CO6 (Understand – L2): Outline the basic concepts and applications of cryptography and network security. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Configure and troubleshoot network utilities and commands. CO8 (Analyze – L4): Implement error detection, routing and congestion control algorithms. CO9 (Apply – L3): Simulate and evaluate network topologies using Packet Tracer and networking tools. 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. • Perform Computer Networks Virtual Labs (NPTEL/Virtual Labs) on routing, CRC, flow control, and network simulation. • Complete a MOOC/NPTEL/SWAYAM course on Computer Networks and network security fundamentals.
11	**References**	**Text Book** Tanenbaum, A. S. — Computer Networks (4th Edition), PHI. **Reference Books** Forouzan, B. A. — Data Communications and Networking, TMH, Latest Edition. 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. • Study of Computer Network Fundamentals. • Comparison of OSI and TCP/IP models. Demonstration of Networking Devices- • Hub, Switch, Bridge, Router, Gateway and Repeater • Working and applications of networking devices	

	Practical exposure using networking tools- • Basic networking commands: PING, IPCONFIG, TRACERT, NETSTAT • 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. • Implementation of error detection and correction methods: Parity, CRC, and Hamming Code. • Demonstration of Stop-and-Wait and Sliding Window protocols. • Analysis of MAC protocols: ALOHA, CSMA, and CSMA/CD. • 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. • Practice on IPv4 addressing, subnetting, CIDR, and subnet mask calculations. • Analysis of routing algorithms and routing table concepts. • Implementation of subnetting and routing-based numerical problems. • 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. • Comparison of connection-oriented and connectionless communication. • Analysis of TCP segment structure and header fields. • Demonstration of TCP connection establishment and termination. • 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 crypto-graphic 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. • Analysis of client-server communication using networking tools. • Demonstration of DNS lookup and HTTP request-response process. • 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 ET

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 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 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 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 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	Propose suitable routing, congestion control, topology or se-	CO8 | PO3

	Solution Design	curity solution with alternatives and justification	
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

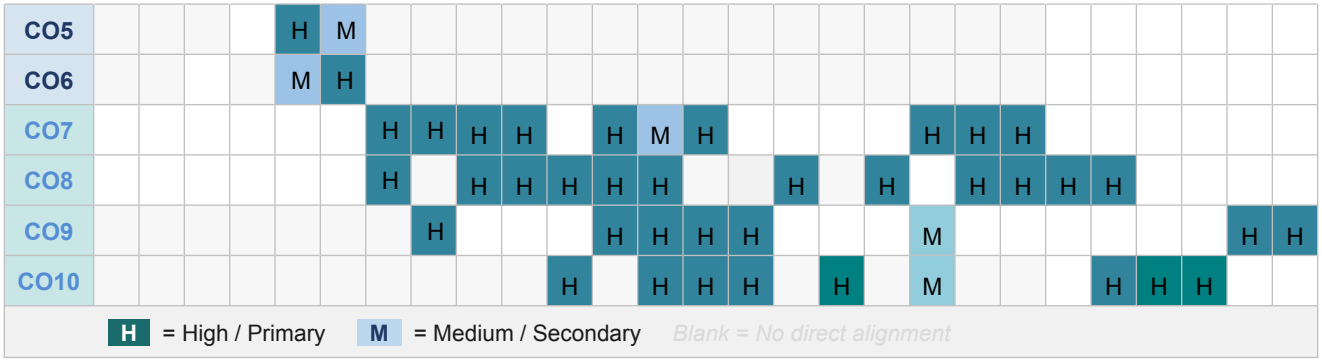
14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

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																							



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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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 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

★ *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

Mathematics – II (MTT1217)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | Semester III | 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 Plan

1. Course Identification

School:	SSES — Sharda School of Engineering & Science	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	III
Course Code:	MTT 1217	**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**	**MTT 1217**
2	**Course Title**	Mathematics-II
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**	**Core — Theory Only (No Laboratory Component)**
6	**Course Objectives**	1. To provide students with a strong foundation in simple, multiple, and logistic regression models for predictive analytics. 2. To develop the ability to estimate, interpret, and evaluate regression and classification models using statistical techniques. 3. To familiarize students with regression diagnostics, regularization methods, and model performance evaluation. 4. To equip students with practical knowledge of machine learning algorithms for regression and classification problems.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Apply – L3): Apply the principles of simple linear regression to estimate model parameters, perform hypothesis testing, and interpret regression results. CO2 (Analyze – L4): Develop and analyze multiple linear regression models, evaluate model adequacy, and diagnose issues such as multicollinearity. CO3 (Analyze – L4): Construct and interpret logistic regression models for classification problems using appropriate estimation and evaluation techniques. CO4 (Evaluate – L5): Evaluate predictive models using classification and regression performance metrics and compare their effectiveness for data-driven decision making. CO5 (Analyze – L4): Perform regression diagnostics, identify influential observations, and apply regularization methods such as Ridge and LASSO regression to improve model performance. CO6 (Apply – L3): Implement machine learning algorithms for regression and classification problems, including model training, validation, testing, and performance assessment.
8	**Course Description**	This course introduces regression analysis and machine learning techniques for predictive modeling, data analysis, and decision-making. Students will learn to develop, evaluate, and interpret statistical and machine learning models for solving real-world problems using data-driven approaches.
9	**Teaching & Learning**	Classroom Instructions (CI): 45 hrs| Self Learning (SL): 45 hrs | Total: 90

	Scheme	hrs
10	**Mode of Examination**	Theory Only. CA: 25% | MTE: 15% | ETE: 60% | Total: 100 marks
11	**Textbook**	Montgomery, D. C., Peck, E. A., & Vining, G. G., Introduction to Linear Regression Analysis, Wiley.
12	**References**	1. Kutner, M. H., Nachtsheim, C. J., Neter, J., & Li, W., Applied Linear Statistical Models, McGraw-Hill. 2. James, G., Witten, D., Hastie, T., & Tibshirani, R., An Introduction to Statistical Learning, 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: Simple Linear Regression (SLR)	
A	Simple Linear Regression Model, Assumptions and Least Squares Estimation of Parameters.	CO1
B	Hypothesis Testing on Slope and Intercept, Confidence Intervals for Regression Parameters.	CO1
C	Coefficient of Determination (R^2), Interpretation of Results and Estimation by Maximum Likelihood Method.	CO1
	Unit 2: Multiple Linear Regression (MLR)	
A	Multiple Linear Regression Model, Estimation of Model Parameters and Properties of Least Squares Estimators.	CO2
B	Hypothesis Testing in MLR, Test of Significance of Regression Model, Confidence Intervals for Regression Coefficients.	CO2
C	Coefficient of Determination (R^2), Adjusted R^2, Multicollinearity, Detection and Effects.	CO2
	Unit 3: Logistic Regression	
A	Logistic regression: Introduction, Definition, Odds Ratio	CO3
B	Estimation by MLE. Logistic model with binary response,	CO3
C	Logit and Probit model. Confusion Matrix, Precision, Recall, F1-Score, ROC Curve and AUC.	CO3, CO4
	Unit 4: Residual Analysis	
A	Residual Analysis, Detection and Treatment of Outliers, Heteroscedasticity.	CO5
B	Ridge Regression, LASSO Regression	CO5
C	Hat matrix: Definition & Properties, PRESS residual and Studentized residual.	CO5
	Unit 5: Machine Learning for regression	
A	Introduction to Machine Learning, Training, Validation and Testing Datasets.	CO6

B	Support Vector Regression (SVR), Random Forest and Naïve Bayes Classifier.	CO4, CO6
C	Gradient Boosting Methods, Model Evaluation Metrics.	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 — 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 Regression Analysis, Applications and Assumptions	UNIT-1	9
DD/MM/YY	Simple Linear Regression Model and Parameter Estimation		
DD/MM/YY	Least Squares Estimation of Regression Coefficients		
DD/MM/YY	Hypothesis Testing on Slope and Intercept		
DD/MM/YY	Confidence Intervals for Regression Parameters	UNIT-2	9
DD/MM/YY	Coefficient of Determination (R^2) and Maximum Likelihood Estimation		
DD/MM/YY	Introduction to Multiple Linear Regression		
DD/MM/YY	Estimation of Parameters in MLR		
DD/MM/YY	Properties of Least Squares Estimators		
DD/MM/YY	Hypothesis Testing in Multiple Regression		
DD/MM/YY	Confidence Intervals for Regression Coefficients	UNIT-3	9
DD/MM/YY	Adjusted R^2 and Model Adequacy		
DD/MM/YY	Multicollinearity: Detection and Effects		
DD/MM/YY	Introduction to Classification and Logistic Regression		
DD/MM/YY	Odds Ratio and Interpretation		
DD/MM/YY	Maximum Likelihood Estimation in Logistic Regression		
DD/MM/YY	Binary Logistic Regression Models		
DD/MM/YY	Logit and Probit Models		
DD/MM/YY	Confusion Matrix, Precision, Recall, F1-Score, ROC Curve and AUC	UNIT-4	9
DD/MM/YY	Residual Analysis and Diagnostic Measures		
DD/MM/YY	Detection and Treatment of Outliers		
DD/MM/YY	Heteroscedasticity and Its Effects		
DD/MM/YY	Ridge Regression and LASSO Regression		
DD/MM/YY	Hat Matrix, PRESS Residual and Studentized Residual		
DD/MM/YY	Introduction to Machine Learning and Predictive Modeling	UNIT-5	9
DD/MM/YY	Training, Validation and Testing Datasets		
DD/MM/YY	Support Vector Regression (SVR)		
DD/MM/YY	Random Forest and Naïve Bayes Classifier		
DD/MM/YY	Gradient Boosting Methods		
DD/MM/YY	Model Evaluation Metrics and 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	Regression Concepts & Model Identification	Recall and explain fundamental concepts of simple linear regression, assumptions, parameter estimation methods, hypothesis testing, and model interpretation.	CO1 | L2–L3	CA | MTE Sec A | ETE Sec A
TS2	Multiple Regression Analysis & Statistical Inference	Analyze multiple regression models, estimate parameters, conduct significance tests, and interpret multicollinearity and model adequacy measures.	CO2 | L3–L4	CA | MTE Sec A | ETE Sec A
TS3	Classification Modeling & Logistic Regression Implementation	Apply logistic regression techniques, estimate model parameters using MLE, interpret odds ratios, and construct classification models.	CO3 | L3–L4	CA | MTE Sec B | ETE Sec B
TS4	Predictive Performance Evaluation	Evaluate classification and regression models using confusion matrix, precision, recall, F1-score, ROC-AUC, and other performance metrics.	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	Regression Diagnostics & Regularization Analysis	Analyze residuals, identify influential observations, assess heteroscedasticity, and evaluate Ridge and LASSO regression techniques.	CO5 | L4–L5	ETE Sec B/C
TS6	Machine Learning Model Development & Validation	Implement machine learning algorithms, perform model training, validation and testing, and evaluate predictive performance on real-world datasets.	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					**H**	**M**
CO6		**M**			**M**	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, CO5	TS1, TS2, TS3, TS5
Technical Video Learning Report	1 Report + Presentation	5	CO3, CO4	TS3, TS4
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	Simple Linear Regression: Model fitting, parameter estimation, hypothesis testing and interpretation	CO1	TS1	5h SL	Numerical computation, model fitting and interpretation of results
Assignment 2	Multiple Linear Regression: Parameter estimation, significance testing, adjusted R^2 and multicollinearity	CO2	TS2	5h SL	Numerical problems, model construction and statistical inference
Assignment 3	Logistic Regression: Odds ratio, binary classification, confusion matrix and ROC analysis	CO2, CO3	TS2, TS3	5h SL	Numerical computation, model fitting and classification performance evaluation
Assignment 4	Residual Analysis: Outlier detection, heteroscedasticity, Ridge and LASSO regression	CO3, CO5	TS3, TS5	5h SL	Diagnostic analysis, regularization implementation and interpretation
Assignment 5	Machine Learning Models: SVR, Random Forest, Naïve Bayes and Gradient Boosting	CO4, CO5, CO6	TS4, TS5, TS6	5h SL	Model implementation, performance comparison and result interpretation
Video Learning	Technical video on regression	CO3,	TS3,	9h SL	Report: learning outcomes,

Report	analysis, logistic regression, ensemble learning, or model evaluation (minimum 3 hrs); structured report and class presentation	CO4	TS4		key concepts and self-reflection. Presentation: 10 min
Case Study Report	Real-world predictive analytics case study (e.g., Customer Churn Prediction, Diabetes Prediction, House Price Prediction, Credit Risk Analysis); in-depth analysis report	CO4, CO5, CO6	TS4, TS5, TS6	6h SL	Technical depth, data collection, model development, performance evaluation and 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 — Regression Concepts & Model Identification TS2 — Multiple Regression Analysis & Statistical Inference	CO1, CO2	Short-answer and numerical questions: assumptions of regression, interpretation of coefficients, hypothesis testing, confidence intervals, coefficient of determination (R^2), adjusted R^2, and multicollinearity concepts.
Section B	10	TS3 — Classification Modeling & Logistic Regression TS4 — Predictive Performance Evaluation	CO2, CO3, CO4	Numerical and analytical problems: logistic regression model fitting, odds ratio interpretation, confusion matrix, precision, recall, F1-score, ROC-AUC computation, and comparison of predictive models.
TOTAL	**15**	**TS1–TS4**	**CO1–CO4**	**Units 1–3 only. CO5 and CO6 are assessed primarily 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	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	15	TS1 — Regression Concepts & Model Identification TS2 — Multiple Regression Analysis & Statistical Inference	CO1, CO2	Short questions covering regression concepts, assumptions, least squares estimation, hypothesis testing, confidence intervals, coefficient of determination (R^2), adjusted R^2, and multicollinearity.

Section B	30	TS3 — Classification Modeling & Logistic Regression TS4 — Predictive Performance Evaluation TS5 — Regression Diagnostics & Regularization Analysis	CO3, CO4, CO5	Medium-length numerical and analytical questions involving logistic regression, odds ratio interpretation, confusion matrix, ROC-AUC, residual analysis, outlier detection, heteroscedasticity, Ridge Regression, and LASSO Regression.
Section C	15	TS5 — Regression Diagnostics & Regularization Analysis TS6 — Machine Learning Model Development & Validation	CO5, CO6	Long/evaluation questions involving machine learning model development, training-validation-testing procedures, Support Vector Regression (SVR), Random Forest, Naïve Bayes, Gradient Boosting, model comparison, and case-study-based predictive analytics.
TOTAL	**60**	**TS1–TS6 (all)**	**CO1–CO6**	Scaled from a 100-mark paper if required. Minimum 20/50 required to pass.

11.1 CO-wise Assessment Instrument Summary

CO	CO Statement (Short)	CA (25)	MTE (25)	ETE (50)	TS	PO Primary
CO1	Apply simple linear regression models, estimate parameters, perform hypothesis testing, and interpret regression results.	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Develop and analyze multiple linear regression models and evaluate model adequacy and multicollinearity.	✔	✔	✔	TS2	PO1, PO2, PO3, PO4
CO3	Construct and interpret logistic regression models for classification problems.	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Evaluate predictive models using classification and regression performance metrics.	✔	✔	✔	TS4	PO1, PO2, PO9, PO10
CO5	Perform regression diagnostics and apply regularization methods to improve model performance.	✔	—	✔	TS5	PO1, PO2, PO4, PO10
CO6	Implement machine learning algorithms for regression and classification problems and assess their performance.	✔	—	✔	TS6	PO1, PO2, PO5, 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	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	–	–	1	1	1	–	–	3	2	1
CO2	3	3	3	3	1	–	–	1	1	1	–	–	3	3	2
CO3	3	3	3	2	2	–	–	1	1	2	1	–	3	3	2
CO4	2	3	2	3	2	–	–	2	3	3	2	1	2	3	2
CO5	2	3	2	3	2	–	–	2	3	2	2	1	2	3	2
CO6	3	3	3	2	3	–	–	1	2	3	3	1	3	3	3
Avg	2.67	3.00	2.50	2.50	1.83	–	–	1.33	1.83	2.00	2.00	1.00	2.67	2.83	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	PO12	PSO1	PSO2	PSO3
CO1	H	H	M	M	M			M	M	M			H	M	M
CO2	H	H	H	H	M			M	M	M			H	H	M
CO3	H	H	H	M	M			M	M	H	M		H	H	M
CO4	M	H	M	H	M			M	H	H	M	M	M	H	M
CO5	M	H	M	H	M			H	H	M	M		M	H	M
CO6	H	H	H	M	H			M	M	H	H	M	H	H	H

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, problem-based, one per unit focus area)	5 assignments × 3 hrs each Total = 15 hrs	CO1–CO5 TS1–TS5	Evaluated based on correctness of computations, model development, interpretation of results, statistical inference, and comparison of predictive performance.
2	Technical Video-Based Learning related to Regression Analysis and Machine Learning (e.g., Logistic Regression, Random Forest, Gradient Boosting, Model Evaluation Techniques)	Video viewing: 3 hrs Report preparation: 3 hrs Presentation: 3 hrs Total = 9 hrs	CO3, CO4 TS3, TS4	Report and Presentation based on learning outcomes, model interpretation, algorithmic understanding, applications, and personal reflections.
3	Real-World Predictive Analytics Case Study (e.g., Customer Churn Prediction, Diabetes Prediction, House	Data collection/study: 4 hrs Report preparation: 2 hrs Total = 6 hrs	CO4, CO5, CO6 TS4, TS5, TS6	Evaluated based on dataset understanding, model selection, technical depth, implementation methodology, performance evaluation, interpretation

	Price Prediction, Credit Risk Assessment, Sentiment Analysis)			of findings, 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 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 in CO3 and CO6 through implementation of logistic regression and machine learning algorithms. Affective domain (A3) appears in CO4 and CO5 through evaluation of predictive performance, model interpretation, and analytical decision-making..*

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

MTT 1217 — 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

Principles of Operating System (CSCR2312)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | Semester III | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	III
Course Code:	CSCR2312	**Course Type:**	Core – Integrated

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**	CSCR2312
2	**Course Title**	**Principles of Operating System**
3	**Credits**	3
4	**Contact Hours (L-T-P-SL)**	2-0-2-2
5	**Course Status**	Core
6	**Course Objective**	1. Introduce the challenges for designing operating systems. 2. Cover different design principles and algorithms for resource management. 3. Enable evaluation of algorithms proposed for resource allocation and scheduling. 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:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Understand – L1/L2): Identify the challenges and understand the basic concepts, types, structures, and services of an Operating System. CO2 (Explore – L2/L3): Explore process management concepts including process states, inter-process communication, CPU scheduling, synchronization, and deadlocks. 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. CO5 (Analyze – L4/L5): Analyze various memory management techniques including paging, segmentation, virtual memory, demand paging, and page replacement algorithms. CO6 (Analyze – L2/L4): Understand file system concepts, file operations, disk scheduling algorithms, and I/O management techniques, and analyze their comparative efficiency. **LAB COs — Assessed via Laboratory Assessment only:** **CO7 (Apply – L3):** Implement Linux/Unix commands, shell utilities, process management programs, and system calls using professional development tools. **CO8 (Create – L5/L6):** Develop system-level applications using process synchronization, inter-process communication, file operations, and scheduling techniques. **CO9 (Apply – L2/L3):** Demonstrate ethical computing practices, documentation skills, responsible system usage, and reflective learning. **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. Reference: 1. Stallings, W. — Operating Systems: Internals and Design Principles, Maxwell Macmillan 2. Tanenbaum, A.S. — Operating System: Design and Implementation, Prentice Hall India 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
	  ○ Working with Directories
	  ○ Understanding of gcc compiler, compiling and executing on Linux Environment.
	• Understanding shell commands and directory structure
	• Study of process monitoring utilities
	• Comparison of Windows and Linux operating systems
	• 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() • Process synchronization using wait(), sleep(), semaphores • Implementation of IPC mechanisms • Thread creation using pthreads • 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 • Gantt chart analysis • Performance comparison of scheduling algorithms • Deadlock detection case studies • 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 • Simulation of page replacement algorithms • Memory fragmentation analysis • Performance comparison of memory allocation techniques • 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 • Disk scheduling simulation • Linux file system navigation • File buffering and descriptor analysis • 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	
W14	S-14.1	Design and implementation of a mini Linux shell	CO8/CO10	3.0
	S-14.2	Process scheduler simulator with team-based role allocation and peer review	CO8/CO10	
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 management, file handling, and Linux utilities for real-world system-level problems	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: 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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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 obser-	CO8

		vations using evidence-based reasoning	
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	TS3 Procedural	TS4 Analytical	TS5 Compar. Eval.	TS6 Synthesis &	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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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 comput-

			ing 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 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

★ *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

Applied AI and ML in Healthcare Informatics (CSME2300)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | Semester III | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	III
Course Code:	CSME2300	**Course Type:**	Core – Integrated

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**	CSME2300
2	**Course Title**	**Applied AI and ML in Healthcare Informatics**
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-3

5	**Course Status**	Core
6	**Course Objective**	To introduce the fundamentals of medical data processing, clinical natural language processing, and predictive modeling using healthcare datasets; and to develop applied machine learning skills through structured clinical lab engineering, ethical AI practices, HIPAA compliance awareness, and collaborative, health-centric project work.
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Remember – L1): Recall and list fundamental concepts of healthcare informatics, medical data standards (HL7, FHIR, DICOM), electronic health records (EHR), and clinical terminology systems (SNOMED-CT, ICD-10) CO2 (Understand – L2): Explain the unique characteristics of clinical data, the working of medical image processing algorithms, physiological signal feature extraction, and specialized neural network architectures for health diagnostics. CO3 (Apply – L3): Develop predictive models and diagnostics systems using supervised and unsupervised machine learning algorithms on tabular clinical data, biometric features, and structured EHRs. CO4 (Analyze – L4): Analyze and debug AI models for healthcare, investigating issues like algorithmic bias, clinical dataset imbalance, interpretability deficits, and processing errors in medical imaging or clinical NLP. CO5 (Evaluate – L5):): Evaluate clinical AI model performance using healthcare-centric metrics (Sensitivity, Specificity, ROC-AUC, F1-score) and optimize models considering fairness, clinical validation constraints, and resource efficiency. CO6 (Create – L6): Design, implement, and demonstrate complete, end-to-end medical AI pipelines integrating data ingestion, preprocessing, explainable ML modeling, and deployment architectures to solve real-world healthcare challenges. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Implement clinical AI workflows using professional tools and frameworks (Python, PyTorch/TensorFlow, MONAI, Scikit-Learn, Jupyter); configure medical data processing setups; maintain reproducible lab protocols and notebooks. CO8 (Create – L5/L6): Design and develop modular healthcare applications addressing real-world diagnostic or operational medical problems with deep societal awareness; propose validated architectures; evaluate outcomes clinically and analytically. CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible medical AI development practices, ensuring compliance with health regulations (HIPAA, GDPR, medical data privacy); perform algorithmic bias self-assessment; reflect on continuous clinical AI growth. CO10 (Apply – L3): Collaborate and communicate effectively in interdisciplinary team-oriented lab activities; plan, implement, and present predictive health solutions; apply medical software project management principles
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. 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:* 1. Topol, E. — *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, Basic Books. *Reference:* 1. Zhou, S.K., Greenspan, H., Shen, D. — *Deep Learning for Medical Image Analysis*, Academic Press. 2. Shortliffe, E.H., Cimino, J.J. — *Biomedical Informatics: Computer Applications in Health Care and Biomedicine* (5th Ed.), Springer.

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 Biomedical Informatics; Electronic Health Records (EHR); Structure of Clinical Data (structured, unstructured, longitudinal).	CO1, CO2, CO3
B	Healthcare Data Standards & Interoperability: HL7, FHIR (Fast Healthcare Interoperability Resources), and ICD-10/SNOMED-CT medical coding terminologies.	
C	Ethics and Regulation: Data privacy protocols, HIPAA and GDPR compliance frameworks in health analytics, anonymization and de-identification vectors.	
Tools Used	Python ecosystem, Jupyter Notebooks, FHIR Sandbox APIs, Clinical text parsers	
Activities	**Objective:** To familiarize students with Linux commands and develop a clear understanding of the C programming environment along with its basic tokens. • Parsing FHIR JSON resources; extracting clinical cohorts from simulated EHR systems; implementing regex and vocabulary matchers for SNOMED-CT tag extractions; executing patient data masking/de-identification algorithms.	
Unit 2	**Control Statements (6-0-12-6 = 24 hrs)**	
A	**A:** Clinical Machine Learning: Risk stratification, patient readmission prediction, disease survival modeling using survival analysis (Kaplan-Meier, Cox Proportional Hazards).	CO3, CO4
B	**B:** Handling Clinical Data Anomalies: Missing values imputation in longitudinal charts (MICE, KNN), addressing massive class imbalances (SMOTE, Focal Loss) in rare disease detection.	
C	**C:** Model Evaluation in Healthcare: Clinical utility vs. statistical metrics; Sensitivity (Recall), Specificity, Positive Predictive Value (PPV), ROC-AUC, and Precision-Recall curves.	
Tools Used	**Tools Used:** Scikit-Learn, Lifelines (Survival Analysis framework), Imbalanced-Learn, Jupyter Lab.	
Activities	**Objective:** To apply decision-making and iterative constructs for designing efficient solutions with appropriate program control flow. • Building an early-warning system for sepsis detection; implementing medical risk scoring metrics; comparing imputation schemes on longitudinal EHR records containing high missing rates. •	
Unit 3	**Functions & Arrays (8-0-16-6 = 30 hrs)**	
A	Clinical Text Characteristics: Medical notes, discharge summaries, radiology reports. Named Entity Recognition (NER) for symptoms, anatomy, and drugs.	CO2, CO3, CO4, CO5, CO6

B	Clinical NLP Architectures: Rule-based systems (MedSpacy), Clinical Embeddings (BioWord2Vec), Transformer models (BioBERT, ClinicalBERT) for clinical semantic extraction.	
C	Information Extraction & Applications: Clinical relation extraction (drug-dosage mappings), automatic medical report summarization, and patient classification.	
Tools Used	**Tools Used:** Spacy (MedSpacy), Hugging Face Transformers, BioBERT, PyTorch, Linux Terminal.	
Activities	**Objective:** To understand the concept of functions, recursive solution, recursion and Arrays, manipulating array elements, arrays of unknown or varying size. • Building a clinical NER pipeline to flag drug adverse reactions from unstructured clinical narratives; fine-tuning a BERT variant to classify medical triage reports; parsing relationships out of unstructured pathology documentation..	
Unit 4	**Pointers & Strings (6-0-12-6 = 24 hrs)**	
A	Medical Imaging Modalities: Introduction to DICOM formats, X-Rays, CT scans, MRI, and Histopathology images. Image preprocessing (Windowing, Hounsfield Unit scaling).	CO3, CO4, CO5
B	Deep Learning for Medical Vision: Convolutional Neural Networks (CNNs) for classification (Pneumonia detection), U-Net architectures for anatomical and tumor segmentation.	
C	Validation & Pitfalls: Overfitting to institutional scanner signatures, domain shift challenges, and multi-center validation protocols.	
Tools Used	**Tools Used:** PyTorch, MONAI (Medical Open Network for AI), SimpleITK, Pydicom, OpenCV.	
Activities	**Objective:** To understand addresses, pointers, dynamic memory allocation, and strings, and apply these concepts for efficient string handling and implementation of string functions. • Reading and processing volumetric 3D CT/MRI scans using Pydicom; building a binary classifier for chest X-ray disease detection; setting up a basic semantic segmentation block using U-Net to map brain tumor boundaries	
Unit 5	**User-Defined Data Types & File Handling (6-0-10-6 = 22 hrs)**	
A	Physiological Signal Analysis: Processing ECG, EEG, and PPG waveforms. Time-domain and frequency-domain feature extraction for cardiac arrhythmia and seizure detection.	CO2, CO3, CO4, CO5, CO6
B	Explainable AI (XAI) for Clinical Safety: The "Black Box" problem in life-critical systems; Post-hoc interpretability using SHAP, LIME, and Saliency Maps / Grad-CAM for medical images.	
C	Deployment & Monitoring: Clinical decision support systems (CDSS) design; concept drift and safety monitoring post-deployment in active clinical networks.	
Tools Used	**Tools Used:** SciPy (Signal library), NeuroKit2, SHAP library, Captum (PyTorch XAI), Grad-CAM.	
Activities	**Objective:** To understand file operations, sorting algorithms, and user-defined structures, and apply them for efficient data organization and processing. Processing raw ECG waveforms to extract Heart Rate Variability (HRV) metrics; using Grad-CAM to highlight exactly which features on an X-ray a CNN used to diagnose a lesion; computing SHAP values to explain a tabular model's patient	

	readmission risk prediction to a physician.	

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/Title	UNIT	Total Lectures
DD/MM/YY	Introduction to Healthcare Informatics and Biomedical Data Ecosystem	UNIT-1	9
DD/MM/YY	Architecture and Components of Electronic Health Records (EHR)		
DD/MM/YY	Structured, Semi-Structured, and Unstructured Clinical Data		
DD/MM/YY	Longitudinal Healthcare Data and Patient Timelines		
DD/MM/YY	Healthcare Data Standards: HL7 Architecture and Messaging		
DD/MM/YY	FHIR Resources, APIs, and Healthcare Interoperability		
DD/MM/YY	Medical Coding Standards: ICD-10 and SNOMED-CT Terminologies		
DD/MM/YY	Healthcare Data Privacy, HIPAA, GDPR, and Ethical AI in Medicine		
DD/MM/YY	Hands-on: Parsing FHIR JSON and Clinical Data De-identification using Python		
DD/MM/YY	Introduction to Clinical Machine Learning and Predictive Analytics	UNIT-2	9
DD/MM/YY	Risk Stratification and Hospital Readmission Prediction Models		
DD/MM/YY	Survival Analysis in Healthcare: Kaplan-Meier Estimation		
DD/MM/YY	Cox Proportional Hazards Model for Clinical Survival Prediction		
DD/MM/YY	Missing Data Handling in EHR Systems: MICE and KNN Imputation		
DD/MM/YY	Class Imbalance Problems in Rare Disease Detection		

DD/MM/YY	SMOTE, Focal Loss, and Advanced Resampling Techniques		
DD/MM/YY	Clinical Evaluation Metrics: Sensitivity, Specificity, PPV, ROC-AUC		
DD/MM/YY	Hands-on: Building an Early Warning Sepsis Prediction Pipeline		
DD/MM/YY	Introduction to Clinical NLP and Healthcare Text Analytics		
DD/MM/YY	Characteristics of Clinical Notes, Radiology Reports, and Discharge Summaries		
DD/MM/YY	Medical Text Preprocessing and Clinical Tokenization Techniques		
DD/MM/YY	Named Entity Recognition (NER) for Symptoms, Drugs, and Anatomy		
DD/MM/YY	Rule-Based Clinical NLP using MedSpacy Framework	UNIT-3	9
DD/MM/YY	Clinical Word Embeddings and BioWord2Vec Representations		
DD/MM/YY	Transformer Architectures: BioBERT and ClinicalBERT		
DD/MM/YY	Clinical Relation Extraction and Medical Report Summarization		
DD/MM/YY	Hands-on: Fine-tuning BioBERT for Medical Text Classification		
DD/MM/YY	Introduction to Medical Imaging Modalities: X-ray, CT, MRI, Histopathology		
DD/MM/YY	DICOM Standards and Medical Image Data Handling		
DD/MM/YY	Image Preprocessing: Windowing, Hounsfield Units, and Noise Reduction		
DD/MM/YY	Fundamentals of Deep Learning for Medical Imaging		
DD/MM/YY	Convolutional Neural Networks (CNNs) for Disease Classification	UNIT-4	9
DD/MM/YY	Pneumonia Detection using Chest X-ray Classification Models		
DD/MM/YY	U-Net Architecture for Medical Image Segmentation		
DD/MM/YY	Domain Shift, Overfitting, and Multi-center Validation Challenges		
DD/MM/YY	Hands-on: Building a Brain Tumor Segmentation Pipeline using U-Net		

DD/MM/YY	Introduction to Biosignals: ECG, EEG, and PPG Fundamentals	UNIT-5	9
DD/MM/YY	Time-Domain Feature Extraction for Physiological Signals		
DD/MM/YY	Frequency-Domain Analysis using FFT and Spectral Methods		
DD/MM/YY	AI Models for Arrhythmia and Seizure Detection		
DD/MM/YY	Clinical Decision Support Systems (CDSS) and Intelligent Healthcare Systems		
DD/MM/YY	Explainable AI (XAI) in Healthcare and the Black-Box Problem		
DD/MM/YY	SHAP and LIME for Clinical Model Interpretability		
DD/MM/YY	Saliency Maps and Grad-CAM for Medical Imaging Explainability		
DD/MM/YY	Deployment Monitoring, Concept Drift, and Clinical AI Safety Validation		

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	Study of Electronic Health Records (EHR) Structure and Clinical Data Formats	**CO7**	3.0
W2	S-2	Parsing and Processing FHIR JSON Healthcare Resources using Python	**CO7**	3.0
W3	S-3	Medical Coding and Terminology Mapping using ICD-10 and SNOMED-CT	**CO7**	3.0
W4	S-4	Clinical Data Privacy and De-identification Techniques	**CO7**	3.0
W5	S-5	Missing Value Imputation in Clinical Datasets using MICE and KNN	**CO7**	3.0
W6	S-6	Handling Imbalanced Clinical Data using SMOTE	**CO7**	3.0
W7	S-7	Clinical Risk Prediction using Machine Learning Models	**CO7**	3.0

W8	S-8	Survival Analysis using Kaplan-Meier and Cox Proportional Hazards Models	**CO8/CO9**	3.0
W9	S-9	Early Warning System for Sepsis Detection	**CO8/CO10**	3.0
W10	S-10	Clinical Text Preprocessing and Medical Named Entity Recognition (NER).	**CO9/CO10**	3.0
W11	S-11	Clinical Text Classification using BioBERT/ClinicalBERT	**CO7**	3.0
W12	S-12	Clinical Relation Extraction from Pathology Reports	**CO7**	3.0
W13	S-13	Medical Image Processing using DICOM and OpenCV	**CO8**	3.0
W14	S-14	Disease Detection from Chest X-ray Images using CNN	**CO8/CO9**	3.0
W15	S-15	ECG Signal Analysis and Explainable AI for Clinical Prediction	**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	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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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																					
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.Anal-ysis	PO3 De-sign	PO4 Inves-tigation	PO5 Tool Us-age	PO6 Engi-neer & World	PO7 Ethics	PO8 Team-work	PO9 Comm.	PO10 Proj.Mgmt	PO11 Life-long
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 & Infra-**	**3 (High)**	Enables development of efficient software solutions; fosters in-

	structure		novation 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 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

★ *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

Applied AI and ML for health informatics 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 CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027–2028
Branch:	CSE	**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: **CO1 (Remember – BTL1):** Professional Communication & Computational Funda-

		mentals 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. **CO2 (Understand – BTL2): Business** Communication & Computational Concepts 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. **CO3 (Apply – BTL3):** Application Development & Professional Interaction Skills 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. **CO4 (Analyze – BTL4):** Critical Thinking, Data Structures & Workplace Problem Solving 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. **CO5 (Evaluate – BTL5):** Employability, Analytical Workflows & Solution Effectiveness Evaluate professional communication practices, resumes, networking strategies, stacks, queues, responsive design methods, and Python-based analytical workflows for improved employability and system efficiency. **CO6 (Create – BTL6):** Integrated Solution Development & Professional Content Creation 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. 2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, MIT Press, Latest Edition. 3. Jon Duckett, HTML and CSS: Design and Build Websites, Wiley Publications. 4. Wes McKinney, Python for Data Analysis, O'Reilly Publications. 5. Aruna Koneru, Professional Communication, Oxford University Press. 6. R.S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publications.
13	**References**	1. Reema Thareja, Data Structures Using C, Oxford University Press. 2. E. Balagurusamy, Programming in ANSI C, McGraw Hill. 3. Herbert Schildt, Python: The Complete Reference, McGraw Hill. 4. David Flanagan, JavaScript: The Definitive Guide, O'Reilly Publications. 5. Raymond Murphy, English Grammar in Use, Cambridge University Press. 6. Norman Lewis, Word Power Made Easy, Goyal Publishers. 7. Sanjay Kumar & Pushp Lata, Communication Skills, Oxford University Press. 8. Alex K., Soft Skills, S. Chand Publications. 9. Arun Sharma & Meenakshi Upadhyay, How to Prepare for Verbal Ability and

		Reading Comprehension, McGraw Hill. 10. 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,	CO5, CO6

	Profit & Loss	
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, com-	0.75: Complete & well-presented | 0.5: Adequate |	CO3–CO6

		munication tasks, resume/document drafting, lab/activity records, project demonstration	0.25: Partial | 0: Absent	
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, aptitude and logical reasoning basics	CO1, CO2, CO4	Communication activity, grammar/verbal ability task, HTML/CSS implementation, responsive webpage exercise, aptitude/reasoning problem-solving, or analytical interpretation task
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 structures, data preprocessing, and computational approaches	✔	✔	✔	Professional writing, presentation skills, frontend/web structuring, analytical interpretation	PO1, PO2, PO9
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	✔	—	✔	Aptitude, employability skills, analytical eval-	PO1, PO2, PO8, PO9,

	workflows, stacks, queues, and professional strategies				uation, reasoning, responsive design analysis	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

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	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 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	A1 — Receiving: Awareness, willingness to attend A2 — Responding: Active participation and reaction A3 — Valuing: Demonstrating professionalism, teamwork, and ethical conduct A4 — Organizing: Integrating professional values, collaboration, and leadership qualities A5 — Internalized professional behavior and ethical responsibility	P1 — Perception: Observing cues and identifying processes P2 — Set: Readiness for practical execution and participation P3 — Guided coding, implementation, 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

Professional Skills, Data Structures & Web Technologies
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: 2027-2028**		
Branch: CSE		**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 2. To understand the significance of problem and its scope 3. Students will make decisions within a framework		
6	Course Outcomes	Students will be able to: CO1: Identify and formulate problem statement with systematic approach. CO2: Develop teamwork and problem-solving skills, along with the ability to communicate effectively with others. CO3: Design the problem solution as per the problem statement framed. CO4: Classify and understand techniques for software verification and validation of project successfully. CO5: Fabricate and implement the solution by using different aspects of programming language. 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. References if any. The presentation, report, work done during the term supported by the documentation, forms the basis of assessment.		
	Mode of examination	**Lab**		
	Weightage 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	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	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 (CSCR2311)

School of Computing Science & Engineering (SSCSE) |B.Tech CS &ME | Semester III | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	III
Course Code:	CSCR2311	**Course Type:**	Core – Integrated

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**	CSCR2311
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. 2. Design and Implementation of Various Basic and Advanced Data Structures. 3. Learn the concepts of various searching, Sorting and Hashing Techniques. 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:** **THEORY COs — Assessed via MTE + ETE:** 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. 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. 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. 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. 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. **LAB COs — Assessed via Laboratory Assessment only:** 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. CO8 (Apply – L3): Apply linear data structures (stacks, queues, linked lists) to solve given problems and develop complete executable solutions with proper modularization. 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. 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 2. 5 small coding-based problems of 3h each. Total = 15h 3. Self-learning on-line course Total = 15h
11	**References**	Textbook: Lipschutz, “Data Structures” Schaum’s Outline Series, TMH Reference: Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein “Data Structures Using C and C++” , PHI 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. Implement programs to compute time complexity of simple algorithms using Big-O notation. Use malloc/calloc to create dynamic arrays and compare with static allocation.	

	Implement Tower of Hanoi recursively and trace tail recursion. Perform address calculation for row-major and column-major 2D arrays. Represent and manipulate sparse matrices using triplet representation. 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. Implement singly linked list with insertion, deletion, traversal, and search. Compare array implementation vs. dynamic implementation of linked lists. Implement doubly linked list and circular linked list with menu-driven programs. Represent a polynomial using linked list and perform addition of two polynomials. Detect and handle overflow/underflow conditions. 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. Implement stack using array and linked list with push/pop/peek operations. Convert infix expression to postfix using stack (handling operator precedence). Evaluate postfix expression using stack. Implement linear queue, circular queue, and priority queue using array. Implement queue using linked list to avoid overflow limitations. 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. Implement binary tree and BST with insertion, deletion, and three traversals (in-order, preorder, postorder). Implement AVL tree with rotation operations (LL, RR, LR, RL). Represent graphs using adjacency matrix and adjacency list. Implement DFS and BFS traversals on graphs. Implement Prim's and Kruskal's algorithms for MST. Apply BST for dictionary/phonebook application. 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. Implement linear search and binary search; compare their time complexities. Implement bubble sort, insertion sort, selection sort, and tree sort. Count and compare number of comparisons/swaps for each sorting algorithm on different input sizes. Design a hash function (e.g., division method, mid-square) for integer/string keys. Implement collision resolution using chaining (linked list) and open addressing (linear probing, quadratic probing). Create a complete dictionary application using hashing. 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	
		Unit 2	

DD/MM/YY	Matrix Operations (Addition, Multiplication, Transpose), Sparse Matrices – Triplet Representation		
DD/MM/YY	Concept of Linked List – Advantages over Arrays, Garbage Collection, Overflow/Underflow		
DD/MM/YY	Singly Linked List – Array Implementation vs Dynamic Implementation	Unit 2 Unit 2 Unit 2 Unit 2 Unit 2 Unit 3 Unit 3 Unit 3	**8**
DD/MM/YY	Singly Linked List Operations: Insertion (Beginning, End, Position), Deletion, Traversal, Search		
DD/MM/YY	Doubly Linked List – Dynamic Implementation, Operations (Insert, Delete, Traverse)		
DD/MM/YY	Circularly Linked List – Dynamic Implementation, Operations, Applications		
DD/MM/YY	Polynomial Representation Using Linked List, Polynomial Addition		
DD/MM/YY	Stack: Definition, Primitive Operations (Push, Pop, Peek), Array Implementation		
DD/MM/YY	Stack: Linked List Implementation, Applications – Reversal, Palindrome Checking		
DD/MM/YY	Stack Application: Infix to Postfix Conversion – Algorithm and Examples		
DD/MM/YY	Stack Application: Evaluation of Postfix Expression	Unit 3 Unit 3 Unit 3 Unit 3 Unit 3 Unit 3	**6**
DD/MM/YY	Queue: Definition, Primitive Operations (Enqueue, Dequeue), Array Implementation		
DD/MM/YY	Circular Queue – Need, Implementation, Overflow/Underflow Conditions		
DD/MM/YY	Priority Queue – Types (Ascending/Descending), Array Implementation		
DD/MM/YY	Deque (Double Ended Queue) – Input Restricted, Output Restricted, Applications		
DD/MM/YY	Linked Queue – Implementation Using Linked List, Comparison with Array Queue		
DD/MM/YY	Queue Applications – Job Scheduling, CPU Scheduling Simulation	Unit 3 Unit 4 Unit 4 Unit 4 Unit 4 Unit 4	**6**
DD/MM/YY	Tree: Terminologies (Root, Parent, Child, Leaf, Depth, Height), Binary Tree – Properties		
DD/MM/YY	Binary Tree Representation – Array Representation, Linked Representation		
DD/MM/YY	Binary Tree Traversals – Inorder, Preorder, Postorder (Recursive and Iterative)		
DD/MM/YY	Binary Search Tree (BST) – Definition, Operations: Insertion, Deletion, Searching		
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, de-	CO4	L4

		tect bugs in BST/AVL operations, analyze collision resolution performance, compare DFS vs BFS traversal paths		
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 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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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

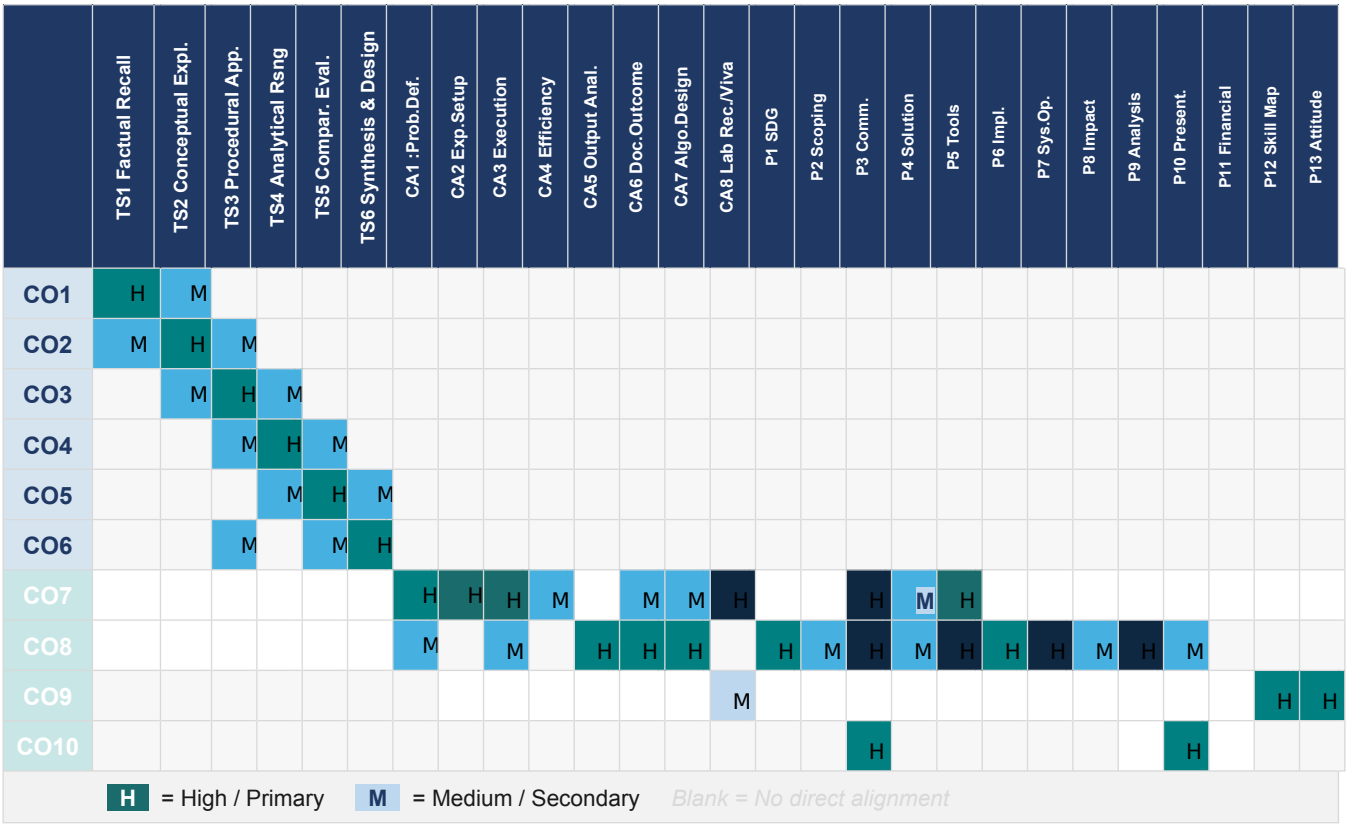
14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

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



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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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 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 pat-

		terns

★ *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 Structures 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 III	Credits 22
Course Code	Course Name
CSCR2310	Computer Networks
MTT1217	Mathematics – II
CSCR2312	Principles of Operating System
CSME2300	Applied AI and ML for health informatics
SKP2301	Professional Skills, Data Structures & Web Technologies

CSCR2600	Project Based Learning (PBL) -1 (Mini-Hackathon Based)
CSCR2311	Data Structure

COURSE PLAN

Data Base Management System (CSCR2314)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	IV
Course Code:	CSCR2314	**Course Type:**	Core – Integrated

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**	CSCR2314
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:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Remember – L1): Explain the basics concepts of data base. 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. CO4 (Analyze – L4): Apply normalization techniques to reduce redundancy from the database. CO5 (Evaluate – L5): To appraise the basic issues of Transaction processing, Serializability& concurrency control. CO6 (Create – L6): Design & develop database for real life problems. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Understand – L2): Understand and apply SQL commands for database creation, retrieval, and manipulation. CO8 (Apply – L3): Create and execute SQL queries using SELECT statements, filtering, grouping, and reporting functions. CO9 (Apply – L3): Perform database operations using DML commands such as INSERT, UPDATE, and DELETE to manage data effectively. 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. Reference: Elmasri, Navathe, Fundamentals of Database Systems, Pearson Education Inc. 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. • 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. • Identify functional dependencies and different anomalies (insertion, deletion, updation) in given database tables. • Perform decomposition of relations and verify lossless join and dependency preservation properties. • Normalize database relations from 1NF to BCNF and 4NF using suitable examples. • Analyze multivalued dependencies and inclusion dependencies in relational schemas. • 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. • Simulate transaction schedules and test for serializability using conflict and view serializability methods. • Analyze recoverable and non-recoverable schedules with suitable examples. • Perform concurrency control experiments using simultaneous transactions in SQL. • Implement transaction control commands such as COMMIT, ROLLBACK, and SAVEPOINT. • Demonstrate deadlock situations and apply deadlock prevention and recovery techniques. • 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. • Simulate Two-Phase Locking (2PL) protocols for concurrent transactions. • Implement timestamp ordering protocols and analyze transaction execution order. • Perform experiments on optimistic concurrency control and validation tech-	

	niques. • Demonstrate Multi-version Concurrency Control (MVCC) using database transactions. • 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**	
W5	S-5.1	Remove tables using DROP TABLE	**CO7**	3.0
	S-5.2	Apply PRIMARY KEY and FOREIGN KEY constraints	**CO8**	
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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 P11 — Financial feasibility and cost estimation	1.5: Detailed | 1.0: Adequate | 0.5: Basic | 0: Absent	CO10 / PO10
End-to-End Implementation	2.0	P5 — Professional toolchain selection	2: Fully operational |	CO7, CO8 /

& System Operation		P6 — Complete project build and integration P7 — System commissioning and operational testing	1–1.5: Partial | 0–0.5: Non-functional	PO3, PO5
Impact Assessment & Critical Reporting	2.0	P8 — Measurable outcome vs stated goals 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 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) 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**	Propose solution with alternatives; justify selection using design	CO8 | PO3

	Proposal	criteria	
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
CO7		H	H				M	H	H		M	M	M	H			M		H	H	M					M	M
CO8		M	H	M			M	M	H	M	H	M	M	H				M	H	H	M		M			M	M
CO9			H	M			M	M	H	M	H	M		H				M	H	H	M		M			M	M

CO10			M	M	H	H	H	H	H	H	H	H	H	H	M	H	H	H	H	H	H	H	H	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	–	–	–	–	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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
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 & Infra-structure	3 (High)	Enables development of efficient software solutions; fosters innova-tion through real-world application design (CO6, CO8) and team-based projects (CO10).
SDG 12	Responsible Consumption & Production	2 (Mod-erate)	Promotes efficient, optimized coding; encourages ethical coding and responsible use of computational resources (CO9, CO7).

18. Bloom's Taxonomy — Domain Level Referenc

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 mo-tor activity P2 — Set: Mental, physical readiness to act P3 — Guided Response: Basic practice through imitation P4 — Mechanism: Habitual correct perfor-mance P5 — Complex Overt Response: Skilled performance P6 — Adaptation: Modify skills for special situations P7 — Origination: Create new solution pat-terns

★ *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

DBMS 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 (CSCR2115)

School of Engineering & Technology (SET) | B.Tech CS & ME | 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:	SET — School of Engineering & Technology	**Batch:**	2026-2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS &ME	**Semester:**	IV
Course Code:	CSCR2115	**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**	CSCR2115
2	**Course Title**	**Theory of Computation**
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. To develop a strong foundation in the principles of automata theory, formal languages, and computational models. 2. To enable students to design and analyze finite automata, pushdown automata, and Turing machines for computational problem solving. 3. To provide understanding of regular expressions, grammars, language representation, and their applications in computation. 4. To familiarize students with the concepts of computability, decidability, and complexity in the Theory of Computation.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Understand – L1/L2): Understand the fundamental concepts of automata theory, formal languages, and related computational models. CO2 (Apply – L2/L3): Design and construct DFA, NDFA, and perform conversion from NDFA to DFA for language recognition problems. CO3 (Apply – L3): Construct finite automata with and without output, and analyze their applications in computational systems. CO4 (Analyze – L3/L4): Implement regular expressions and grammars corresponding to finite automata and analyze their equivalence. CO5 (Apply – L3/L4): Design Pushdown Automata (PDA) from Context Free Languages (CFL) and grammars, and perform interconversion between them. CO6 (Analyze – L4/L5): Design Turing Machines for computational problems and develop an understanding of computability, decidability, and undecidability concepts.
8	**Course Description**	The course introduces some fundamental concepts in automata theory and formal languages including grammar, finite automaton, regular expression, formal language, pushdown automaton, and Turing machine. Not only do they form basic models of computation, they are also the foundation of many branches of computer science, e.g. compilers, software engineering, concurrent systems, etc. The properties of these models will be studied and various rigorous techniques for analyzing and comparing them will be discussed, by using both formalism and examples.
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**	K.L.P. Mishra and N.Chandrasekaran, "Theory of Computer Science(Automata, Languages and Computation)", PHI

12	**References**	1.Peter Linz, "Formal Languages and Auomata", Narosa Publishing House 2.Hopcroft, Ullman, "Introduction to Automata Theory, Language and Computation", Narosa Publishing House

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**	
A	Introduction to languages, Kleene closures, Finite Automata (FA), Transition graph, Nondeterministic finite Automata (NFA), Deterministic finite Automata (DFA).	CO1, CO2
B	Equivalence of NDFA and DFA, Construction of DFA from NFA and optimization of Finite Automata.	CO1, CO2
C	Applications and Limitation of FA. (FAT tool).	CO1, CO2
Unit 2	**Regular Expression and Finite Automata**	
A	Regular Expression, Finite Automata with null move, Regular Expression to Finite Automata.	CO1, CO2,CO4
B	Arden Theorem, Pumping Lemma for regular expressions.	CO1, CO2,CO4
C	FA with output: Moore machine, Mealy machine and Equivalence.	CO1, CO2,CO3
Unit 3	**REGULAR & CONTEXT FREE LANGUAGE**	
A	Defining grammar, Chomsky hierarchy of Languages and Grammar. Ambiguous to Unambiguous CFG.	CO3, CO4
B	Simplification of CFGs.	CO3, CO4
C	Normal forms for CFGs, Pumping lemma for CFLs.	CO3, CO4
Unit 4	**PUSH DOWN AUTOMATA**	
A	Description and definition of PDA and Non-Deterministic PDA, Working of PDA.	CO1, CO3, CO5
B	Acceptance of a string by PDA with final state and with Null store. Two stack PDA.	CO1, CO3, CO5
C	Conversion of PDA into CFG, Conversion of CFG into PDA.	CO1, CO3, CO5
Unit 5	**TURING MACHINE**	
A	Turing machines (TM): Basic model, definition and representation, Language acceptance by TM.	CO6, CO1
B	Turing machine as a computational machine, Halting problem of TM, Universal TM (Visual Turing machine).	CO6, CO1
C	Modifications in TM, Undecidability of Post correspondence problem, Church's Thesis, Godel Numbering.	CO6, CO1

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 Output based FA and Regular Expressions 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 and CO4 (regular Expressions). Affective (A3) for CO4,CO5 and CO6 (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	Symbol, Alphabets, Strings	UNIT-1	9
DD/MM/YY	Introduction to languages, Kleene closures		
DD/MM/YY	Introduction to languages, Kleene closures		
DD/MM/YY	Finite Automata (FA), Transition graph		
DD/MM/YY	Deterministic finite Automata (DFA)		
DD/MM/YY	Minimisation Of DFA		
DD/MM/YY	Nondeterministic finite Automata (NFA)		
DD/MM/YY	Equivalence of NDFA and DFA		
DD/MM/YY	Construction of DFA from NFA and optimization of Finite Automata		
DD/MM/YY	Regular Expression	UNIT-2	9
DD/MM/YY	Finite Automata with null move		
DD/MM/YY	Finite Automata		
DD/MM/YY	Regular Expression to Finite Automata.		
DD/MM/YY	Regular Expression to Finite Automata.		
DD/MM/YY	Arden Theorem		
DD/MM/YY	Pumping Lemma for regular expressions.		
DD/MM/YY	FA with output: Moore machine		
DD/MM/YY	Mealy machine and Equivalence		
DD/MM/YY	Defining grammar	UNIT-3	9
DD/MM/YY	Chomsky hierarchy of Languages and Grammar.		
DD/MM/YY	Chomsky hierarchy		
DD/MM/YY	Ambiguous to Unambiguous CFG.		
DD/MM/YY	Ambiguous to Unambiguous CFG.		
DD/MM/YY	Simplification of CFGs.		
DD/MM/YY	Simplification		
DD/MM/YY	Normal forms for CFGs		
DD/MM/YY	Pumping lemma for CFLs.		
DD/MM/YY	Definition of PDA, Working of PDA.	UNIT-4	9
DD/MM/YY	Description of Non-Deterministic PDA		
DD/MM/YY	Description of Non-Deterministic PDA		
DD/MM/YY	Acceptance of a string by PDA with final state and with Null store		
DD/MM/YY	Two stack PDA.		
DD/MM/YY	Conversion of PDA into CFG		

DD/MM/YY	Conversion of CFG into PDA.		
DD/MM/YY	Conversion of CFG into PDA.		
DD/MM/YY	Language acceptance by TM.		
DD/MM/YY	Turing machine as a computational machine	UNIT-5	9
DD/MM/YY	Turing machine as a computational machine		
DD/MM/YY	Halting problem of TM		
DD/MM/YY	Halting problem of TM		
DD/MM/YY	Universal TM (Visual Turing machine).		
DD/MM/YY	Universal TM (Visual Turing machine).		
DD/MM/YY	Undecidability of Post correspondence problem		
DD/MM/YY	Undecidability of Post correspondence problem		
DD/MM/YY	Church's Thesi9		

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
ID	**Dimension**	**What is Measured**	**CO / BTL**	**Assessment**
TS1	Conceptual Understanding of Automata & Formal Languages	Understand fundamental concepts of automata theory, formal languages, symbols, strings, alphabets, and language classifications; identify computational models for given problems	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	Finite Automata Design & Interpretation	Design and analyze DFA and NDFA models; perform conversion from NDFA to DFA; interpret state transitions and language acceptance	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	Automata Construction & Applications	Construct finite automata with and without outputs; apply automata concepts to pattern matching and computational applications	CO3 | L3	CA | MTE Sec B | ETE Sec B

TS4	Regular Expressions & Grammar Analysis	Analyze and implement regular expressions and grammars corresponding to finite automata; evaluate equivalence among representations	CO4 | L3–L4	MTE Sec B | ETE Sec B
TS5	Pushdown Automata & Context Free Language Evaluation	Design Pushdown Automata (PDA) from Context Free Grammars (CFG) and CFLs; analyze parsing and stack-based computation mechanisms	CO5 | L3–L4	ETE Sec B/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

[Type here]

Item	Topic / Focus	COs	TS Dims	SL Hours	Evaluation Criteria
Assignment 1	Introduction to automata, alphabets, strings, languages, and finite automata concepts	CO1	TS1	5h SL	Conceptual understanding + problem solving
Assignment 2	DFA and NDFA design, state transition diagrams, and NDFA to DFA conversion	CO2	TS2	5h SL	Automata construction + conversion accuracy
Assignment 3	Finite automata with output (Moore and Mealy Machines) and applications	CO2, CO3	TS2, TS3	5h SL	State machine implementation + analysis
Assignment 4	Regular expressions, regular grammars, and equivalence with finite automata	CO3, CO4	TS3, TS4	5h SL	Expression design + grammar conversion
Assignment 5	Context Free Grammar (CFG), Pushdown Automata (PDA), and CFL applications	CO4, CO5	TS4, TS5	5h SL	PDA design + grammar analysis
Assignment 6	Turing Machines, decidability, computability, and undecidable problems	CO5, CO6	TS5, TS6	5h SL	Computational analysis + TM design
Video Learning Report	Technical video on automata theory, CFG/PDA, or Turing Machines (minimum 3 hours); structured report + presentation	CO2, CO4	TS2, TS4	9h SL	Concept clarity, report quality, presentation
Case Study Report	Real-world applications of Theory of Computation such as compiler design, lexical analysis, pattern matching, NLP, and AI parsing	CO4, CO5, CO6	TS4, TS5, TS6	6h SL	Technical depth, comparative analysis, application understanding

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 Understanding of Automata & Formal Languages TS2 — Finite Automata Design & Interpretation	CO1, CO2	Short-answer questions: define automata concepts, explain formal languages, identify DFA/NDFA properties, perform simple state transitions and conversions
Section B	15	TS3 — Automata Construction & Applications TS4 — Regular Expressions & Grammar Analysis	CO2, CO3, CO4	Problem-solving and analytical questions: construct automata, convert regular expressions and grammars, analyze automata equivalence, implement Moore/Mealy machines

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 — Regular Expressions	**CO1, CO2**	Short questions (all units): definitions, regular expressions, PDA, TM
Section B	**25**	TS3 — Algorithmic Application TS4 — Performance Evaluation TS5 — Analysis	**CO3, CO4, CO5**	Medium questions: Converting reular expressions to PDA, Constructing PDA, Constructing Turing machines
Section C	**10**	TS5 —Psuhdown Automata TS6 — Turing Machine	**CO5, CO6**	Long/evaluation questions: Modifications of TM, Languages accepted by PDA and TM, Applications
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	Formulate the concept of Automata and related terminology.	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Design DFA and NDFA and conversion from NDFA to DFA.	✔	✔	✔	TS2	PO1, PO3, PO4
CO3	Construct finite automata without output and with output.	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Implement regular expression and grammar corresponding to DFA and vice-versa	✔	✔	✔	TS4	PO9, PO10, PO11
CO5	Design Push down Automata from Context Free Language or Grammar and vice-versa.	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Design Turing Machine for computational problems, Develop a clear understanding of un-decidability.	✔	—	✔	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	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	–	–	–	2	3	2	2	2	2	2	2
CO2	3	2	3	3	–	–	–	2	2	2	2	2	2	2	3
CO3	3	3	3	3	–	–	–	3	2	2	3	2	3	2	2
CO4	2	3	2	2	2	–	–	2	3	3	2	2	3	2	2
CO5	2	2	3	–	–	–	–	3	3	2	2	–	3	–	–
CO6	3	2	-	–	-	–	–	–	–	2	3	–	3	3	–
Avg	**2.67**	**2.50**	**2.80**	**2.75**	**1.00**	**–**	**–**	**2.40**	**2.60**	**2.14**	**2.33**	**2.00**	**2.66**	**2.20**	**2.25**

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	H	H				M	H	M	M	M	M	M	M
CO2	H	M	H	H				M	M	M	M	M	M	M	H
CO3	H	H	H	H				H	M	M	H	M	H	M	M
CO4	M	H	M	M	M			M	H	H	M	M	H	M	M
CO5	M	M	H					H	H	M	M		H		
CO6	H	M								M	H		H	H	

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, problem-based, one per unit focus area)	5 assignments × 3 hrs each 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., PDA, TM)	Video viewing: 3 hrs Report preparation: 3 hrs Presentation: 3 hrs 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., Regular Expressions and PDA)	Data collection/study: 4 hrs Report preparation: 2 hrs 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 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 (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

Conditio	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

TOC — 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

Introduction to Cloud Computing (CSCR2117)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	IV
Course Code:	CSCR2117	**Course Type:**	Core – Integrated Only

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**	CSCR2117
2	**Course Title**	Introduction to Cloud Computing
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-2
5	**Course Status**	Minor Elective
6	**Course Outcomes (COs)**	After successful completion of this course, the student will be able to: **THEORY COs — Assessed via MTE + ETE:**

		CO1 (Remember – L1): Define key concepts of cloud computing, service models, deployment models, and cloud architecture. CO2 (Understand – L2): Explain virtualization, cloud infrastructure components, storage systems, and resource management techniques. CO3 (Apply – L3): Use cloud tools, platforms, and serverless computing models to build basic cloud-based applications. CO4 (Analyze – L4): Compare traditional databases with cloud-native databases and analyze the architecture and features of Amazon RDS. CO5 (Evaluate – L5): Assess RDS performance, security, and scalability using monitoring, logging, and optimization strategies. CO6 (Create – L6): Design and implement a scalable cloud-based solution integrating RDS for AI/ML workflows. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Implement cloud labs using professional tools (AWS, VirtualBox, CloudSim, Hadoop); configure environments; demonstrate operations; maintain lab records. CO8 (Create – L5/L6): Design and develop real-world cloud solutions addressing societal problems; evaluate outcomes analytically with SDG alignment. CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible cloud practices; perform skill self-assessment; reflect on lifelong professional growth. 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. 2. NPTEL/SWAYAM: Cloud Computing course. 3. MOOC: AWS Cloud Practitioner Essentials (Coursera/edX).
10	**References**	**Textbooks:** 1. Rajkumar Buyya, Thamarai Selvi, Christian Vecchiola – Mastering Cloud Computing, McGraw Hill. 2. AWS Official Documentation – Amazon RDS Developer Guide. 3. Thomas Erl – Cloud Computing: Concepts, Technology & Architecture, Pearson. **References:** 1. Ben Piper & David Clinton – AWS Certified Solutions Architect Study Guide, Wiley. 2. Michael J. Kavis – Architecting the Cloud, Wiley. 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	9
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	9
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	9
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	9
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	9
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 setup CA7 — Solution plan / flowchart	1.0: Well-defined with design | 0.5: Partial | 0: Missing	CO7, CO8
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

Introduction to Cloud Computing — 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

System Design SI (Case Study Based) (CSAI2001)

School of Engineering & Technology (SET) | B.Tech CS &ME | 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:	SET — School of Engineering & Technology	**Batch:**	2026-2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	IV
Course Code:	CSAI2001	**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**	CSAI2001
2	**Course Title**	**System Design SI (Case Study Based)**
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 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: CO1: Assess the existing software systems to understand their architecture, design choices, and scalability. CO2: Outline complex systems to extract high-level design and functional

		requirements. CO3: Apply system design principles, design patterns, and architectural decisions to improve or optimize existing systems. CO4: Examine trade-offs in various design decisions regarding performance, security, and maintainability. CO5: Determine alternative system designs through modeling tools and industry frameworks. CO6: Formulate real-world system case studies to propose scalable, 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. 2. Sam Newman, Building Microservices: Designing Fine-Grained Sys-tems, O'Reilly Media, 2021. 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. 2. Gaurav Sen, System Design Interview – An Insider'Guide, Self-Published, 2022. 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 Responsibility Segregation), Dependency Injection	**CO3, CO4**
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;	UNIT-1	9
DD/MM/YY	Introduction to Reverse Engineering		
DD/MM/YY	Role of System Decomposition in Software Architecture		
DD/MM/YY	Role of System Decomposition in Software Architecture		
DD/MM/YY	Role of System Decomposition in Software Architecture		
DD/MM/YY	Design Documentation Analysis and Reverse Engineering Techniques		
DD/MM/YY	Design Documentation Analysis and Reverse Engineering Techniques		
DD/MM/YY	UML Modeling;		
DD/MM/YY	Case Study: Reverse Engineering a Monolithic Web Application		
DD/MM/YY	Microservices vs. Monoliths; Load Balancing Concepts	UNIT-2	9
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	Database Sharding and Distributed Data Management		
DD/MM/YY	CAP Theorem and Eventual Consistency Concepts		
DD/MM/YY	CAP Theorem and Eventual Consistency Concepts		

DD/MM/YY	Case Study: Reverse Engineering Twitter's System Architecture		
DD/MM/YY	Case Study: Reverse Engineering Twitter's System Architecture		
DD/MM/YY	MVC (Model-View-Controller) and Layered Architecture	UNIT-3	9
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	Comparative Analysis of Design Patterns and Architectural Styles		
DD/MM/YY	Performance Bottlenecks in Large-Scale Systems	UNIT-4	9
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	Caching Strategies and Performance Enhancement		
DD/MM/YY	Failover Mechanisms and High Availability Systems		
DD/MM/YY	Failover Mechanisms and High Availability Systems		
DD/MM/YY	Case Study: Reverse Engineering Payment Systems like PayPal/Stripe		
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	9
DD/MM/YY	Improving System Scalability		
DD/MM/YY	Resource Utilization		
DD/MM/YY	Case Study: Optimizing the Uber System for Global Scalability		
DD/MM/YY	Case Study: Optimizing the Uber System for Global Scalability		
DD/MM/YY	Reverse Engineering		
DD/MM/YY	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
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	2.83	2.67	1.83	1.83	2.33	2.33	2	3	3	2.83

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		

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,	Data Collection / Study: 4 hrs Report Prepara-	CO4, CO5, CO6 TS4,	Evaluated based on technical depth, architecture evaluation, scalability analysis, fact finding, redesign sugges-

	PayPal/Stripe systems)	tion: 2 hrs Total = 6 hrs	TS5, TS6	tions, 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 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 (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

System Design — 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

Foundations of Ethical Hacking (CSAI2002)

School of Engineering & Technology (SET) | B.Tech CS & ME | 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:	School of Engineering & Technology (SET)	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	IV
Course Code:	CSAI2002	**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**	CSAI2002
2	**Course Title**	**Foundations of 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.
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**	Classroom Instructions (CI): 45 hrs | Self Learning (SL): 45 hrs | Total: 90 hrs

S.No	Attribute	Details
	Scheme	
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)	
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 Under-stand	L3 Apply	L4 Analyze	L5 Eval-uate	L6 Create
1	1.A – Security Fundamen-tals, 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 Ma-chines		✔	✔			
5	2.B – Open Ports, OS Fin-gerprinting, Network Attack Surface		✔	✔			
6	2.C – Enumeration, System Hacking		✔	✔	✔		
7	3.A – Viruses, Worms, Tro-jans, Covert Communication		✔	✔			
8	3.B – Keystroke Logging, Spyware, Malware Counter-measures		✔	✔	✔		
9	3.C – Sniffers, Session Hi-jacking, DoS/DDoS			✔	✔	✔	
10	4.A – Web Server Hacking, Web Application Hacking			✔	✔		
11	4.B – Database Hacking			✔	✔	✔	
12	4.C – Wireless Technolo-gies, Mobile Security, Wire-less LANs		✔	✔	✔		
13	5.A – IDS, Firewalls, Hon-eypots		✔			✔	
14	5.B – Physical Security, So-cial Engineering			✔		✔	✔
15	5.C – Case Studies in Eth-ical 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		✔	✔						✔									
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 (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		
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		

Date	Topics to be Covered	UNIT	Total Lectures
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		
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

ID	Dimension	What is Measured	CO / BTL	Assessment
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 /	Assessment 1 (10	**15**	CO1, CO2, CO3, CO4,	TS1, TS2, TS3, TS4,

Component	Quantum	Marks	COs Assessed	Skill Dimensions
Application-based)	Marks) + Assessment 2 (5 Marks)		CO5	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

S.No	Activity	Hours	COs / TS	Evaluation Criteria
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 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–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

Foundations of Ethical Hacking

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 — SET | Theory-Only Course: CA 25 + MTE 15 + ETE 60 = 100 | 6 Theory Skill Dimensions TS1–TS6

COURSE PLAN

Information Security (CSAI2003)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028

Branch:	CS & ME	Semester:	IV
Course Code:	CSAI2003	Course Type:	Elective – Integrated Only

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**	CSAI2003
2	**Course Title**	**Information security**
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:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Remember – L1): Recall the fundamental concepts of information security, threats, cryptography, authentication, and network security. CO2 (Understand – L2): Explain security mechanisms, access control models, operating system security, and intrusion detection techniques. 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.. CO5 (Evaluate – L5): Evaluate security policies, privacy laws, access control strategies, and intrusion prevention mechanisms for organizational security CO6 (Create – L6): Design secure information systems using authentication, access control, cryptographic, and network security principles. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): CO8 (Create – L5/L6): CO9 (Apply – L2/L3): 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) 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 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 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:** • .Understand the fundamental concepts of information security and cybersecurity threats. • Identify malware, phishing, social engineering attacks, and security vulnerabilities. • 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:** • Understand the principles of cryptography, steganography, and cryptanalysis for securing information. • Analyze classical encryption techniques, block ciphers, and stream ciphers used in data protection. • 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:** • Understand the fundamentals of network security, network attacks, and the goals of securing communication systems. • Identify and evaluate network security mechanisms such as Firewalls, IDS, IPS, VPNs, and secure email protocols. • 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:** • Understand the concepts of identification, authentication, access control, and their role in information security. • Identify authentication mechanisms such as MFA, biometrics, tokens, smart cards, and Single Sign-On (SSO). • 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:** • 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. • 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 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)

[Type here]

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	CO7	3.0

		system clock work together to change the token every 30 seconds, even when the phone is offline.		
W12	S-12.1	Use a tool like ExifTool or an offline metadata viewer to inspect a photograph taken by a smartphone	**CO7**	3.0
W13	S-13.1	Use command-line search filters like grep with regular expressions to scan a local system 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 Se-	Apply network security mechanisms such as firewalls,	CO3 | L3	MTE Sec B |

	curity Implementation	IDS/IPS, VPNs, SSL/TLS, and secure email protocols to solve practical security problems and communication threats		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 TS2 — Cryptography & Data Protection Concepts	CO1, CO2	Short-answer: definitions.
Sec B	6	TS3 — Network & Email Security Implementation 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 TS2 — Cryptography & Data Protection Concepts	CO1, CO2	Short questions: definitions.
Sec B	50	TS3 — Network & Email Security TS4 — Authentication & Access Control Analysis TS5 — Privacy, Compliance & Security Evaluation	CO3, CO4, CO5	Medium questions: Comparison, Tools and Techniques
Sec C	25	TS5 — Privacy, Compliance & Security Evaluation TS6 — Integrated Security Design & Case Study Synthesis	CO5, CO6	Long/design questions: Applications, working principles/
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 CA2 — Investigation planning, tool/environment selection CA7 — Methodology, workflow, attack/defense analysis plan	1.0: Well-defined with design | 0.5: Partial | 0: Missing	CO7, CO8
Code Execution & Computational Efficiency	1.0	CA3 — Correct execution of scanning/sniffing/auditing/crypto tasks 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 CA6 — Evidence validation, screenshots, observations and conclusion	0.75: Thorough | 0.5: Adequate | 0.25: Partial | 0: Absent	CO8, CO9

		documentation		
Professional Attitude & Ethical Conduct	0.25	CA6 — Structured report, screen-shots, references, conclusion CA8 — Viva-voce understanding and communication 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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	TS3 Procedural	TS4 Analytical	TS5 Compar. Eval.	TS6 Synthesis &	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	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 Inves-tigation	PO5 Tool Usage	PO6 En-gineer & 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 & Infra-structure	3 (High)	Enables development of efficient software solutions; fosters innova-tion through real-world application design (CO6, CO8) and team-based projects (CO10).
SDG 12	Responsible Consumption & Production	2 (Mod-erate)	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 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

★ *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

IS 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
Integrated Professional Communication and Intelligent Computing

School of Computing Science and Engineering (SSCSE) | B.Tech CS&ME | Semester - IV | Batch 2026-2030 / Lab-Only Course Plan — 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:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**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: **CO1 (Remember – BTL1): Communication & Computing Fundamentals** Recall the fundamental concepts of professional communication, workplace readiness, machine learning, advanced data structures, and modern frontend development technologies. **CO2 (Understand – BTL2): Business Communication & Technical Workflows** Explain the principles of business communication, interpersonal effectiveness, machine learning workflows, data structure operations, JavaScript programming, and asynchronous processing techniques. **CO3 (Apply – BTL3): Professional Interaction & Computational Problem Solving** 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. **CO4 (Analyze – BTL4): Critical Thinking, LSRW & System Analysis** Analyze workplace scenarios, verbal communication, machine learning models, graph algorithms, and advanced computational structures using critical thinking and structured analytical approaches. **CO5 (Evaluate – BTL5): Decision Making & Technology Evaluation** Evaluate communication strategies, logical reasoning methods, machine learning algorithms, data structures, and frontend development approaches for effective and scalable solutions. **CO6 (Create – BTL6): Industry-Oriented Communication & Application Development** 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 1. Business Communication Today – Bovee, Courtland L. & Thill, John V.A comprehensive resource covering professional communication, business interaction, presentations, workplace communication, and interpersonal effectiveness. 2. Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow – Aurélien Géron Covers machine learning fundamentals, regression, classification, and practical implementation using modern ML frameworks. 3. Data Structures and Algorithms Made Easy – Narasimha Karumanchi Provides strong conceptual and practical understanding of trees, heaps, hashing, graphs, and algorithmic problem solving. 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. 5.Quantitative Aptitude for Competitive Examinations & A Modern Approach to Verbal & Non-Verbal Reasoning – R.S. Aggarwal Covers quantitative aptitude, logical reasoning, analytical thinking, verbal ability, and placement-oriented problem-solving techniques.
13	**References**	1. *Communication Skills* – Sanjay Kumar & Pushp Lata Widely used in Indian universities; covers LSRW skills, interpersonal communication, presentation techniques, and professional communication. 2. *Soft Skills* – Alex K. Focuses on personality development, leadership communication, employability skills, workplace etiquette, and professional behavior. 3. *English Grammar in Use* – Raymond Murphy Useful for grammar improvement, sentence correction, language accuracy, and verbal ability enhancement. 4. *Word Power Made Easy* – Norman Lewis Highly effective for vocabulary building, speaking fluency, and verbal communication development. 5. *Cracking the Coding Interview & Placement Aptitude* – Various Authors Useful for company-specific aptitude preparation, logical reasoning, and placement-oriented analytical thinking. 6. Online Resources: • British Council Learning English – Grammar, listening, speaking, and workplace communication practice • Toastmasters International – Public speaking and leadership communication frameworks • EFSET & Speak and Improve Tools – LSRW assessment and speaking practice • Overleaf Resume Tools – ATS-based resume building and formatting • Newspaper editorials (*The Hindu* / *Indian Express*) for reading comprehension, vocabulary, and critical thinking practice 7. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning. 8. Kyle Simpson, You Don't Know JS Series. 9. Reema Thareja, Data Structures Using C. 10. David Flanagan, JavaScript: The Definitive Guide. 11. Ian Goodfellow, Deep Learning. 12. NPTEL – Machine Learning and Data Structures Courses. 13. MDN Web Docs – JavaScript and DOM. 14. LeetCode – Trees, BST, Heap, Graph and Hashing Problems. 15. Kaggle Learn – Machine Learning. 16. GeeksforGeeks – DSA and JavaScript. 17. JavaScript.info. 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. BST Validation, Successor, Predecessor, Floor and Ceiling Operations.	**CO4**
H	AVL Tree Concepts, Rotation Operations and Height Balance Factor. 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, MBTI Personality Assessment	**CO3**

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. 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. 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)***	
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	**CO6**

	Fill Algorithms	

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 execution, debugging, tool usage	1.00: Correct and successfully executed | 0.50: Minor logical/syntax issues | 0: Not working/Incomplete	CO1–CO5

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 Usage, Communication & Practical Execution	CO1, CO2, CO3	Practical implementation task involving Data Structures, Machine 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 workflows and programming concepts	✔	✔	✔	Communication Skills, Programming Logic, Analytical Understanding	PO1, PO2,PO9

CO3	Apply communication strategies, DSA techniques, APIs and front-tend 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 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.	**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 structured workflows. **A5 — Characterizing:** Consistent display of professionalism, communication confidence, ethical conduct, technical competency and industry readiness.	**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 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, presentation reports and project/activity submissions	Incomplete documentation may reduce CA/CE evaluation marks
Professional Participation	Active Involvement	Team discussions, viva voce, collaborative activities, communication exercises and project demonstra-	Lack of participation may affect professionalism, communication and activity-based evaluation com-

		tions	ponents

⚠ *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.

Integrated Professional Communication and Intelligent Computing — 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

Clinical Data Analytics (CSME2301)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | IV 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2027-2028
Branch:	CS & ME	**Semester:**	IV
Course Code:	CSME2301	**Course Type:**	Core – Integrated

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**	CSME2301
2	**Course Title**	**Clinical Data Analytics**
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-3-4
5	**Course Status**	Core
6	**Course Objective**	1. Introduce the fundamentals of healthcare informatics, clinical data analytics, and healthcare data management systems.

		2. Develop understanding of clinical data collection, preprocessing, feature selection, healthcare standards, and database management techniques. 3. Enable the application of statistical analysis, data visualization, and exploratory data analysis techniques for healthcare datasets. 4. Provide knowledge of machine learning techniques and predictive analytics methods for disease prediction and healthcare decision support systems. 5. Familiarize students with advanced healthcare technologies, ethical issues, data privacy, security regulations, and future trends in clinical data analytics.
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Understand – L1/L2): Understand the fundamentals of healthcare informatics, clinical data analytics, healthcare data types, and healthcare applications. CO2 (Explore – L2/L3): Explore clinical data collection, preprocessing methods, feature selection techniques, healthcare standards, and healthcare databases. CO3 (Apply – L3): Apply statistical analysis, data visualization, and exploratory data analysis techniques using healthcare datasets and analytical tools. CO4 (Apply/Analyze – L3/L4): Apply machine learning techniques and predictive models for healthcare analytics and disease prediction. CO5 (Analyze/Evaluate – L4/L5): Analyze advanced healthcare technologies including AI, IoT, medical image analytics, and NLP applications in healthcare systems. CO6 (Analyze/Evaluate – L4/L5): Evaluate ethical, privacy, security, and future challenges in clinical data analytics and healthcare informatics systems. CO8 (Apply/Analyze – L3/L4): Perform statistical analysis, exploratory data analysis, and visualization of clinical datasets using Python libraries and healthcare analytics tools. CO9 (Analyze – L4): Implement and analyze machine learning algorithms for disease prediction and healthcare data classification problems. CO10 (Evaluate/Create – L5/L6): Develop healthcare analytics mini-projects integrating clinical data analysis, visualization, prediction models, and ethical considerations for real-world healthcare applications.
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: 45 hrs)**	1. Coding Problems on Predictive data analysis — 20 coding problems minimum. 2. Virtual Labs (NPTEL): C programming experiments. 3. MOOC course on clinical data analytics (SWAYAM/Coursera).
11	**References**	Textbook: Healthcare Data Analytics — Edited by Chandan K. Reddy and Charu C. Aggarwal Reference: Statistics and Machine Learning Methods for EHR Data — Edited by Hulin Wu Reference: Healthcare Data Analytics and Management — Edited by Nilanjan Dey and others

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	CO Mapping
	Unit 1: Introduction	
A	Introduction to Healthcare Informatics and Clinical Data Analytics, Importance of Data Analytics in Healthcare	**CO1**

B	Types of Clinical Data-Electronic Health Records (EHR), Electronic Medical Records (EMR), Laboratory and Imaging Data, Wearable Sensor Data, FDA regulatory compliance, HIPAA Compliance	**CO2**
C	Applications of Clinical Analytics-Disease Prediction, Patient Monitoring, Hospital Management, Personalized Healthcare; Challenges in Healthcare Data Analytics	**CO2**
	Unit 2 : Clinical Data Collection and Preprocessing	
A	Sources of Clinical Data- Structured vs Unstructured Medical Data, Data Cleaning Techniques, Data Transformation and Normalization	**CO1, CO2**
B	Feature Selection and Extraction- Types of Feature Selection Methods	**CO1, CO2**
C	Health data Standards- LOINC, SNOMED-CT, ICD codes , Data Storage and Database Basics in Healthcare	**CO1, CO2**
	Unit 3: Data Visualization and Statistical Analysis	
A	Introduction to Healthcare Statistics, Descriptive Statistics- Mean, Median, Mode, Standard Deviation, Correlation	**CO3**
B	Clinical Data Visualization Techniques-Bar Charts, Histograms, Pie Charts, Heatmaps	**CO4**
C	Introduction to Data Analytics Tools- Python, Pandas, Matplotlib, Exploratory Data Analysis (EDA) in Healthcare	**CO4**
	Unit 4: Machine Learning for Clinical Analytics	
A	Introduction to Machine Learning in Healthcare, Supervised and Unsupervised Learning	**CO5**
B	Classification and Prediction Techniques- Decision Tree, Naïve Bayes, K-Nearest Neighbor (KNN), Logistic Regression	**CO5**
C	Introduction to Disease Prediction Models, Model Evaluation Metrics-Accuracy, Precision, Recall, F1-Score	**CO5**
	Unit 5: Advanced Trends, Ethics and Applications	
A	Introduction to AI in Healthcare, Telemedicine and Smart Healthcare Systems, Wearable Devices and IoT in Healthcare	**CO6**
B	Basics of Medical Image Analytics, Introduction to NLP in Clinical Text Analysis	**CO6**
C	Data Privacy and Security in Healthcare, Ethical Issues in Clinical Data Analytics, Future Trends in Healthcare Analytics	**CO6**

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 — 45 Lectures)

Date	Topics to be Covered	Unit	Total Lectures
DD/MM/YY	Introduction to Healthcare Informatics and Clinical Data Analytics	Unit 1	8
DD/MM/YY	Importance of Data Analytics in Healthcare		
DD/MM/YY	Types of Clinical Data: EHR and EMR		
DD/MM/YY	Laboratory and Imaging Data, Wearable Sensor Data		

Date	Topics to be Covered	Unit	Total Lectures
DD/MM/YY	FDA Regulatory Compliance and HIPAA Compliance		
DD/MM/YY	Applications of Clinical Analytics: Disease Prediction		
DD/MM/YY	Patient Monitoring and Hospital Management Systems		
DD/MM/YY	Personalized Healthcare and Challenges in Healthcare Analytics		
DD/MM/YY	Sources of Clinical Data and Structured vs Unstructured Data	Unit 2	8
DD/MM/YY	Data Cleaning Techniques in Healthcare Data		
DD/MM/YY	Data Transformation and Normalization Techniques		
DD/MM/YY	Introduction to Feature Selection and Extraction		
DD/MM/YY	Types of Feature Selection Methods		
DD/MM/YY	Healthcare Data Standards: LOINC and SNOMED-CT		
DD/MM/YY	ICD Codes and Healthcare Databases		
DD/MM/YY	Data Storage and Database Basics in Healthcare		
DD/MM/YY	Introduction to Healthcare Statistics	Unit 3	9
DD/MM/YY	Descriptive Statistics: Mean, Median, Mode		
DD/MM/YY	Standard Deviation and Correlation Analysis		
DD/MM/YY	Clinical Data Visualization using Bar Charts and Histograms		
DD/MM/YY	Pie Charts and Heatmaps in Healthcare Analytics		
DD/MM/YY	Introduction to Python for Healthcare Analytics		
DD/MM/YY	Introduction to Pandas Library		
DD/MM/YY	Introduction to Matplotlib Library		
DD/MM/YY	Exploratory Data Analysis (EDA) in Healthcare		
DD/MM/YY	Introduction to Machine Learning in Healthcare	Unit 4	9
DD/MM/YY	Supervised and Unsupervised Learning		
DD/MM/YY	Decision Tree Algorithm for Healthcare Analytics		
DD/MM/YY	Naïve Bayes Algorithm in Clinical Data Analytics		
DD/MM/YY	K-Nearest Neighbor (KNN) Algorithm		
DD/MM/YY	Logistic Regression for Disease Prediction		
DD/MM/YY	Disease Prediction Models in Healthcare		
DD/MM/YY	Model Evaluation Metrics: Accuracy and Precision		
DD/MM/YY	Recall and F1-Score Evaluation Metrics		
DD/MM/YY	Introduction to AI in Healthcare	Unit 5	11
DD/MM/YY	Telemedicine and Smart Healthcare Systems		
DD/MM/YY	Wearable Devices and IoT in Healthcare		
DD/MM/YY	Basics of Medical Image Analytics		
DD/MM/YY	Introduction to NLP in Clinical Text Analysis		
DD/MM/YY	Data Privacy and Security in Healthcare		
DD/MM/YY	Ethical Issues in Clinical Data Analytics		
DD/MM/YY	Future Trends in Healthcare Analytics		
DD/MM/YY	Case Studies in Clinical Data Analytics-I		
DD/MM/YY	Case Studies in Clinical Data Analytics-II		
DD/MM/YY	Case Studies in Clinical Data Analytics-III		

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	Exp. No.	Experiment	Lab CO	Marks
W1	1	Study of Healthcare Informatics and Clinical Data Types using sample healthcare datasets	CO7	3
W2	2	Data cleaning and handling missing values in clinical datasets using Python	CO7	3
W3	3	Data transformation and normalization techniques for healthcare datasets	CO7	3
W4	4	Feature selection and extraction methods for clinical data analysis	CO7	3
W5	5	Implementation of healthcare data standards mapping using ICD/LOINC/SNOMED-CT datasets	CO7	3
W6	6	Computation of descriptive statistics (mean, median, mode, standard deviation) on healthcare datasets	CO8	3
W7	7	Correlation analysis and visualization of clinical datasets	CO8	3
W8	8	Visualization of healthcare data using bar charts, histograms, pie charts, and heatmaps	CO8	3
W9	9	Exploratory Data Analysis (EDA) on healthcare datasets using Pandas and Matplotlib	CO8	3
W10	10	Implementation of Decision Tree classifier for disease prediction	CO9	3
W11	11	Implementation of Naïve Bayes classifier for healthcare data classification	CO9	3
W12	12	Implementation of K-Nearest Neighbour (KNN) algorithm for patient data analysis	CO9	3
W13	13	Implementation of Logistic Regression for disease prediction models	CO9	3
W14	14	Evaluation of healthcare prediction models using Accuracy, Precision, Recall, and F1-score	CO9	3
W15	15	Mini-project on clinical data analytics integrating preprocessing, visualization, machine learning, and ethical/privacy considerations	CO10	3

ℹ *Instructions: Write Python 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	Fundamentals of Clinical Data Analytics	Recall and explain healthcare informatics concepts, healthcare data types, EHR/EMR systems, and healthcare analytics applications	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	Clinical Data Collection and Preprocessing Interpretation	Explain clinical data preprocessing, feature selection, healthcare standards, normalization, and healthcare database concepts	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	Statistical Analysis and Data Visualization Application	Apply healthcare statistics, visualization techniques, Python, Pandas, and EDA tools for healthcare data analysis	CO3 | L3–L4	CA | MTE Sec B | ETE Sec B

TS4	Machine Learning and Predictive Analytics Evaluation	Apply and analyze machine learning techniques, prediction models, and evaluation metrics in healthcare analytics	CO4 | L3–L5	MTE Sec B | ETE Sec B
TS5	Advanced Healthcare Analytics and Intelligent Systems	Analyze AI, IoT, wearable systems, medical image analytics, and NLP applications in healthcare	CO5 | L4–L5	ETE Sec B/C
TS6	Ethical, Privacy, and Security Evaluation in Healthcare	Evaluate ethical issues, data privacy laws, security requirements, and future trends in clinical data analytics	CO6 | L4–L5	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	50%	**50**	Theory COs only: CO1, CO2, CO3, CO4, CO5, CO6

(ETE)			
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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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

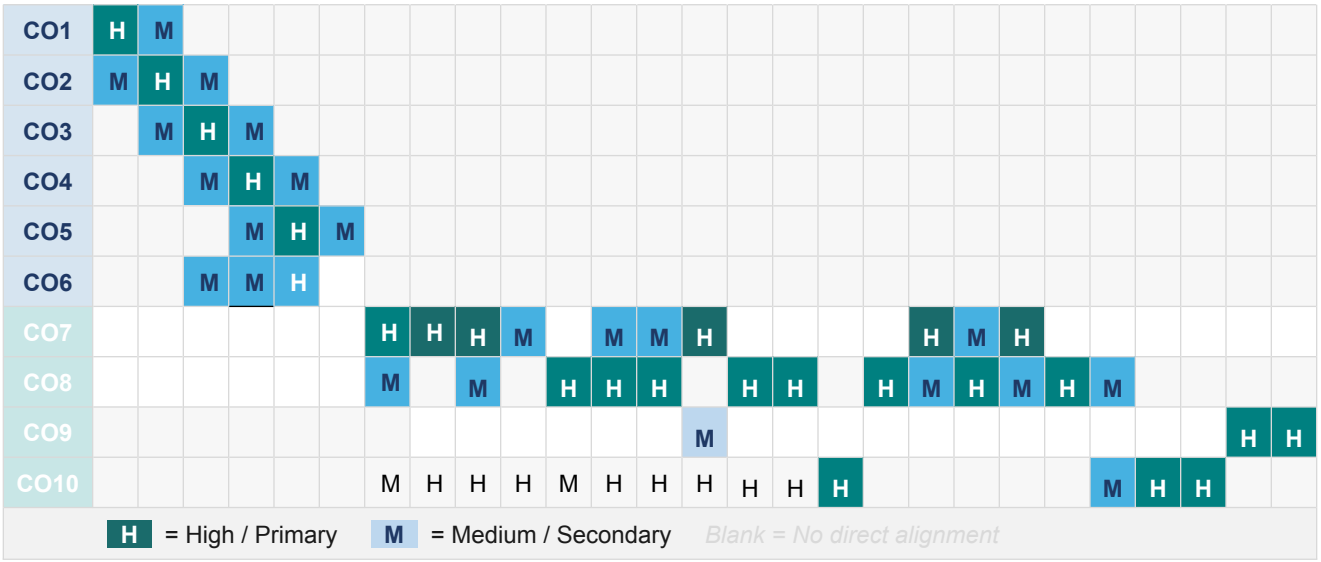
14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

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	TS3 Procedural	TS4 Analytical	TS5 Compar. Eval.	TS6 Synthesis &	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 Inves-tigation	PO5 Tool Usage	PO6 En-gineer & 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 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

★ *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

CDA 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: 2026-2030**	
Program: B.Tech.		**Current Academic Year: 2027-2028**	
Branch: CSE / IT		**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 2. To understand the significance of problem and its scope 3. Students will make decisions within a framework	
6	Course Outcomes	Students will be able to: CO1: Identify and formulate problem statements with systematic approach. CO2: Develop teamwork and problem-solving skills, along with the ability to communicate effectively with others. CO3: Design the problem solution as per the problem statement framed. CO4: Explain the characteristics, architecture of database approach, describe the components of the project. CO5: Fabricate and implement the solution by using different object oriented concepts like encapsulation, polymorphism etc. 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. References if any.	

		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 attaint ed	3	2.7	0.3	1.8	0.7	0.7	0.8	0.5	3	3	2	1	1.3	0.5

Semester IV	**23**
Course Code	Course Name
CSCR2314	Data Base Management System
CSCR2115	Theory of Computation
CSCR2117	Introduction to Cloud Computing
SKP2401	Integrated Professional Communication and Intelligent Computing
CSME2301	Clinical Data Analytics
CSCR2601	Project Based Learning (PBL) -2 (Research Methodology Based)
	Program Elective-1
CSAI2001	System Design - SI (Case Study Based)
CSAI2002	Foundations of Ethical Hacking
CSAI2003	Information Security

COURSE PLAN

Signal Systems and Medical Systems Processing (CSME3300)

Sharda School of Computing Sciences & Engineering (SSCSE) | B.Tech CS & ME) | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2028–2029
Branch:	CS & ME	**Semester:**	V
Course Code:	CSME3300	**Course Type:**	Core – Integrated

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**	CSME3300
2	**Course Title**	**Signal Systems and Medical Systems Processing**
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-2
5	**Course Status**	Core
6	**Course Objective**	The objective of this course is • To introduce the fundamental concepts and characteristics and classification of signals, system properties and important operations on signals. • To understand the principles and methods used for frequency domain analysis of signals and systems for representation and transformation such as Fourier series, Fourier and Laplace transforms. • To develop basic understanding of systems and their transfer functions, and to apply digital signal processing techniques to realize digital filters. • To develop the insights necessary to acquire and process biomedical signals, and to conduct case studies on applications on ECG, EEG and EMG signals. • To analyze advanced signal processing techniques such as STFT, medical image processing, and anomaly detection using machine learning techniques.
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** The objective of this course is • To introduce the fundamental concepts and characteristics and classification of signals, system properties and important operations on signals. • To understand the principles and methods used for frequency domain analysis of signals and systems for representation and transformation such as Fourier series, Fourier and Laplace transforms. • To develop basic understanding of systems and their transfer functions, and to

		apply digital signal processing techniques to realize digital filters. • To develop the insights necessary to acquire and process biomedical signals, and to conduct case studies on applications on ECG, EEG and EMG signals. • To analyze advanced signal processing techniques such as STFT, medical image processing, and anomaly detection using machine learning techniques. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Familiarization of MATLAB/Python and implementing programs for Biomedical signal processing such as signal representation, transformation, correlation etc., configure experimental setups; demonstrate system operation; maintain structured lab records. CO8 (Create – L5/L6): Design and develop experimental set up for signal representation using DFT and implement programs for finding IDFT. Develop applications addressing real-world problems in medical domain; evaluate outcomes analytically. CO9 (Apply – L2/L3): Demonstrate digital filtering techniques for bio medical signals and plot the frequency response. CO10 (Apply – L3): Apply different methods and algorithm for artifact removal in bio-signals, waveform analysis and feature extraction from bio-signals and pattern classification in bio-signals.
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. MATLAB/Python — 15 coding problems for biomedical signal processing \ Minimum 2 Virtual Labs (NPTEL): MATLAB/Python programming experiments in Digital signal processing . 3. MOOC course on Signals and Systems, Biomedical Signal Processing (SWAYAM/Coursera).
11	**References**	**Text Books:** 1. Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003. 2. J. J. Carr & J. M. Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia. **References:** 1. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edn. 2. Proakis, J. G., & Manolakis, D. G. (2006). Digital signal processing: Principles, algorithms, and applications (4th ed). Pearson. ISBN-13 9780131873742. 3. Webster, J. G. (ed.), “Medical instrumentation: application and design”, Fourth edition, John Wiley & Sons, Hoboken 4. Signals & Systems - Simon Haykin and Van Veen,Wiley, 2nd Edition. 5. Signals, Systems and Transforms - C. L. Philips, J. M. Parr and Eve A. Riskin, Pearson education.3rd Edition, 2004. 6. Rangayyan, Rangaraj M, Biomedical signal analysis, John Wiley & Sons, 2015 7. Subasi, Abdulhamit. Biomedical signal analysis and its usage in healthcare in Biomedical Engineering and its Applications in Healthcare, pp. 423-452. Springer, 2019. 8. Devasahayam, S.R., Signals and systems in biomedical engineering: signal processing and physiological systems modeling. Springer Science & Business Media, 2014.

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	CO Mapping
Unit 1	**Fundamentals of Signals & Systems**	
A	Signal Classification: Continuous vs. discrete-time, deterministic vs. stochastic, energy vs. power signals, Basic operations on signals.	**CO1**
B	System Properties: Linearity, time-invariance (LTI), causality, and stability.	**CO1**

C	Mathematical Operations: Time-shifting, scaling, convolution, and correlation. Relation between convolution and correlation.	**CO1**
Tools Used	MATLAB, Python	
Activities	**Objective:** To familiarize students with MATLAB commands and develop a clear understanding of the MATLAB tools and libraries for signal processing. • Introduction to MATLAB ○ To define and use variables and functions in MATLAB ○ To define and use Vectors and Matrices in MATLAB ○ To study various MATLAB arithmetic operators and mathematical functions ○ To create and use m-files. • Basic plotting of signals ○ To study various MATLAB commands for creating two and three-dimensional plots. ○ Write a MATLAB program to plot the following continuous time and discrete time signals. i. Step Function ii. Impulse Function iii. Exponential Function iv. Ramp Function v. Sine Function	
Unit 2	**Frequency Domain Analysis**	
A	Fourier Analysis: Fourier Series and Fourier Transforms (CTFT/DTFT) for periodic and aperiodic signals, Properties of Fourier series, Complex Fourier spectrum.	**CO1, CO2**
B	Discrete Systems: Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) algorithms.	**CO1, CO2**
C	Transformations: Laplace transforms (continuous time), Properties of LT's relation between LTs, and F.T. of a signal. Z-transforms (discrete time) to analyze system transfer functions, Properties of Z-transforms.	**CO1, CO2**
Tools Used	MATLAB, Python	
Activities	**Objective:** To familiarize students with the concepts of Time amplitude transformation. Convolution and auto, cross correlation functions • Time and amplitude transformation ○ To perform amplitude-scaling, time-scaling, and time shifting on a given signal. Handling Files ○ Perform linear convolution of the given sequences. ○ Compute the autocorrelation of a sequence x(n) and verify the property. compute the cross-correlation of sequences x(n) and y(n) and verify the property.	
Unit 3	**Signal Transmission through Linear Systems**	
A	Introduction to Systems, Classification of Systems, Linear Time Invariant (LTI) systems, impulse response, Transfer function of a LTI system.	**CO1**
B	Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, System bandwidth, Ideal LPF, HPF and BPF characteristics.	**CO2, CO3, CO4**
C	Digital Filter design: Filtering Techniques: Moving average filters, smoothing, and artifact removal Filter Types: Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filter design methods.	**CO2, CO3, CO4**
Tools Used	MATLAB, Python	
Activities	**Objective:** To implement LP, HP and BP digital filters and obtain magnitude and phase responses. Compute the impulse and step response of a system • Implementation of LP FIR filter for a given sequence • Implementation of HP FIR filter for a given sequence	

	• Implementation of LP IIR filter for a given sequence • Implementation of HP IIR filter for a given sequence • Generation of Sinusoidal signal through filtering. • Write a MATLAB program to find the impulse response and step response of a system from its difference equation. • Compute and plot the response of a given system to a given input. • Frequency response of a system Write a MATLAB program to plot the magnitude and phase response of a given system	
Unit 4	**Biomedical Signal Acquisition & Sampling**	
A	The Clinical Context: Origins of biomedical signals (Action potentials, ECG, EEG, EMG) and clinical applications.	**CO1, CO2**
B	Sampling Theory: The Nyquist Sampling Theorem, analog-to-digital (A/D) conversion, aliasing, and signal reconstruction.	**CO3, CO4, CO5**
C	Biomedical signal processing Case studies - Removal of artifacts - QRS Detection and classification of ectopic beats in ECG signals - Detection of epileptic seizures in EEG signals - Study of muscular contraction using parametric analysis of EMG signals.	**CO3, CO4**
Tools Used	MATLAB, Python	
Activities	**Objective:** To understand properties of ECG, EEG and EMG signals. Understand and implement Nyquist Sampling Theorem, analog-to-digital (A/D) conversion, aliasing, and signal reconstruction and Artifact removal in bio-signals • Implementation of signal sampling, analysis of under, over and perfect sampling • Removal of artifacts from EEG, ECG signals • Removal of 50Hz powerline noises from biomedical signals • Design of Notch (Band elimination filter) for noise removal	
Unit 5	**Advanced Processing & Medical Systems**	
A	Time-Frequency Analysis: Short-Time Fourier Transform (STFT), Wavelet Transform, and filter banks.	**CO1, CO2, CO3, CO5**
B	Medical Imaging Basics: Introduction to 2D signals in imaging modalities like MRI, CT, and Ultrasound.	**CO2, CO4, CO5, CO6**
C	Pattern Recognition: Basic feature extraction, machine learning, and decision theory for anomaly detection.	**CO4, CO5, CO6**
Tools Used	MATLAB, Simulink. Python	
Activities	**Objective:** To understand the concept of STFT, Medical image processing. Classification of medical images using Machine Learning techniques. • Checking linearity/non-linearity of a system using SIMULINK. • Compute the STFT using a Wideband configuration (very short window size, e.g., N=32). Observe excellent time resolution (sharp on/off boundaries) but poor frequency resolution (the 1000 Hz and 1050 Hz peaks blur into one). • Perform feature extraction, pre-processing, feature selection and classification (kNN, ANN, SVM etc) for biological images such as X-ray, MRI images	

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/Title	UNIT	Total Lectures
DD/MM/YY	Signal Classification: Continuous vs. discrete-time, deterministic vs. stochastic.	UNIT-1	6
DD/MM/YY	Signal Classification: energy vs. power signals, Basic operations on signals.		

DD/MM/YY	System Properties: Linearity, time-invariance (LTI)		
DD/MM/YY	System Properties: causality, and stability.		
DD/MM/YY	Mathematical Operations: Time-shifting, scaling.		
DD/MM/YY	Mathematical Operations: Convolution, and correlation. Relation between convolution and correlation.		
DD/MM/YY	Fourier Analysis: Fourier Series and Fourier Transforms (CTFT/DTFT) for periodic and aperiodic signals.	UNIT-2	6
DD/MM/YY	Properties of Fourier series, Complex Fourier spectrum.		
DD/MM/YY	Discrete Systems: Discrete Fourier Transform (DFT)		
DD/MM/YY	Fast Fourier Transform (FFT) algorithms.		
DD/MM/YY	Transformations: Laplace transforms (continuous time), Properties of LT's relation between LTs, and F.T. of a signal.		
DD/MM/YY	Z-transforms (discrete time) to analyze system transfer functions, Properties of Z-transforms.		
DD/MM/YY	Introduction to Systems, Classification of Systems	UNIT-3	8
DD/MM/YY	Linear Time Invariant (LTI) systems, system, impulse response.		
DD/MM/YY	Transfer function of a LTI system.		
DD/MM/YY	Filter characteristics of linear systems. Distortion less transmission through a system.		
DD/MM/YY	Signal bandwidth, System bandwidth, Ideal LPF, HPF and BPF characteristics.		
DD/MM/YY	Digital Filter design: Filtering Techniques.		
DD/MM/YY	Moving average filters, smoothing, and artifact removal		
DD/MM/YY	Filter Types: Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filter design methods.		
DD/MM/YY	The Clinical Context: Origins of biomedical signals (Action potentials, ECG, EEG, EMG) and clinical applications.	UNIT-4	8
DD/MM/YY	The Clinical Context: Origins of biomedical signals (Action potentials, ECG, EEG, EMG) and clinical applications.		
DD/MM/YY	Sampling Theory: The Nyquist Sampling Theorem.		
DD/MM/YY	analog-to-digital (A/D) conversion, aliasing, and signal reconstruction.		
DD/MM/YY	Moving averages, Multivariable thresholding		
DD/MM/YY	Biomedical signal processing Case studies - Removal of artifacts - Detection of epileptic seizures in EEG signals.		
DD/MM/YY	QRS Detection and classification of ectopic beats in ECG signals		

DD/MM/YY	Study of muscular contraction using parametric analysis of EMG signals.		
DD/MM/YY	Time-Frequency Analysis: Short-Time Fourier Transform (STFT).	UNIT-5	6
DD/MM/YY	Wavelet Transform, and filter banks.		
DD/MM/YY	Medical Imaging Basics: Introduction to 2D signals in imaging modalities like MRI, CT, and Ultrasound.		
DD/MM/YY	Medical Imaging Basics: Introduction to 2D signals in imaging modalities like MRI, CT, and Ultrasound.		
DD/MM/YY	Pattern Recognition: Basic feature extraction, machine learning.		
DD/MM/YY	Decision theory for anomaly detection.		

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 MATLAB: a. To define and use variables and functions in MATLAB. b. To define and use Vectors and Matrices in MATLAB.	**CO7**	3.0
	S-1.2	Introduction to MATLAB: c.To study various MATLAB arithmetic operators and mathematical functions. d. To create and use m-files.	**CO7**	
W2	S-2.1	Basic plotting of signals: To study various MATLAB commands for creating two and three-dimensional plots	**CO7**	3.0
	S-2.2	Basic plotting of signals: Write a MATLAB program to plot the following continuous time and discrete time signals. i. Step Function ii. Impulse Function iii. Exponential Function iv. Ramp Function v. Sine Function	**CO7**	
W3	S-3.1	Time and Amplitude transformations: Write a MATLAB program to perform amplitude-scaling, time-scaling, and time shifting on a given signal.	**CO7**	3.0
	S-3.2	Convolution of given signals: Write a MATLAB program to obtain linear convolution of the given sequences.	**CO7**	
W4	S-4.1	Autocorrelation and Cross-correlation: a). Write a MATLAB program to compute the autocorrelation of a sequence x(n) and verify the property. b). Write a MATLAB program to compute the cross-correlation of sequences x(n) and y(n) and verify the property.	**CO7**	3.0
	S-4.2	Computation of signal transforms: Compute and plot the Fourier transform of a given signal.	**CO7**	
W5	S-5.1	Computation of signal transforms: Compute and plot the Z-transform of a given signal.	**CO7**	3.0
	S-5.2	Impulse response and Step response of a given system: Write a MATLAB program to find the impulse response and step response of a system from its difference equation	**CO7**	
W6	S-6.1	Impulse response and Step response of a given system: Compute and plot the response of a given system to a given input.	**CO7**	3.0

	S-6.2	Write a MATLAB program to find the pole-zero diagram, and bode diagram of a given system from the given system function.	CO7	
W7	S-7.1	Implementation of digital Filters: Implementation of LP FIR filter for a given sequence	CO7	3.0
	S-7.2	Implementation of digital Filters: Implementation of HP FIR filter for a given sequence Implementation of LP IIR filter for a given sequence.	CO7	
W8	S-8.1	Implementation of digital Filters: Implementation of HP IIR filter for a given sequence, Generation of Sinusoidal signal through filtering	CO7	3.0
	S-8.2	Write a MATLAB program to find the impulse response and step response of a system from its difference equation.	CO7	
W9	S-9.1	Write a MATLAB program to compute and plot the response of a given system to a given input.	CO7	3.0
	S-9.2	Write a MATLAB program to compute Frequency response of a system Write a MATLAB program to plot the magnitude and phase response of a given system	CO7	
W10	S-10.1	Write a MATLAB program to Implementation of signal sampling, analysis of under, over and perfect sampling	CO7	3.0
	S-10.2	Implement MATLAB/Python program for removal of artifacts from EEG, ECG signals.	CO7	
W11	S-11.1	Implement MATLAB/Python program to remove 50Hz powerline noises from biomedical signals.	CO7	3.0
	S-11.2	Implement MATLAB/Python program to design of Notch (Band elimination filter) for noise removal.	CO7	
W12	S-12.1	Compute the STFT using a Wideband configuration (very short window size, e.g., N=32). Observe excellent time resolution (sharp on/off boundaries) but poor frequency resolution (the 1000 Hz and 1050 Hz peaks blur into one).	CO7	3.0
	S-12.2	Implement checking linearity/non-linearity of a system using SIMULINK.	CO7	
W13	S-13.1	Perform feature extraction for biological images such as X-ray, MRI images	CO8	3.0
	S-13.2	Perform pre-processing, feature selection for biological images such as X-ray, MRI images	CO8	
W14	S-14.1	Perform classification (kNN, ANN, SVM etc) for biological images such as X-ray, MRI images using kNN algorithm	CO8/CO9	3.0
	S-14.2	Perform classification for biological images such as X-ray, MRI images using ANN.	CO8/CO10	
W15	S-15.1	Perform classification for biological images such as X-ray, MRI images using SVM and Bayesian classifiers	CO8/CO9	3.0
	S-15.2	Perform segmentation for biological images such as X-ray, MRI images using using suitable segmentation techniques	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	**Recall basics and terminologies of signals and systems**	Recall the basic concepts and terminologies associated with signals and systems, understand classification of signals, system properties and important operations on signals.	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	**Understand the principles and methods for signal representation and transforms**	Understand the principles and methods used for frequency domain analysis of signals and systems for representation and transformation such as Fourier series, Fourier and Laplace transforms.	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	**Application & Implementation of digital filters**	Develop basic understanding of systems and their transfer functions, and to apply digital signal processing techniques to realize digital filters.	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	**Analysis & interpret Performance Evaluation of biomedical signal processing**	Analyze different techniques to acquire and process biomedical signals, and to conduct case studies on applications on ECG, EEG and EMG signals.	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	**Evaluation of advanced signal processing techniques such as STFT, medical image processing, and anomaly detection using ML.**	Evaluate the effectiveness of advanced signal processing techniques such as STFT, medical image processing, and anomaly detection using machine learning techniques.	CO5 | L4–L5	ETE Sec B/C
TS6	**Create applications for acquisition, representation and processing of biomedical signals for real-word applications.**	Create digital signal processing applications for better acquisition, representation and processing of biomedical signals for real-word applications.	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	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	**10**	TS1 — Recall basics and terminologies of signals and systems TS2 — Understand the principles and methods	**CO1, CO2**	Short-answer: Define terminologies associated with signals and systems, understand classification of signals, system properties and important operations on signals- frequency domain

		for signal representation and transforms		analysis of signals and systems for representation and transformation such as Fourier series, Fourier and Laplace transforms
Section B	**15**	TS3 — Application & Implementation of digital filters TS4 Analysis & interpret Performance Evaluation of biomedical signal processing	**CO2, CO3, CO4**	Numerical problems: Basic understanding of systems and their transfer functions, and to apply digital signal processing techniques to realize digital filters. Case studies on applications on ECG, EEG and EMG signals.
TOTAL	**25**	TS1–TS4	**CO1–CO4**	Units 1–3 only. CO5 and CO6 assessed in ETE only.

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

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): Basics and terminologies of signals and systems - frequency domain analysis of signals and systems for representation and transformation such as Fourier series, Fourier and Laplace transforms
Section B	**25**	TS3 — Application & Implementation of digital filters TS4 Analysis & interpret Performance Evaluation of biomedical signal processing TS5 — Evaluation of advanced signal processing techniques such as STFT, medical image processing, and anomaly detection using ML.	**CO3, CO4, CO5**	Medium questions: Basic understanding of systems and their transfer functions, and to apply digital signal processing techniques to realize digital filters. Case studies on applications on ECG, EEG and EMG signals
Section C	**10**	TS5 — Evaluation of advanced signal processing techniques such as STFT, medical image processing, and anomaly detection using ML. -Acquisition, representation and processing of biomedical signals for real-word applications	**CO5, CO6**	Long/evaluation questions: Advanced signal processing techniques such as STFT, medical image processing, and anomaly detection using machine learning techniques.
TOTAL	**50**	TS1–TS6 (all)	**CO1–CO6**	Scaled from 100-mark paper if needed. Minimum 20/50 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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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

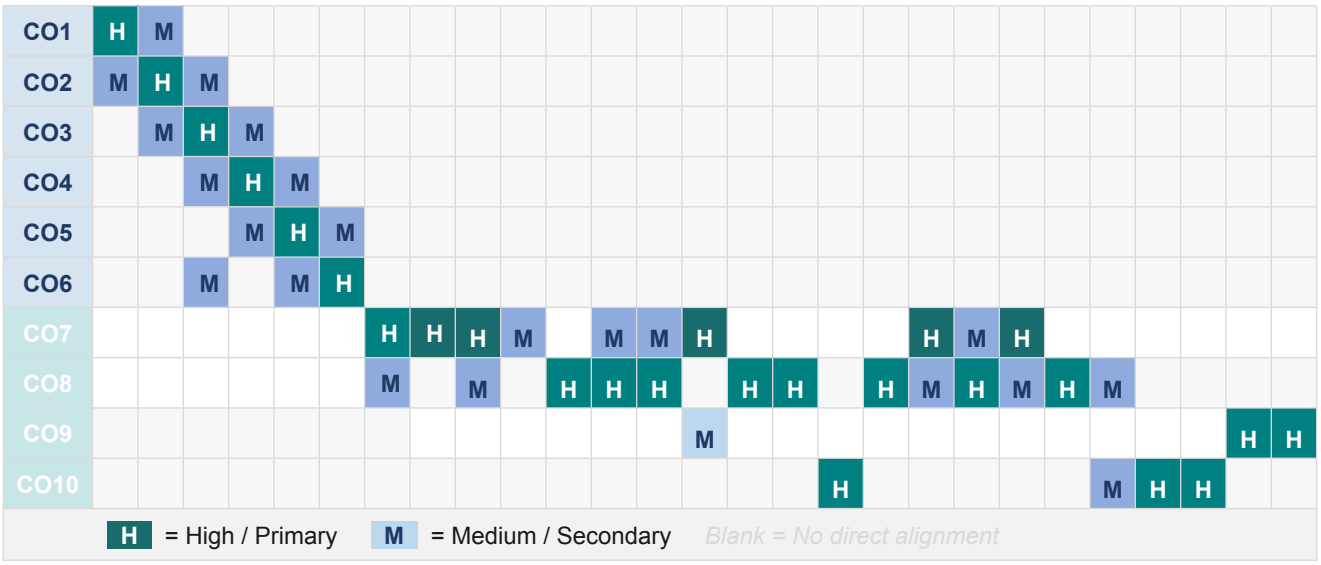
14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

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	TS3 Procedural	TS4 Analytical	TS5 Compar. Eval.	TS6 Synthesis &	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 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

★ *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

B.Tech – CS & ME

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

SSMSP 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 Analysis of Algorithms *(CSCR3311)*

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2028–2029
Branch:	CS & ME	**Semester:**	V

Course Code:	CSCR3311	Course Type:	Core – Integrated

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**	34
4	**Contact Hours (L-T-P-SL)**	3-0-2-3
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) 2. Knowledge of algorithm design strategies 3. Familiarity with an assortment of important algorithms. Enable students to analyze time and space complexity
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** **CO1** (**Analyze-L1):** The asymptotic performance of algorithms **CO2** (Understand – L2): The dynamic-programming and Greedy paradigm and explain when an algorithmic design situation calls for it. **CO3** (Apply – L3): A familiarity with major algorithms and data structures **CO4** (Analyze – L4): Important algorithmic design paradigms and methods of analysis **CO5** (Evaluate – L5): NP-complete problems and develop algorithms to solve the problems. **CO6** (Create – L6): Appropriate algorithm design techniques for solving problems. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Implement C programs using professional tools (gcc, Linux CLI, debuggers); configure experimental setups; demonstrate system operation; maintain structured lab records. 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. CO9 (Apply – L2/L3): Demonstrate professional, ethical, and responsible practices; perform skill self-assessment; reflect on learning to cultivate lifelong professional growth. 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 2. Practicing algorithm problems 3. Understanding proofs and complexity analysis 4. Coding algorithms 5. Solving numerical/examples 6. Watching lectures/tutorials
11	**References**	1.Cormen et al., “Introduction of Computer Algorithms”, Prentice Hall India 2.Sahni et al., “Fundamentals of Computer Algorithms”, Galgotia Publications. 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, 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 1. WAP to demonstrate the concept of Linear and Binary Search 2. WAP to implement Merge sort 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 1. WAP to implement Matrix Chain Multiplication problem 2. WAP to demonstrate the concept of Longest Common Subsequence(LCS) 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) 2. WAP to demonstrate concept of Fractional Knapsack Problem 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** 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 1. WAP to demonstrate the concept of Naïve String matching algorithm. 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 — 45 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		
DD/MM/YY	Performance measurements, Properties of Asymptotic Notations		
DD/MM/YY	Mathematical analysis for Recursive algorithms		
DD/MM/YY	Recurrences relations		
DD/MM/YY	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	Overview of the Greedy paradigm	Unit 2	9
DD/MM/YY	Analysis and example: task scheduling		
DD/MM/YY	Analysis and example: task scheduling		
DD/MM/YY	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:		
DD/MM/YY	N-Queens problem and Sum of subsets		
DD/MM/YY	N-Queens problem and Sum of subsets		
DD/MM/YY	Difference between dynamic programming and divide and conquer	**Unit 3**	9
DD/MM/YY	All pair shortest path problems: Floyd-Warshall Algorithm		
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	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**	9
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	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**	
W11	S-11.1	Write a program to implement Naïve string matching problem.	**CO7**	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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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	Document pre/post skill gaps; map personal contributions to project	CO9 | PO11

	Growth Mapping	dimensions	
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

15. PART IV

COMBINED MAPPINGS & REFERENCE

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

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 &**	**2**	Promotes efficient, optimized coding; encourages ethical coding

	Production	**(Moderate)**	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 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

★ *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

DAA 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

Software Engineering and Project Management (CSAD2100)

SSCSE | B.Tech CS& ME | Semester V | 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	**Batch:**	2026-2030
Program:	B.Tech	**Current Academic Year:**	2028-2029
Branch:	CS & ME	**Semester:**	V
Course Code:	CSAD2100	**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**	CSAD 2100
2	**Course Title**	**Software Engineering and Project Management**
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. To Define the Project Management principles while developing software. 2. To understand the principles, concepts, and methodologies of Software Engineering and Project Management and software development planning. 3. To apply project scheduling, cost estimation, risk management, and resource allocation techniques in software projects. 4. To utilize project management tools such as Microsoft Project and Jira for project planning, tracking, and reporting. 5. To develop skills in team coordination, communication, conflict management, and quality assurance in software projects.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Understand – L1/L2): Define the Project Management principles while developing software. CO2 (Explore – L2/L3): Explain different project scheduling techniques. CO3 (Apply – L3): Apply various project monitoring, control and review techniques. CO4 (Analyze – L4/L5): Categorize various activities and estimate the risks involved in various project activities. CO5 (Analyze – L4/L5): Assess project quality and issues related to contract management. CO6 (Analyze – L2/L4): Discuss the impact of project planning on the performance of the organizations.
8	**Course Description**	Software Engineering and Project Management focuses on the planning, scheduling, monitoring, and control of software development projects. The course covers project estimation, risk management, resource allocation, team coordination, and software quality management using modern project management techniques and tools. It also provides practical exposure to project planning and tracking through tools such as Microsoft Project and Jira.
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. **Software Engineering and Project Management** By Subramanian Chandramouli and Saikat Dutt 2. **Software Engineering and Project Management: A Unified Framework** By Walker Royce
12	**References**	1. **Peopleware: Productive Projects and Teams** By Tom DeMarco and Tim Lister*Introduction to Machine Learning with Python* — Andreas C. Müller & Sarah Guido — **1st Edition**

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 Software Project Planning	
A	Fundamentals of Software Engineering and Project Management (SPM), Need Identification, Vision and Scope Document, Project Management Cycle, SPM Objectives	**CO1**
B	SPM Framework, Software Project Planning, Planning Objectives, Project Plan, Types of Project Plan, Structure of a Software Engineering and Project Management Plan	**CO1**
C	Software Project Estimation, Estimation Methods, Estimation Models, Decision Process	**CO1**
	Unit 2: Project Organization and Scheduling Project Elements	
A	Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks, Project Life Cycle and Product Life Cycle	CO2
B	Ways to Organize Personnel, Project Schedule, Scheduling Objectives, Building the Project Schedule, Scheduling Terminology and Techniques	CO2/CO3
C	Network Diagrams: PERT, CPM, Bar Charts: Milestone Charts, Gantt Charts	CO2
	Unit 3: Project Monitoring and Control	
A	Dimensions of Project Monitoring & Control, Earned Value Analysis	CO3
B	Earned Value Indicators: Budgeted Cost for Work Scheduled (BCWS), Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI)	CO3
C	Software Reviews, Types of Review: Inspections, Deskchecks, Walkthroughs, Code Reviews	CO3
	Unit 4: Project Management Tools	

A	Software Configuration Items and Tasks, Baselines, Plan for Change, Change Control, Change Requests Management, Version Control	CO4
B	Risk Management: Risks and Risk Types, Risk Breakdown Structure (RBS), Risk Management Process: Risk Identification, Risk Analysis, Risk Planning, Risk Monitoring	CO4
C	Cost Benefit Analysis, Software Engineering and Project Management Tools: CASE Tools, MS-Project	CO5
	Unit 5: Software Quality and Staffing in Project Management	
A	Concept of Software Quality, Software Quality Attributes, Software Quality Metrics and Indicators, The SEI Capability Maturity Model (CMM)	CO5
B	SQA Activities, Formal SQA Approaches: Proof of Correctness, Statistical Quality Assurance, Product versus process quality management	CO6/CO5
C	Introduction, types of contract, stages in contract, placement, typical terms of a contract, contract management, acceptance	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	Topics to be Covered	Unit	Total Lectures
DD/MM/YY	**Introduction**	**UNIT-1**	**9**
DD/MM/YY	Introduction to Software Project Planning		
DD/MM/YY	Fundamentals of Software Engineering and Project Management (SPM)		
DD/MM/YY	Need Identification, Vision and Scope Document		
DD/MM/YY	Project Management Cycle, SPM Objectives		
DD/MM/YY	SPM Framework, Software Project Planning, Planning Objectives		
DD/MM/YY	Project Plan, Types of Project Plan, Structure of a Software Engineering and Project Management Plan		
DD/MM/YY	Software Project Estimation, Estimation Methods		
DD/MM/YY	Estimation Models, Decision Process		
DD/MM/YY	**Project Organization and Scheduling Project Elements**	**UNIT-2**	**9**
DD/MM/YY	Work Breakdown Structure (WBS), Types of WBS, Functions, Activities and Tasks		
DD/MM/YY	Project Life Cycle and Product Life Cycle		
DD/MM/YY	Ways to Organize Personnel, Project Schedule		
DD/MM/YY	Scheduling Objectives, Building the Project Schedule		
DD/MM/YY	Scheduling Terminology and Techniques		
DD/MM/YY	Scheduling Terminology and Techniques		
DD/MM/YY	Network Diagrams: PERT, CPM, Bar Charts: Milestone Chart		
DD/MM/YY	Network Diagrams: PERT, CPM,		
DD/MM/YY	CPM, Bar Charts: Milestone Charts, Gantt Charts		
DD/MM/YY	**Project Monitoring and Control**	**UNIT-3**	**9**

DD/MM/YY	Dimensions of Project Monitoring & Control		
DD/MM/YY	Dimensions of Project Monitoring & Control		
DD/MM/YY	Earned Value Analysis		
DD/MM/YY	Earned Value Indicators: Budgeted Cost for Work Scheduled (BCWS), Cost Variance (CV), Schedule Variance (SV)		
DD/MM/YY	Cost Performance Index (CPI), Schedule Performance Index (SPI)		
DD/MM/YY	Software Reviews, Types of Review: Inspections		
DD/MM/YY	Deskchecks, Walkthroughs, Code Reviews		
DD/MM/YY	Deskchecks, Walkthroughs, Code Reviews		
DD/MM/YY	**Project Management Tools**	**UNIT-4**	**9**
DD/MM/YY	Software Configuration Items and Tasks, Baselines, Plan for Change		
DD/MM/YY	Plan for Change, Change Control, Change Requests Management, Version Control		
DD/MM/YY	Risk Management: Risks and Risk Types, Risk Breakdown Structure (RBS),		
DD/MM/YY	Risk Management Process: Risk Identification, Risk Analysis, Risk Planning, Risk Monitoring		
DD/MM/YY	Risk Management Process: Risk Identification, Risk Analysis, Risk Planning, Risk Monitoring		
DD/MM/YY	Cost Benefit Analysis		
DD/MM/YY	Software Engineering and Project Management Tools: CASE Tools, MS-Project		
DD/MM/YY	Software Engineering and Project Management Tools: CASE Tools, MS-Project		
DD/MM/YY	**Software Quality and Staffing in Project Management**	**UNIT-5**	**9**
DD/MM/YY	Concept of Software Quality, Software Quality Attributes		
DD/MM/YY	Software Quality Metrics and Indicators		
DD/MM/YY	The SEI Capability Maturity Model (CMM)		
DD/MM/YY	SQA Activities, Formal SQA Approaches: Proof of Correctness		
DD/MM/YY	Statistical Quality Assurance, Product versus process quality management		
DD/MM/YY	Introduction, types of contract, stages in contract		
DD/MM/YY	placement, typical terms of a contract, contract management, acceptance		
DD/MM/YY	placement, typical terms of a contract, contract management, acceptance		
DD/MM/YY	Statistical Quality Assurance, Product versus process quality management		

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	**Project Planning and Estimation**	Ability to prepare project plans, estimation models, and scope documents for software projects	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	**Project Scheduling and Organization**	Understanding scheduling techniques, WBS preparation, and project organization strategies	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	**Project Monitoring and Control**	Ability to monitor project performance using earned value analysis and review techniques	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	**Risk and Configuration Management**	Application of risk management, version control, change management, and configuration practices	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	**Software Quality Assurance**	Understanding software quality attributes, quality metrics, and SQA activities	CO5 | L4–L5	ETE Sec B/C
TS6	**Project Management Tools and Contract Management**	Effective utilization of project management tools and understanding software contracts and management practices	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	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	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	Study and Analysis of Software Project Planning and Estimation Techniques	CO1	TS1	5h SL	Report submission + conceptual evaluation
Assignment 2	Comparative Study of Project Scheduling Techniques: PERT, CPM, and Gantt Charts	CO2	TS2	5h SL	Concept interpretation + short analytical problems
Assignment 3	Risk Management and Change Control in Software Engineering and Project Management	CO2, CO3	TS2, TS3	5h SL	Data preprocessing implementation + comparison
Assignment 4	Software Quality Assurance Models and Capability Maturity Model (CMM)	CO3, CO4	TS3, TS4	5h SL	Numerical computation + model analysis
Assignment 5	Role of Project Management Tools such as Microsoft Project and CASE Tools in Software Development	CO3, CO4, CO5	TS3, TS4, TS5	5h SL	Algorithm implementation + performance evaluation
Video Learning Report	Technical video on JIR and Report Generation report + presentation	CO2, CO3	TS2, TS3	9h SL	Report: learning outcomes, concepts, self-reflection. Presentation: 10 min
Case Study Report	Case Study on Agile Project Management using Jira	CO4, CO5, CO6	TS4, TS5, TS6	6h SL	Technical depth, dataset analysis, model comparison, performance evaluation

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

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	**CO1, CO2**	Short-answer: Define ML,

		Recall & OS Identification TS2 — Conceptual Explanation & Process Interpretation		Application, Phases
Section B	**15**	TS3 — Algorithmic Application TS4 — Algorithmic Analysis & Performance Evaluation	**CO2, CO3, CO4**	Processes, Techniques
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)

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, applications, algorithms
Section B	**25**	TS3 — Algorithmic Application TS4 — Performance Evaluation TS5 — Memory System Analysis	**CO3, CO4, CO5**	Medium questions: Phases of data preprocessing, data cleaning, data aggregation
Section C	**10**	TS5 — Memory System Analysis TS6 — File & Disk Management Evaluation	**CO5, CO6**	Long/evaluation questions: Phases of Data Integration, classification, clustering, regression
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 fundamental concepts, applications, learning paradigms, and problem framing in Machine Learning	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Apply data preprocessing, feature engineering, data cleaning, transformation, and reduction techniques for ML datasets	✔	✔	✔	TS2	PO1, PO3, PO4
CO3	Implement supervised learning algorithms such as Linear Regression, Logistic Regression, LDA, SVM, Decision Trees, and	✔	✔	✔	TS3	PO1, PO2, PO3, PO4

	Random Forests					
CO4	Integrate and interpret the effectiveness and performance of machine learning models using validation and evaluation techniques	✔	✔	✔	TS4	PO9, PO10, PO11
CO5	Analyze unsupervised learning and dimensionality reduction techniques including Clustering and PCA	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Understand hypothesis testing, parameter estimation, model evaluation, and ensemble learning methods for efficient predictive analysis	✔	—	✔	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	2	3			2
CO2	2	-	2	-	2	-	-	-	3	3	3			2
CO3	2	-	3	-	2	-	-	1	3	2	3			3
CO4	2	-	2	-	2	-	-	1	3	2	3			3
CO5	1	-	3	-	2	3	-	1	3	3	3			3
CO6	2	-	3	3	2	2	-	1	3	3	3			2
Avg	2.0	-	2.3	3	1.8	2.5	-	1.00	1.00	3	3			2.50

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

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

S.No	Activity	Hours	COs / TS	Evaluation Criteria
1	**Explore and practice project planning and scheduling using Microsoft Project. Create a Work Breakdown Structure (WBS), Gantt Chart, and Network Diagram for a sample software project. Study Agile and Scrum methodologies using Jira and prepare sprint backlogs.**	Total = 15 hrs	CO1–CO4 TS1–TS4	Report + Presentation based on implementation
2	**Analyze case studies of successful and failed software projects to identify project management challenges and solutions.** **Prepare a risk management plan and perform cost estimation for a mini software project.**	Total = 15 hrs	CO2, CO3 TS2, TS3	Report + Presentation based on implementation

3	**Explore software quality assurance practices, CMM levels, and software review techniques through online resources and research papers. Develop project documentation including project scope, scheduling reports, resource allocation, and progress tracking reports.**	Total = 15 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 (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

SEPM — 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

Big Data Analytics (CSDS3103)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2028–2029
Branch:	CS & ME	**Semester:**	V
Course Code:	CSDS3103	**Course Type:**	Elective – Integrated

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:** **THEORY COs — Assessed via MTE + ETE:** **CO1** (Remember – L1): Define the fundamental concepts of Big Data analysis. **CO2** (Understand – L2): Demonstrate and explain appropriate techniques and tools to solve actual Big Data problems (derive value from vast data sets). **CO3** (Apply – L3): Develop the distributed and parallel computing and its application for big data analysis. **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. **CO6** (Create – L6): Compile and contrast among different big data analytics tools and how they can help solving Industry challenges. **LAB COs — Assessed via Laboratory Assessment only:** **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. **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. **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. **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). 2. Virtual Labs (NPTEL/SWAYAM): Big Data experiments on Hadoop, Spark, and HDFS. 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 Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012 Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer 2007 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. • Discussion on characteristics of Big Data (5Vs) with real-world examples • Demonstration of large dataset handling using Apache Hadoop vs traditional systems • Case study: Failure of conventional databases in handling large-scale data • Demo: Data ingestion using Apache Kafka or Apache Flume • 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:** To enable students to understand and apply scalable data mining and machine learning techniques on large datasets. • Demonstration of Apriori algorithm using Weka • Clustering demo (K-means) using Spark MLlib • Decision Tree model building using Apache Mahout • Visualization of classification results and model accuracy • 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:** To provide hands-on understanding of Hadoop ecosystem, distributed storage, and processing frameworks. • Installation/demo of Apache Hadoop (pseudo-distributed mode) • Demonstration of file operations in HDFS • Execution of basic MapReduce programs (Word Count) • Query execution using Apache Hive • 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:** To enable students to perform real-time data analytics and apply advanced models on streaming data. • Regression modelling demo using large datasets • Real-time stream processing demo using Apache Spark Streaming • Demonstration of data pipelines using Apache Flink • Case study: Real-time analytics (stock market / social media) • 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:** To enable students to analyze, interpret, and visualize large datasets using modern visualization and text analytics tools. • Dashboard creation using Tableau or Power BI • Visualization of big datasets using Apache Superset • Text analytics demo using NLTK • 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 (a) Install and configure Apache Hadoop (b) Run basic Linux commands for file/directory handling (c) Start Hadoop services	CO7	3.0
	S-1.2	ii. Hadoop Basics (a) Explore Hadoop ecosystem (b) Execute basic Hadoop commands (c) Check cluster status	CO7	
W2	S-2.1	i. HDFS Operations (a) Create directories in HDFS (b) Upload and download files (c) Analyze file blocks and replication	CO7	3.0
	S-2.2	i. Advanced HDFS Commands (a) File permissions and access control (b) Monitoring HDFS status (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 (a) Create database and tables (b) Load datasets into Hive	CO7	3.0
	S-4.2	i. Hive Queries (a) SELECT, WHERE, GROUP BY (b) Aggregation operations	CO7	
W5	S-5.1	i. Advanced Hive (a) Joins and subqueries (b) Partitioning and bucketing	CO7	3.0
	S-5.2	i. Introduction to Pig (a) Write basic Pig scripts (b) Perform data transformations	CO7	
W6	S-6.1	i. Pig Latin Programming (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 (a) Run Spark shell (b) Perform basic RDD operations	CO7	3.0
	S-7.2	i. Spark Transformations and Actions (a) Implement Word Count using Spark	CO7	
W8	S-8.1	i. Spark DataFrames (a) Create and manipulate DataFrames	CO7	3.0
	S-8.2	i. Spark SQL (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 (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 (a) Import dataset (b) Create charts	**CO8**	3.0
	S-13.2	i. Dashboard creation and storytelling	**CO8**	
W14	S-14.1	i. Text Analytics (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 (a) Data ingestion → processing → visualization	**CO8/CO9**	3.0
	S-15.2	i. Setting up Big Data Environment (a) Install and configure Apache Hadoop (b) Run basic Linux commands for file/directory handling (c) Start Hadoop services	**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, 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 &**	Compare different big data approaches; evaluate time/space trade-offs; justify tool choices with performance	CO5 | L5	ETE Sec B/C

	Algorithmic Justification	evidence.		
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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 P9 — Statistical/comparative analysis; technical report	2: Rigorous | 1.5: Good | 1: Basic | 0: Absent	CO8, CO10 / PO6
Communication,	**2.0**	P3 — Communication plan and testing	2: Excellent | 1.5:	CO10 / PO8,

Presentation & Teamwork		strategy P10 — Professional presentation quality and delivery	Good | 1: Adequate | 0: Poor	PO9
Skill Reflection, Ethics & Professional Attitudes	**1.0**	P12 — Skill growth mapping (pre/post project) 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**	Evaluate actual outcomes against goals; quantify impact using defined	CO8 | PO6

	Impact & Outcome	metrics	
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*

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

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	3 (High)	Develops industry-relevant programming and professional tool

	Growth		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 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

★ *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

BDA 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

Natural Language Processing (CSAI4200)

*School of Engineering & Technology (SET) | **B. Tech (CSE) with Specialization in CS & ME** | Semester V | 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 — School of Smart Computing Science & Engineering	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2028–2029
Branch:	CS & ME	**Semester:**	V
Course Code:	CSAI4200	**Course Type:**	Elective

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**	CSAI4200
2	**Course Title**	**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. 2. Enable students to apply NLP algorithms and programming techniques for processing natural language text. 3. Develop understanding of morphology, syntax, semantics, discourse, and pragmatics in NLP systems. 4. Familiarize learners with lexical resources, text corpora, and machine learning approaches for NLP tasks. **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:** CO1: (Understand – L1/L2): Define computational linguistics concepts, NLP fundamentals, ambiguity, and language processing techniques. CO2: (Explore – L2/L3): Explain text corpora, lexical resources, and language understanding techniques used in NLP systems. CO3: (Apply – L3): Apply NLP programming concepts, regular expressions, lexical resources, and Python libraries for raw text processing. CO4: (Analyze – L4): Analyze tagging methods, classification techniques, and information extraction approaches from textual data. CO5: (Analyze – L4/L5): Analyze sentence structures, semantic interpretation, logic representations, and deep learning sequence models in NLP. 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. 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. 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

⚠ **CO***5 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	PO12	PSO1	PSO2	PSO3
CO1	3	2	–	–	2	–	–	–	–	–	2	2	2	2	3
CO2	2	2	–	–	3	–	–	–	–	–	2	2	2	2	2
CO3	2	2	3	–	3	–	–	1	–	1	2	3	3	3	2
CO4	2	3	–	–	3	–	–	–	–	–	2	1	1	1	2
CO5	2	3	–	–	1	–	–	–	–	–	1	1	1	1	2
CO6	3	3	3	3	3	2	–	3	–	2	3	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**	**2.0**	**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	PO12	PSO1	PSO2	PSO3
CO1	H	M			M						M	M	M	M	H
CO2	M	M			H						M	M	M	M	M
CO3	M	M	H		H			M		M	M	H	H	H	M
CO4	M	H			H						M	M	M	M	M
CO5	M	H			M						M	M	M	M	M

CO6	H	H	H	H	H	M		H		M	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	**NLP Programming Assignments and Text Analysis**	5 assignments × 5 hrs each Total = 25 hrs	CO1–CO4 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 Report preparation: 3 hrs Presentation: 2 hrs Total = 10 hrs	CO2, CO3 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 Report preparation: 3 hrs 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 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 (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

Digital Forensics (CSCF2100)

School of Engineering & Technology (SET) | B.Tech CS & ME | Semester V | 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:	School of Engineering & Technology (SET)	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2028-2029
Branch:	CS & ME	**Semester:**	V
Course Code:	CSCF2100	**Course Type:**	Elective course

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**	CSCF2100
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)

S.No	Attribute	Details
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.
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)	
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

	Topic	CO Mapping
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		✔	✔	✔		
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			✔		✔	✔

S.No	Topic	L1 Remember	L2 Understand	L3 Apply	L4 Analyze	L5 Evaluate	L6 Create
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			✔	✔										✔				
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		

Date	Topics to be Covered	UNIT	Total Lectures
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		
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

CO	TS1 Digital Forensics Fundamentals	TS2 Forensic Investigation	TS3 Data Recovery & Tools	TS4 Network Forensics	TS5 E-mail & Steganography	TS6 Reporting & Communication

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
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

CO	CO Statement (Short)	CA (25)	MTE (15)	ETE (60)	TS	PO Primary
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 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–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

Communication, Coding and Career Readiness Skills (SKP3501)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | Semester VI | 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 & Lab Session Plan*

1. Course Identification

School:	SSCSE	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2028–2029
Branch:	CSE	**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: **CO1 (Remember – L1):Fundamentals of Professional Communication & Intelligent Systems** 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. **CO2 (Understand – L2): Principles of Leadership, AI Models & Frontend Architecture** 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. **CO3 (Apply – L3): Application of Employability Skills & Computational Workflows** 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. **CO4 (Analyze – L4):Analysis of Communication Competencies & Scalable System Design** 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** 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. **CO6 (Create – L6): Creation of Professional Profiles & AI-Powered Applications** 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**	1. **Soft Skills: Know Yourself & Know the World** – Dr. Alex K. 2. **Quantitative Aptitude for Competitive Examinations**– R.S. Aggarwal 3. **A Modern Approach to Verbal & Non-Verbal Reasoning** – R.S. Aggarwal 4. **Business Communication** – Meenakshi Raman & Prakash Singh 5. Word Power Made Easy – Norman Lewis 6. Jurafsky and Martin – Speech and Language Processing 7. AurélienGéron – Hands-On Machine Learning with Scikit-Learn and TensorFlow 8. Jon Duckett – React and Modern Frontend Development 9. Thomas H. Cormen – Introduction to Algorithms 10. Full Stack Open Documentation and React Official Docs
13	**References**	1 Ian Goodfellow – Deep Learning 2 Sebastian Raschka – Build a Large Language Model From Scratch 3 Kyle Simpson – You Don't Know JS 4. Aditya Bhargava – Grokking Algorithms 5 David Flanagan – JavaScript: The Definitive Guide 6 Hugging Face Documentation 7 OpenAI API Documentation 8 React Official Documentation 9 Redux Toolkit Documentation 10 LeetCode Advanced DSA Problems 11 GeeksforGeeks – DP and Graph Algorithms 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 verbal communication enhancement.	**CO4**
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 L2 — Understand: Explain ideas, concepts, principles L3 — Apply: Use knowledge to solve new problems 4 — Analyze: Break down information, examine patterns 5 — Evaluate: Judge, justify, assess, make decisions 6 — Create: Design, develop, produce new solutions	A1 — Receiving: Awareness, willingness to attend \n A2 — Responding: Active participation and reaction \n 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.

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: SET	**Batch: 2026-2030**
Program: B.Tech.	**Current Academic Year: 2028-29**

Branch:		**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. 2. To understand the significance of problem and its scope. 3. Students will make decisions within a framework.	
7	Course Outcomes	Students will be able to: CO1: Identify and formulate problem statement. CO2: Design relational database schema. CO3: Develop the solution by using different aspects of programming language. CO4: Classify and understand various test techniques for verification and validation of project. CO5: Analyze and make use of modern for solving real word problems. 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. 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	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
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: SET		**Batch: 2026-2030**	
Program: B Tech.		**Current Academic Year: 2028-2029**	
Branch: CSE		**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. 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. 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: 1. **CO1: Students develop awareness** of the social, health, and environmental challenges faced by the community 2. **C02: Students are more appreciative** of socio-economic realities beyond textbooks and classrooms 3. **CO3: Students learn to apply their knowledge** through research, awareness creation, and services for community benefit 4. **CO4: Students are able to carry** out community-based projects with sincerity, teamwork and timely delivery 5. **CO5: Students learn to respectfully engage** with communities with purposive intent to contribute to society and sustainable development 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	CE	ESE
		30%	30%	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		**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. 2. Develop and refine oral and written communication skills. 3. Identify areas for future knowledge and skill development.	
6	Course Outcomes	Students will be able to: • CO1. Integrate the concepts and strategies of academic study in a real time environment. • CO2. Identify, formulate and model problems and find engineering solution based on a systems approach. • CO3. Develop teamwork and apply prior acquired knowledge in problem solving. • CO4. Develop communication, interpersonal and other critical skills required for career growth. • CO5. Practice engineer's responsibilities, self-understanding, self-discipline and ethical standards. • 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	PO 10	PO 11	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 V	Credits: 23
Course Code	Course Name
CSME3300	Signal Systems and Medical Engineering
CSCR3311	Design and Analysis of Algorithm
CSAD2100	Software Engineering and Project Management
SKP3501	Communication, coding and career Readiness skills
CSCR3600	Project Based Learning (PBL) -3 (Hackathon Based)
CCP3001	Community Connect
CSCR3700	Summer Internship-I
Program Elective-2	
CSDS3103	Big Data Analytics
CSAI4200	Natural Language Processing
CSCF2100	Digital Forensics

COURSE PLAN

Deep Learning and Reinforcement Learning in Medical Data (CSME3301)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | Semester VI | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2028–2029
Branch:	CSE	**Semester:**	VI
Course Code:	CSME3301	**Course Type:**	Core – Integrated

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**	CSME6300
2	**Course Title**	Deep Learning and Reinforcement Learning in Medical Data
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-3
5	**Course Status**	Core - Integrated
6	**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. This course aims to introduce students to recent advances in deep learning in healthcare and the application of deep learning algorithms to medical data, including practical considerations for adapting models to the diversity of healthcare data.
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** 1. CO1 (Remember – L1): Recall Neural Networks relate it with Deep Learning concepts to solve real-life applications 2. CO2 (Understand – L2): Compare and classify Regularization approaches for Deep Learning. 3. CO3 (Apply – L3): Build Convolutional Neural Network models for image analysis and their applicability in societal problem solving. 4. CO4 (Analyse – L4): Examine the Sequence models and analyse the relationships among them. 5. CO5 (Evaluate – L5): Adapt neural networks to complex clinical data, predicting patient

		trajectories and automating treatment decisions. 6. CO6 (Create – L6): Predict the behavior of Deep learning models and apply them to solve real-life applications. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Utilize deep learning frameworks such as TensorFlow, Keras, or PyTorch to design and build neural networks. CO8 (Create – L5/L6): Implement and evaluate core deep learning architectures like Multi-Layer Perceptrons (MLPs), Convolutional Neural Networks (CNNs), and Recurrent Neural Networks (RNNs). CO9 (Apply – L2/L3): Apply deep learning models to real-world datasets for domains such as image classification, natural language processing, and sequence modeling. CO10 (Apply – L3): Interpret model performance by fine-tuning hyperparameters and evaluating metrics to prevent issues like overfitting
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: 45 hrs.)**	1. https://learn.deeplearning.ai/ 2. https://course.fast.ai/ MOOC Courses - Coursera Deep Learning Course, Udacity – Deep Learning
11	**References**	1. Deep Learning, by Goodfellow I., Bengio Y. & Courville A. (2016) 2. Visualizing and Understanding Convolutional Networks, by Matt Zeiler, Rob Fergus 3. TensorFlow: a system for large-scale machine learning, by Martín A., Paul B., Jianmin C., Zhifeng C., Andy D. et al. (2019) 4. Deep learning in neural networks, by JuergenSchmidhuber (2015) 5. https://cs230.stanford.edu/syllabus/ 6. https://towardsdatascience.com/september-edition-machine-learning-case-studies-a3a61dc94f23 7. Deep Learning: A Practitioner's Approach by Josh Patterson, Oreilly. 8. https://www.cs.ox.ac.uk/teaching/courses/2024-2025/dlhealthcare/ 9. https://www.coursera.org/specializations/reinforcement-learning#courses

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	**Deep Feed Forward Networks (5-0-5-5 = 15 hrs)**	
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	
C	Architecture Design- Hidden Units Back-Propagation and Other Differentiation Algorithms	
Tools Used	Google Colab, PyTorch.	
Activities	**Objective:** • To familiarize students with the Google Colab environment. • To make students learn the implementation of various activation functions.	
Unit 2	**Regularization with Deep Learning (10-0-7-8) = 25 hrs)**	

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, Basic Algorithms: Stochastic Gradient Descent, Momentum, Nesterov Momentum Parameter Initialization Strategies Algorithms with Adaptive Learning Rates, AdaGrad. RMSProp. Adam	
C	Introduction to Autoencoder, Undercomplete Autoencoder, Regularized Autoencoders, Representational Power, Layer Size and Depth. Stochastic Encoders and Decoders, Applications of Encoder Decoder models	
Tools Used	PyTorch. TensorFlow, Keras, Hugging Face, NVIDIA NGC	
Activities	**Objective:** • To implement regularization method based prcaticals. • Understand and demonstrate the Adagrad (Adaptive Gradient) optimizer. • WAP to understand the architecture and training process of an Autoencoder	
Unit 3	**Convolution Neural Networks (10-0-8-10) = 30 hrs)**	
A	Introduction to CNN: 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	
C	Efficient Convolution Algorithms, Random or Unsupervised Features of CNN , Normalization, Applications of CNN in Computer Vision – ImageNet	
Tools Used	PyTorch. TensorFlow, Keras, Hugging Face, NVIDIA NGC	
Activities	**Objective:** • To build a CNN and understand the impact of padding. • To understand the various datasets like MNIST, CIFAR-10, ImageNet and implement using variation in the number of filters, dropout layers and learning rate.	
Unit 4	**Sequence Modeling: Recurrent Neural Networks (10-0-8-10) = 30 hrs)**	
A	Sequence Learning Problems, Recurrent Neural Network and its significance in the 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	
C	Introduction of Long Short Term Memory Neural Networks, Learning Algorithm of LSTM/ RNN Bidirectional LSTMs	
Tools Used	PyTorch. TensorFlow, Keras, Hugging Face, NVIDIA NGC	
Activities	**Objective:** • To implement sequence learning problems. • To implement LSTM/GRUs.	
Unit 5	**Reinforcement Learning(10-0-7-12) = 29 hrs)**	
A	Fundamentals of Reinforcement Learning	CO2, CO3, CO4, CO5, CO6
B	Sample Based Learning Methods	

C	Prediction and Control with Function Approximation	
Tools Used	PyTorch. TensorFlow, Keras, Hugging Face, NVIDIA NGC	
Activities	**Objective:** • To understand and implement GANs. • To understand the working of deep networks by selecting hyperparameters and debugging startegies.	

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	Recall Neural networks, Deep learning, and its Practical aspects for real-life applications, Introduction to Simple Deep Neural Networks	Unit 1	5
DD/MM/YY	Platform for Deep Learning, Deep Learning Software Libraries		
DD/MM/YY	Introduction to Deep Feed Forward Networks, Learning XOR, Gradient-Based Learning,		
DD/MM/YY	Activation Functions, ReLU, Softmax, Sigmoid, Error Functions		
DD/MM/YY	Architecture Design- Hidden Units Back-Propagation and Other Differentiation Algorithms		
DD/MM/YY	Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems,	Unit 2	10
DD/MM/YY	Dataset Augmentation, Noise Robustness, Semi-Supervised Learning,		
DD/MM/YY	Multitask Learning, Early Stopping, Parameter Tying and Parameter Sharing, Bagging,		
DD/MM/YY	Drop Out, Difficulty of training deep neural networks, Greedy layer-wise training, Adversarial Training		
DD/MM/YY	How Learning Differs from Pure Optimization, Challenges in Neural Network Optimization,		
DD/MM/YY	Basic Algorithms: Stochastic Gradient Descent, Momentum, Nesterov Momentum Parameter Initialization Strategies		
DD/MM/YY	Algorithms with Adaptive Learning Rates, AdaGrad. RMSProp. Adam		
DD/MM/YY	Introduction to Autoencoder, Undercomplete Autoencoder		
DD/MM/YY	Regularized Autoencoders, Representational Power, Layer Size, and Depth.		
DD/MM/YY	Stochastic Encoders and Decoders, Applications of Encoder-Decoder models		
DD/MM/YY	Introduction to CNN: Role, significance, and applicability in societal problem solving	Unit 3	10
DD/MM/YY	The Convolution Operation, Motivation, and Pooling		
DD/MM/YY	The Neuroscientific Basis for Convolutional Networks		
DD/MM/YY	Prior Probability Distribution, Convolution, and Pooling as an Infinitely Strong Prior,		
DD/MM/YY	Variants of the Basic Convolution Function, Structured Outputs		
DD/MM/YY	Data types with different dimensionalities and numbers of channels		
DD/MM/YY	Efficient Convolution Algorithms		
DD/MM/YY	Random or Unsupervised Features of CNN		
DD/MM/YY	Normalization		
DD/MM/YY	Applications of CNN in Computer Vision – ImageNet		
DD/MM/YY	Sequence Learning Problems	Unit 4	10
DD/MM/YY	Recurrent Neural Network and its significance in real world		

DD/MM/YY	RNN model		
DD/MM/YY	Backpropagation through time, Bidirectional RNNs		
DD/MM/YY	Different types of RNNs		
DD/MM/YY	Gated Recurrent Unit (GRU)		
DD/MM/YY	Recursive Neural Networks: The Challenge of Long-Term Dependencies		
DD/MM/YY	Introduction of Long Short-Term Memory Neural Networks		
DD/MM/YY	Learning Algorithm of LSTM/ RNN Bidirectional LSTMs		
DD/MM/YY	Learning Algorithm of LSTM/ RNN Bidirectional LSTMs		
DD/MM/YY	Fundamentals of Reinforcement Learning	**Unit 5**	10
DD/MM/YY	Sample Based Learning Methods		
DD/MM/YY	Sample Based Learning Methods		
DD/MM/YY	Sample Based Learning Methods		
DD/MM/YY	Sample Based Learning Methods		
DD/MM/YY	Prediction and Control with Function Approximation		
DD/MM/YY	Prediction and Control with Function Approximation		
DD/MM/YY	Prediction and Control with Function Approximation		
DD/MM/YY	Prediction and Control with Function Approximation		
DD/MM/YY	Prediction and Control with Function Approximation		

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 implement a Single Layer Perceptron and apply Activation Functions.	**CO7**	3.0
	S-1.2	Write a program to predict Housing Price using Multiple Linear Regression.	**CO7**	
W2	S-2.1	Write a program to implement Deep Feed Forward Network to predict Housing price available on Kaggle.	**CO7**	3.0
	S-2.2	Write a program to implement classification using Deep Feed Forward Network on dataset available on Kaggle.	**CO7**	
W3	S-3.1	Write a program to implement Classification using Deep Feed Forward Network.	**CO7**	3.0
	S-3.2	Write a program to implement Classification using Logistic Regression.	**CO7**	
W4	S-4.1	Write a program to implement Deep Neural Network for the Concrete dataset using keras.	**CO7**	3.0
	S-4.2	Write a program to implement regularization to overcome over fitting problem in Housing price Prediction	**CO7**	

W5	S-5.1	Write a program to implement a linear model for the Red Wine Quality dataset.	**CO7**	3.0
	S-5.2	Digit Recognition from MNIST : Given a zip codes hand written on envelops, identify the digit for each hand written character. A model of this problem would allow a computer program to read and understand handwritten zip codes and sort envelops by geographic region	**CO7**	
W6	S-6.1	Digit Recognition from MNIST : Given a zip codes hand written on envelops, identify the digit for each hand written character. A model of this problem would allow a computer program to read and understand handwritten zip codes and sort envelops by geographic region	**CO7**	3.0
	S-6.2	Write a program to implement regularization (Lasso and ridge) to overcome over fitting problem in Housing Price Prediction.	**CO7**	
W7	S-7.1	Dog-Breed Classifier: Design and train a convolutional neural network to analyze images of dogs and correctly identify their breeds. Use transfer learning and well-known architectures to improve this model—this is excellent preparation for more advanced applications	**CO7**	3.0
	S-7.2	Dog-Breed Classifier: Design and train a convolutional neural network to analyze images of dogs and correctly identify their breeds. Use transfer learning and well-known architectures to improve this model—this is excellent preparation for more advanced applications	**CO7**	
W8	S-8.1	WAP to implement Bagging and Boosting algorithms and classification using data augmentation.	**CO7**	3.0
	S-8.2	WAP to demonstrate effect of Dropout Probability on Model Performance.	**CO7**	
W9	S-9.1	Stock market prediction on NASDAQ stocks: Given the current and past price movements for a stock, determine whether the stock should be bought, held or sold. A model of this decision problem could provide decision support to financial analysts	**CO7**	3.0
	S-9.2	The Slot-Filling (Spoken Language Understanding) consists in assigning a label to each word given a sentence. It's a classification task.	**CO7**	
W10	S-10.1	WAP to understand and demonstrate the Adagrad (Adaptive Gradient) optimizer	**CO7**	3.0
	S-10.2	Write a program to implement credit card fraud detection prediction.	**CO7**	
W11	S-11.1	WAP to understand the architecture and training process of an Autoencoder	**CO7**	3.0
	S-11.2	WAP to understand the architecture and training process of an Autoencoder	**CO7**	
W12	S-12.1	Implement Convolutional Autoencoders in Python with Keras on MNIST dataset	**CO7**	3.0
	S-12.2	Implement Convolutional Autoencoders in Python with Keras on MNIST dataset	**CO7**	
W13	S-13.1	WAP to build a CNN and understand the impact of padding	**CO8**	3.0
	S-13.2	WAP to build a CNN and understand the impact of padding	**CO8**	
W14	S-14.1	Write a program to implement Generative Adversarial Network	**CO8/CO9**	3.0
	S-14.2	Write a program to implement Generative Adversarial Network	**CO8/CO10**	
W15	S-15.1		**CO8/CO9**	3.0
	S-15.2		**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	**Deep Feed Forward Networks**	Recall Neural Networks, Activation functions	CO1 | L1–L2	MTE Sec A | ETE Sec A
TS2	**Regularization for Deep Learning**	Understand regularization, parameter norm penalties, early stopping, bagging, adaptive learning rates algorithms, autoencoders etc.	CO2 | L2	MTE Sec A | ETE Sec A
TS3	**Convolutional Neural Networks**	Understanding CNN and its components, efficient CNN algorithms etc.	CO3 | L3	MTE Sec B | ETE Sec B
TS4	**Sequence Modeling: Recurrent Neural Networks**	Understanding sequence learning problems, RNNs, GRUs, and LSTMs	CO4 | L4	MTE Sec B | ETE Sec B
TS5	**Regularization Learning**	Practical design process for regularization learning techniques based on real-world problems:	CO5 | L5	ETE Sec B/C
TS6	**Regularization Learning**	Practical design process for regularization learning techniques based on real-world problems:	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 — Deep Feed Forward Networks, TS2 — Regularization for Deep Learning	**CO1, CO2**	Short-answer: definitions, activation functions, regularization, and its types.
Sec B	**6**	TS3 — Convolution Neural Networks, TS4 — Sequence Modeling	**CO3, CO4**	CNN and Its Components, Sequence learning problems, and algorithms
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 — Deep Feed Forward Networks, TS2 — Regularization for Deep Learning	**CO1, CO2**	Short questions: concept MCQs (all units)
Sec B	**50**	TS3 — Convolution Neural Networks, TS4 — Sequence Modeling	**CO3, CO4, CO5**	Medium questions: algorithm comparison, complexity analysis

Sec C	**25**	TS5 — practical design process, TS6 — architectural design components	**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 CA2 — Experimental design and tool configuration 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 CA4 — Efficiency: time/space complexity, optimization	1.0: Correct & efficient | 0.5: Correct, not optimized | 0: Fails	CO7
Output Analysis, Outcome & Lab	**0.75**	CA5 — Output analysis and result interpretation	0.75: Thorough | 0.5: Adequate | 0.25: Partial |	CO8, CO9

Documentation		CA6 — Documented outcome with verification CA8 — Lab record completeness; viva-voce comprehension	0: Absent	
Professional Attitude & Ethical Conduct	**0.25**	CO9 — Documentation ethics, responsible practice 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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																					
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 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 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

★ *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

CSME3301 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

Embedded System and Wearable Devices (CSME3100)

Sharda School of Computing Science & Engineering | B.Tech CS&ML | 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 and Engineering	**Batch:**	2024-28
Program:	B.Tech	**Current Academic Year:**	2028-2029
Branch:	CS & ME	**Semester:**	VI
Course Code:	CSME3100	**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**	CSME3100
2	**Course Title**	**Embedded System and Wearable Devices**
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**	After completing the course, students will be able to: 1. Understand embedded system architecture and programming fundamentals. 2. Explain wearable device architecture and sensing technologies. 3. Develop embedded applications using sensors and wireless communication. 4. Apply Machine Learning techniques for wearable and edge computing applications. 5. Analyze security, privacy, and power optimization issues in wearable systems.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** **CO1:** Explain embedded system architecture, microcontrollers, memory organization, and embedded software. **CO2:** Design embedded applications using sensors, actuators, communication protocols, and embedded operating systems. **CO3:** Analyze wearable device architectures, physiological sensors, and wireless body area networks. **CO4:** Develop AI-enabled wearable applications using TinyML, edge computing, and cloud integration. **CO5:** Evaluate security, privacy, energy efficiency, and ethical issues in wearable computing systems. **CO6:** Design intelligent wearable solutions for healthcare, fitness, smart industry, and smart environments.

8	**Course Description**	This course introduces the principles of embedded systems and their integration with wearable technologies. Students will learn embedded hardware, microcontrollers, sensors, wireless communication, edge AI, TinyML, wearable operating systems, security, power management, and real-world healthcare and industrial 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**	1. Tammy Noergaard, Embedded Systems Architecture, 2nd Edition, Elsevier. 2. Frank Vahid & Tony Givargis, Embedded System Design, Wiley. 3. Peter Marwedel, Embedded System Design, Springer. 4. John G. Webster, Wearable Sensors: Fundamentals, Implementation and Applications, Academic Press. 5. Shuvra S. Bhattacharyya et al., Embedded Systems Design with Platform FPGAs, Morgan Kaufmann.
12	**References**	1. Jonathan W. Valvano, Embedded Microcomputer Systems, Cengage. 2. David E. Simon, An Embedded Software Primer, Addison-Wesley. 3. Michael Miller, Wearable Technology, Pearson. 4. Pete Warden & Daniel Situnayake, TinyML, O'Reilly. 5. Joseph Yiu, The Definitive Guide to ARM Cortex-M Processors, Elsevier.

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 I: Fundamentals of Embedded Systems	
A	Introduction to Embedded Systems – Characteristics, Classification, Embedded vs. General Purpose Computing, Embedded Hardware Architecture	**CO1**
B	Microcontrollers, ARM Cortex-M Architecture, Memory Organization, GPIO, Timers, Interrupts, ADC/DAC	**CO1, CO2**
C	Embedded C Programming, Development Tools, IDEs, Cross Compilation, Debugging Techniques	**CO2**
	Unit II: Embedded System Design and Communication	
A	Embedded Software Design Flow, Real-Time Operating Systems (RTOS), Task Scheduling, Interrupt Handling, Device Drivers	**CO2**
B	Sensor Interfacing, Actuators, UART, SPI, I²C, CAN Communication Protocols	**CO2, CO3**
C	Bluetooth Low Energy (BLE), Wi-Fi, MQTT, Power Management Techniques, Edge Devices	**CO2, CO5**
	Unit III: Wearable Devices and Smart Sensors	
A	Introduction to Wearable Computing, Types of Wearables, Smart Watches, Smart Bands, Smart Glasses, Smart Clothing	**CO3**
B	Wearable Sensors – Accelerometer, Gyroscope, ECG, EMG, EEG, Temperature Sensor, Pulse Oximeter, Heart Rate Monitoring	**CO3**
C	Flexible Electronics, Body Area Networks (BAN), Wireless Health Monitoring	**CO3, CO6**

	Unit IV: AI for Wearable Devices	
A	Edge AI, TinyML Fundamentals, TensorFlow Lite for Microcontrollers, Tiny Neural Networks	**CO4**
B	Sensor Data Analytics, Activity Recognition, Human Activity Detection, Fall Detection, Gesture Recognition	**CO4**
C	Anomaly Detection, Federated Learning Basics, Cloud and Edge Integration, AI-enabled Healthcare Systems	**CO4, CO6**
	Unit V: Security, Privacy and Applications	
A	Security Challenges, Authentication, Encryption, Secure Boot, Trusted Execution Environment, Privacy Preservation	**CO5**
B	Battery Management Systems, Energy Harvesting, Sustainable Wearables, Energy-Efficient Embedded Design	**CO5**
C	Medical Wearables, Industrial Wearables, Smart Healthcare, Sports Analytics, AR/VR Wearables, Future Trends in Intelligent Wearable Computing	**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	Topics to be Covered / Title	UNIT	Total Lectures
DD/MM/YY	Introduction to Embedded Systems, Characteristics and Applications	UNIT–1	9
DD/MM/YY	Classification of Embedded Systems, Embedded vs. General Purpose Computing		
DD/MM/YY	Embedded Hardware Architecture and Design Considerations		
DD/MM/YY	Microcontrollers and ARM Cortex-M Architecture		
DD/MM/YY	Memory Organization, GPIO, Timers		
DD/MM/YY	Interrupts, ADC and DAC		
DD/MM/YY	Embedded C Programming Fundamentals		
DD/MM/YY	Development Tools, IDEs and Cross Compilation		
DD/MM/YY	Debugging Techniques and Unit-I Review		
DD/MM/YY	Embedded Software Design Flow	UNIT–2	9
DD/MM/YY	Real-Time Operating Systems (RTOS) and Task Scheduling		
DD/MM/YY	Interrupt Handling and Device Drivers		
DD/MM/YY	Sensor Interfacing and Actuators		
DD/MM/YY	UART, SPI and I²C Communication Protocols		
DD/MM/YY	CAN Bus and Bluetooth Low Energy (BLE)		
DD/MM/YY	Wi-Fi, MQTT and Embedded IoT Communication		
DD/MM/YY	Power Management Techniques and Edge Devices		
DD/MM/YY	Unit-II Discussion and Case Study		
DD/MM/YY	Introduction to Wearable Computing	UNIT–3	9
DD/MM/YY	Types of Wearables: Smart Watches, Bands, Glasses and Clothing		
DD/MM/YY	Wearable Sensors: Accelerometer and Gyroscope		
DD/MM/YY	Biomedical Sensors: ECG, EMG and EEG		
DD/MM/YY	Temperature, Pulse Oximeter (SpO_2) and Heart Rate Monitoring		
DD/MM/YY	Flexible Electronics and Smart Materials		
DD/MM/YY	Body Area Networks (BAN)		
DD/MM/YY	Wireless Health Monitoring and Unit-III Review		
DD/MM/YY	Edge AI and TinyML Fundamentals	UNIT–4	9
DD/MM/YY	TensorFlow Lite for Microcontrollers		
DD/MM/YY	Tiny Neural Networks and Embedded AI		
DD/MM/YY	Sensor Data Analytics and Activity Recognition		
DD/MM/YY	Human Activity Detection and Fall Detection		
DD/MM/YY	Gesture Recognition and Anomaly Detection		

Date	Topics to be Covered / Title	UNIT	Total Lectures
DD/MM/YY	Federated Learning and Cloud-Edge Integration		
DD/MM/YY	AI-enabled Healthcare Systems and Unit-IV Review		
DD/MM/YY	Security Challenges in Embedded and Wearable Systems	UNIT–5	9
DD/MM/YY	Authentication, Encryption and Secure Boot		
DD/MM/YY	Trusted Execution Environment and Privacy Preservation		
DD/MM/YY	Battery Management Systems and Energy Harvesting		
DD/MM/YY	Sustainable Wearables and Low-Power Design		
DD/MM/YY	Medical, Industrial and Smart Healthcare Wearables		
DD/MM/YY	Sports Analytics and AR/VR Wearables		
DD/MM/YY	Future Trends in Intelligent Wearable Computing		
DD/MM/YY	Course Review, Case Studies and End Semester Revision		

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	**Embedded Systems Fundamentals**	Understanding of embedded system concepts, architecture, microcontrollers, ARM Cortex-M, memory organization, and embedded programming principles.	**CO1 / L2**	CA, MTE, ETE
TS2	**Embedded System Design and Communication**	Ability to apply embedded software design, RTOS concepts, sensor interfacing, communication protocols (UART, SPI, I²C, CAN, BLE, Wi-Fi), and power management techniques.	**CO2 / L3**	CA, MTE, ETE
TS3	**Wearable Computing and Smart Sensor Analysis**	Ability to analyze wearable architectures, physiological sensors, body area networks, and wireless health monitoring systems.	**CO3 / L4**	CA, MTE, ETE
TS4	**AI-Enabled Embedded Intelligence**	Application and analysis of Edge AI, TinyML, TensorFlow Lite, activity recognition, sensor analytics, and AI-enabled wearable applications.	**CO4 / L4**	CA, MTE, ETE
TS5	**Security, Privacy, and Sustainable Embedded Design**	Evaluation of security mechanisms, privacy preservation, authentication, encryption, energy-efficient design, battery management, and sustainable wearable technologies.	**CO5 / L5**	CA, MTE, ETE

TS6	**Intelligent Wearable System Design and Innovation**	Ability to design innovative embedded and wearable solutions for healthcare, fitness, industrial automation, smart environments, and future intelligent systems by integrating embedded computing, AI, and IoT technologies.	**CO6 / L6**	CA, MTE, 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 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
Assignment–1 (Problem Solving & Numerical Exercises)	Embedded system architecture, ARM Cortex-M, memory organization, RTOS scheduling, communication protocols.	**8**	**CO1, CO2**	**TS1, TS2**
Assignment–2 (Technical Video Learning Report)	Review and analysis of recent technologies in Edge AI, TinyML, wearable computing, or embedded IoT (3–5 page report with presentation)	**5**	**CO3, CO4**	**TS3, TS4**
Case Study Analysis	Analysis of a real-world wearable/embedded application (e.g., Smart Healthcare, Industrial Wearables, Smartwatch Architecture, AI-based Health Monitoring)	**7**	**CO4, CO5, CO6**	**TS4, TS5, TS6**
Quiz / Viva / Class Participation	Short quizzes, concept tests, classroom discussions, and technical	**5**	**CO1–CO6**	**TS1–TS6**

	presentations covering all units			
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	Fundamentals of Embedded Systems: Architecture, Microcontrollers, ARM Cortex-M, Memory Organization, GPIO, Timers, Interrupts	**CO1**	**TS1**	**6**	Conceptual understanding, technical accuracy, problem-solving, neat presentation
Assignment 2	Embedded System Design: RTOS, Task Scheduling, Sensor Interfacing, UART, SPI, I²C, CAN, BLE, Wi-Fi, MQTT	**CO2**	**TS2**	**7**	Application of embedded concepts, protocol analysis, correctness of solutions
Assignment 3	Wearable Devices and Smart Sensors: BAN, Biomedical Sensors, Health Monitoring Systems	**CO3**	**TS3**	**6**	Sensor analysis, architecture explanation, comparison of wearable technologies
Assignment 4	AI for Wearable Devices: Edge AI, TinyML, TensorFlow Lite, Activity Recognition, Fall Detection	**CO4**	**TS4**	**7**	AI model interpretation, analytical thinking, application to wearable systems
Assignment 5	Security, Privacy, Power Management, Sustainable Wearables, Emerging Applications	**CO5**	**TS5**	**6**	Critical evaluation, security analysis, energy-efficient design recommendations
Video Learning Report	Review of recent advancements in Embedded AI, TinyML, Smart Wearables, or Embedded IoT (NPTEL/MOOC/IEEE/Industry Talk)	**CO3, CO4**	**TS3, TS4**	**5**	Quality of summary, technical insights, learning outcomes, presentation and referencing
Case Study Report	Analysis of a real-world intelligent wearable system (Smart Healthcare, Industrial Wearables, Smartwatch Ecosystem, AI-based Remote Patient Monitoring)	**CO5, CO6**	**TS5, TS6**	**8**	Problem analysis, innovation, solution evaluation, technical report quality and conclusions

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, TS2**	**CO1, CO2**	Short-answer questions, definitions, embedded system architecture, ARM Cortex-M, memory organization, RTOS basics, communication protocols, numerical/problem-solving questions.
Section B	**15**	**TS2, TS3, TS4**	**CO2, CO3, CO4**	Descriptive and analytical questions on RTOS, sensor interfacing, wearable architectures, BAN, smart sensors, and introductory Edge AI/TinyML concepts. Case-based and application-oriented questions are encouraged.
TOTAL	**25**	**TS1–TS4**	**CO1–CO4**	Balanced assessment covering conceptual understanding, application, and analytical skills across Units 1–3.

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-answer and objective/descriptive questions assessing embedded system fundamentals, ARM architecture, RTOS, embedded programming, communication protocols, and numerical/problem-solving concepts.
Section B	**25**	**TS3, TS4**	**CO3, CO4**	Analytical and application-oriented questions on wearable computing, biomedical sensors, Body Area Networks (BAN), Edge AI, TinyML, activity recognition, and AI-enabled wearable systems. Questions may include case-based scenarios and design-oriented analysis.
Section C	**20**	**TS5, TS6**	**CO5, CO6**	Long-answer questions requiring critical evaluation and system design involving security, privacy, authentication, power management, sustainable wearables, healthcare applications, industrial wearables, and future intelligent wearable solutions.
TOTAL	**60**	**TS1–TS6**	**CO1–CO6**	Comprehensive assessment covering all units with balanced evaluation across Bloom's Taxonomy from understanding to creation.

11.1 CO-wise Assessment Instrument Summary

CO	CO Statement (Short)	CA (25)	MTE (25)	ETE (50)	TS	PO Primary
CO1	Explain embedded system architecture, components, and programming fundamentals.	✔	✔	✔	**TS1**	**PO1**
CO2	Develop embedded applications using RTOS, sensors, actuators, and communication protocols.	✔	✔	✔	**TS2**	**PO3**
CO3	Analyze wearable architectures, smart sensors, and Body Area Networks.	✔	✔	✔	**TS3**	**PO2**
CO4	Apply Edge AI and TinyML techniques for intelligent wearable systems.	✔	✔*	✔	**TS4**	**PO5**
CO5	Evaluate security, privacy, power management, and sustainable embedded systems.	✔	—	✔	**TS5**	**PO8**
CO6	Design innovative wearable solutions for healthcare, industry, and smart environments.	✔	—	✔	**TS6**	**PO3**

⚠ *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	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	–	2	–	–	–	–	–	–	2	3	2	–
CO2	3	3	3	2	3	–	–	–	1	1	–	2	3	3	2
CO3	3	3	2	2	2	1	–	–	–	–	–	2	3	3	2
CO4	3	3	3	3	3	1	–	–	1	1	–	3	3	3	3
CO5	2	3	2	3	3	2	2	3	–	–	–	3	2	3	2
CO6	3	3	3	3	3	2	2	2	2	2	1	3	3	3	3
Avg	2.83	2.83	2.33	2.60	2.67	1.50	2.00	2.50	1.33	1.33	1.00	2.50	2.83	2.83	2.40

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	M			M							M	H	M	
CO2	H	H	H	M	H				M	M		M	H	H	M
CO3	H	H	M	M	M	M						M	H	H	M
CO4	H	H	H	H	H	M			M	M		H	H	H	H
CO5	M	H	M	H	H	M	M	H				H	M	H	M
CO6	H	H	H	H	H	M	M	M	M	M	M	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 1:** Embedded System Fundamentals – Architecture, ARM Cortex-M, Memory Organization, GPIO, Timers, Interrupts	**6**	**CO1 / TS1**	Conceptual understanding, technical accuracy, presentation
2	**Assignment 2:** Embedded Software Design, RTOS, Communication Protocols (UART, SPI, I²C, CAN, BLE, Wi-Fi, MQTT)	**7**	**CO2 / TS2**	Application of concepts, problem-solving ability, correctness

3	**Assignment 3:** Wearable Devices, Smart Sensors, Body Area Networks (BAN), Wireless Health Monitoring	**6**	**CO3 / TS3**	Technical analysis, comparison of technologies, report quality
4	**Assignment 4:** Edge AI, TinyML, TensorFlow Lite, Activity Recognition, Fall Detection	**7**	**CO4 / TS4**	Analytical thinking, AI application, technical interpretation
5	**Assignment 5:** Security, Privacy, Battery Management, Energy Harvesting, Sustainable Wearables	**6**	**CO5 / TS5**	Critical evaluation, innovation, technical justification
6	**Technical Video Learning Report:** Review of an NPTEL/MOOC/IEEE/Industry webinar on Embedded Systems, Edge AI, TinyML, or Wearable Computing	**5**	**CO3, CO4 / TS3, TS4**	Learning outcomes, technical summary, presentation, references
7	**Case Study Report:** Analysis of a real-world intelligent wearable system (e.g., Smart Healthcare, AI-based Patient Monitoring, Industrial Wearables, Smartwatch Ecosystem)	**8**	**CO5, CO6 / TS5, TS6**	Problem analysis, solution evaluation, innovation, 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 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 (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

EMBEDDED SYSTEM AND WEARABLE DEVICES

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

Biomedical Instrumentation (CSME3302)

School of Computing Science and Engineering (SSCSE) | B.Tech CS&ME | 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 and Engineering	**Batch:**	2026–2030

Program:	B.Tech	**Current Academic Year:**	2028-2029
Branch:	CS & ME	**Semester:**	VI
Course Code:	CSME3302	**Course Type:**	Core – Theory

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**	CSME3302
2	**Course Title**	**Biomedical Instrumentation**
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 fundamental knowledge of biomedical instrumentation and healthcare technologies. • Understand biomedical sensors, transducers, and physiological measurement systems. • Apply instrumentation techniques for biomedical signal acquisition and analysis. • Analyze medical imaging and patient monitoring technologies. • Evaluate therapeutic and diagnostic biomedical equipment used in healthcare.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** **CO1 (Understand – L1/L2):** Understand the fundamental concepts of human physiology, biomedical systems, transducers, sensors, and signal acquisition techniques used in healthcare applications. **CO2 (Explore – L2/L3):** Explore the principles and operation of biomedical electrodes, amplifiers, electro-physiological measurement systems, and electrical safety requirements in medical environments. **CO3 (Apply – L3/L4):** Apply biomedical instrumentation techniques to measure physiological and non-electrical parameters such as blood pressure, cardiac output, pulmonary functions, blood gases, and oxygen saturation. **CO4 (Analyze – L4/L5):** Analyze the working principles, performance characteristics, and clinical applications of medical imaging systems, biotelemetry, and patient monitoring technologies. **CO5 (Evaluate – L5/L6):** Evaluate the role of diagnostic, monitoring, and therapeutic biomedical equipment in healthcare delivery, patient care, and clinical decision-making. **CO6 (Create – L5/L6):** Design and interpret biomedical instrumentation solutions by integrating physiological measurements, medical devices, healthcare technologies,

		and intelligent clinical systems for modern healthcare applications.
8	**Course Description**	This course introduces the principles and applications of biomedical instrumentation used for the measurement, monitoring, diagnosis, and treatment of physiological conditions. It covers biomedical sensors, transducers, electrodes, amplifiers, physiological parameter measurements, medical imaging systems, patient monitoring, and therapeutic devices. Students gain an understanding of the interaction between engineering principles and healthcare technologies, enabling them to analyze biomedical signals and instrumentation systems. The course provides a foundation for advanced studies in biomedical engineering, medical diagnostics, intelligent healthcare systems, and clinical instrumentation 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**	1. R. S. Khandpur, *Handbook of Biomedical Instrumentation*, 3rd ed. New Delhi, India: Tata McGraw-Hill Education, 2014. 2. L. Cromwell, F. J. Weibell, and E. A. Pfeiffer, *Biomedical Instrumentation and Measurements*, 2nd ed. New Delhi, India: Pearson Education, 2002. 3. J. G. Webster and J. W. Clark, *Medical Instrumentation: Application and Design*, 4th ed. Hoboken, NJ, USA: John Wiley & Sons, 2010.
12	**References**	1. J. G. Webster and J. W. Clark, *Medical Instrumentation: Application and Design*, 5th ed. Hoboken, NJ, USA: John Wiley & Sons, 2018. 2. R. Rangayyan, *Biomedical Signal Analysis: A Case-Study Approach*, 2nd ed. Hoboken, NJ, USA: John Wiley & Sons, 2015. 3. J. Enderle and J. D. Bronzino, *Introduction to Biomedical Engineering*, 4th ed. Cambridge, MA, USA: Academic Press, 2021.

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:Physiology and Transducers	
A	Cell and its Structure; Resting and Action Potential; Functional Organization of the Nervous System; Structure of Nervous System; Neurons, Synapse, Neurotransmitters and Neural Communication	CO1
B	Cardiovascular System; Respiratory System; Basic Components of a Biomedical System	CO1, CO2
C	Transducers; Selection Criteria; Piezoelectric Transducers; Ultrasonic Transducers; Temperature Measurement; Fiber Optic Temperature Sensors	CO1, CO2
	Unit 2: Electro-Physiological Measurements	

A	Electrodes: Limb Electrodes, Floating Electrodes, Pre-gelled Disposable Electrodes, Micro, Needle and Surface Electrodes	CO2
B	Amplifiers: Preamplifiers, Differential Amplifiers, Chopper Amplifiers, Isolation Amplifiers	CO2, CO3
C	ECG, EEG, EMG, ERG; Lead Systems and Recording Methods; Typical Waveforms; Electrical Safety in Medical Environment; Shock Hazards; Leakage Current; Safety Testing Instruments	CO2, CO3, CO4
	Unit 3: Non-Electrical Parameter Measurements	
A	Measurement of Blood Pressure, Cardiac Output, Heart Rate and Heart Sounds	CO3
B	Pulmonary Function Measurements; Spirometer; Photo Plethysmography; Body Plethysmography	CO3, CO4
C	Blood Gas Analyzers: pH of Blood, pCO_2 and pO_2 Measurements; Finger-tip Oximeter; ESR, GSR Measurements; Standard HL7	CO3, CO4
	Unit 4: Medical Imaging	
A	Radiographic and Fluoroscopic Techniques; X-rays; Computed Tomography (CT); Mammography	CO4
B	MRI, fMRI, Ultrasonography, Endoscopy and Thermography	CO4, CO5
C	Biotelemetry Systems and Patient Monitoring Systems	CO4, CO5
	Unit 5: Assisting and Therapeutic Equipment	
A	Pacemakers, Defibrillators, Ventilators, Nerve Stimulators and Muscle Stimulators	CO5
B	Diathermy, Heart-Lung Machine, Audiometers and Dialyzers	CO5, CO6
C	Lithotripsy; Clinical Applications of Therapeutic Equipment; Intelligent Biomedical Devices and Healthcare Systems	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	Topics to be Covered/Title	UNIT	Total Lectures
DD/MM/YY	Cell and its Structure; Resting and Action Potential	UNIT-1	9
DD/MM/YY	Functional Organization of the Nervous System; Structure of Nervous System		

DD/MM/YY	Neurons, Synapse, Neurotransmitters and Neural Communication		
DD/MM/YY	Cardiovascular System		
DD/MM/YY	Respiratory System		
DD/MM/YY	Basic Components of a Biomedical System		
DD/MM/YY	Transducers; Selection Criteria		
DD/MM/YY	Piezoelectric Transducers; Ultrasonic Transducers		
DD/MM/YY	Temperature Measurement; Fiber Optic Temperature Sensors		
DD/MM/YY	Electrodes: Limb Electrodes, Floating Electrodes	UNIT-2	9
DD/MM/YY	Pre-gelled Disposable Electrodes		
DD/MM/YY	Micro, Needle and Surface Electrodes		
DD/MM/YY	Amplifiers: Preamplifiers		
DD/MM/YY	Differential Amplifiers, Chopper Amplifiers		
DD/MM/YY	Isolation Amplifiers		
DD/MM/YY	ECG, EEG, EMG, ERG; Lead Systems and Recording Methods		
DD/MM/YY	Typical Waveforms; Electrical Safety in Medical Environment		
DD/MM/YY	Shock Hazards; Leakage Current; Safety Testing Instruments		
DD/MM/YY	Measurement of Blood Pressure	UNIT-3	9
DD/MM/YY	Cardiac Output		
DD/MM/YY	Heart Rate and Heart Sounds		
DD/MM/YY	Pulmonary Function Measurements		
DD/MM/YY	Spirometer; Photo Plethysmography		
DD/MM/YY	Body Plethysmography		
DD/MM/YY	Blood Gas Analyzers: pH of Blood		
DD/MM/YY	pCO_2 and pO_2 Measurements; Finger-tip Oximeter		
DD/MM/YY	ESR, GSR Measurements; Standard HL7		
DD/MM/YY	Radiographic and Fluoroscopic Techniques	UNIT-4	9
DD/MM/YY	X-rays; Computed Tomography (CT)		
DD/MM/YY	Mammography		

DD/MM/YY	MRI, fMRI		
DD/MM/YY	Ultrasonography		
DD/MM/YY	Endoscopy and Thermography		
DD/MM/YY	Biotelemetry Systems		
DD/MM/YY	Patient Monitoring Systems		
DD/MM/YY	Patient Monitoring Systems		
DD/MM/YY	Pacemakers	UNIT-5	9
DD/MM/YY	Defibrillators, Ventilators		
DD/MM/YY	Nerve Stimulators and Muscle Stimulators		
DD/MM/YY	Diathermy		
DD/MM/YY	Heart-Lung Machine		
DD/MM/YY	Audiometers and Dialyzers		
DD/MM/YY	Lithotripsy		
DD/MM/YY	Clinical Applications of Therapeutic Equipment		
DD/MM/YY	Intelligent Biomedical Devices and Healthcare 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–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	Physiology, Biomedical Systems and Transducers Fundamentals	Recall and understand the fundamentals of human physiology, biomedical systems, sensors, transducers, signal acquisition principles, and measurement concepts used in healthcare	**CO1 | L1–L2**	**CA | MTE Sec A | ETE Sec A**

		applications.		
TS2	Electro-Physiological Measurement Systems	Explain the principles and operation of biomedical electrodes, amplifiers, electro-physiological measurements (ECG, EEG, EMG, ERG), and electrical safety requirements in medical environments.	**CO2 | L2–L3**	**CA | MTE Sec A | ETE Sec A**
TS3	Physiological Parameter Measurement and Clinical Interpretation	Apply biomedical instrumentation techniques to measure and interpret physiological and non-electrical parameters such as blood pressure, cardiac output, pulmonary function, blood gases, and oxygen saturation.	**CO3 | L3–L4**	**CA | MTE Sec B | ETE Sec B**
TS4	Medical Imaging and Patient Monitoring Analysis	Analyze the operation, performance, and clinical applications of medical imaging systems, biotelemetry systems, and patient monitoring technologies used in modern healthcare.	**CO4 | L4–L5**	**MTE Sec B | ETE Sec B**
TS5	Therapeutic and Diagnostic Biomedical Equipment Evaluation	Evaluate the performance, safety, and healthcare applications of diagnostic, monitoring, and therapeutic biomedical equipment used in patient care and treatment.	**CO5 | L5–L6**	**CA | ETE Sec B/C**
TS6	Biomedical Instrumentation Design and Healthcare Applications	Design and interpret biomedical instrumentation solutions by integrating physiological measurements, medical devices, healthcare technologies, patient safety considerations, and intelligent clinical systems for real-world healthcare applications.	**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 Physiology, Biomedical Systems & Transducers Fundamentals	TS2 Electro-Physiological Measurement Systems	TS3 Physiological Parameter Measurement & Clinical Interpretation	TS4 Medical Imaging & Patient Monitoring Analysis	TS5 Therapeutic & Diagnostic Biomedical Equipment Evaluation	TS6 Biomedical Instrumentation Design & Healthcare Applications
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 2 (Case study / Problem-based)	2 assignments	**10**	CO1, CO2, CO3, CO4, CO5, CO6	TS1, TS2, TS3, TS4, TS5, TS6
Assessment	2 Assessments	**15**	CO2, CO3	TS2, TS3
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	Human physiology, biomedical systems, transducers, sensors, signal acquisition principles, and healthcare measurement systems	**CO1**	**TS1**	**4h SL**	Report submission + conceptual understanding of physiological systems and transducer principles
Assignment 2	Biomedical electrodes, amplifiers, ECG, EEG, EMG, ERG, lead systems, and electrical safety in medical environments	**CO2**	**TS2**	**4h SL**	Instrumentation principles + measurement system analysis
Assignment 3	Measurement of blood pressure, cardiac output, heart rate, pulmonary functions, blood gas analysis, pulse oximetry, ESR, GSR, and HL7 standards	**CO3**	**TS3**	**4h SL**	Physiological parameter interpretation + clinical measurement analysis
Assignment 4	Medical imaging systems including X-ray, CT, MRI, fMRI, ultrasonography, endoscopy, thermography, and patient monitoring technologies	**CO4**	**TS4**	**4h SL**	Imaging system analysis + healthcare technology evaluation
Assignment 5	Therapeutic and assisting biomedical equipment: pacemakers, defibrillators, ventilators, dialyzers, heart-lung	**CO5**	**TS5**	**4h SL**	Device evaluation + healthcare application assessment

	machines, and intelligent medical devices				
Video Learning Report	Technical video learning on biomedical instrumentation, physiological signal monitoring, medical imaging systems, patient monitoring, or therapeutic medical devices (minimum 3 hours) with structured report and presentation	**CO2, CO3**	**TS2, TS3**	**15h SL**	Learning outcomes, technical understanding, self-reflection, and presentation quality
Case Study Report	Real-world biomedical instrumentation case study (e.g., ECG monitoring system, ICU patient monitoring, MRI diagnosis, pacemaker implementation, ventilator systems, wearable health monitoring)	**CO4, CO5, CO6**	**TS4, TS5, TS6**	**10h SL**	Technical depth, comparative analysis, research quality, safety considerations, ethical understanding, and healthcare application interpretation

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	**8**	**TS1 – Physiology, Biomedical Systems and Transducers Fundamentals**	**CO1, CO2, CO3**	Short-answer and conceptual questions on cell physiology, nervous system, cardiovascular and respiratory systems, biomedical systems, transducers, sensors, electrodes, amplifiers, and physiological measurement principles.
		TS2 – Electro-Physiological Measurement Systems		
		TS3 – Physiological Parameter Measurement and Clinical Interpretation		
Section B	**7**	**TS2 – Electro-Physiological Measurement Systems**	**CO2, CO3, CO4**	Explanatory, analytical, numerical, and diagram-based questions on ECG, EEG, EMG, ERG, lead systems, electrical safety, blood pressure measurement, cardiac output, spirometry, blood gas analysis, pulse oximetry, and clinical interpretation of physiological measurements.
		TS3 – Physiological Parameter		

		Measurement and Clinical Interpretation		
		TS4 – Medical Imaging and Patient Monitoring Analysis *(introductory concepts if covered)*		
TOTAL	**15**	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	20	TS1 – Physiology, Biomedical Systems and Transducers FundamentalsTS2 – Electro-Physiological Measurement Systems	CO1, CO2	Short-answer, conceptual, and diagram-based questions on physiology, biomedical systems, transducers, sensors, electrodes, amplifiers, ECG, EEG, EMG, ERG, lead systems, and electrical safety concepts.
Section B	25	TS3 – Physiological Parameter Measurement and Clinical InterpretationTS4 – Medical Imaging and Patient Monitoring AnalysisTS5 – Therapeutic and Diagnostic Biomedical Equipment Evaluation	CO3, CO4, CO5	Analytical, explanatory, numerical, and application-oriented questions on blood pressure measurement, cardiac output, spirometry, blood gas analysis, pulse oximetry, medical imaging systems (X-ray, CT, MRI, Ultrasound), patient monitoring systems, pacemakers, defibrillators, ventilators, and therapeutic equipment.
Section C	15	TS3 – Physiological Parameter Measurement and Clinical InterpretationTS4 – Medical Imaging and Patient Monitoring AnalysisTS5 – Therapeutic and Diagnostic Biomedical Equipment EvaluationTS6 – Biomedical Instrumentation Design and Healthcare Applications	CO3, CO4, CO5, CO6	Case-study, clinical interpretation, system-design, and problem-solving questions involving biomedical instrumentation systems, medical imaging applications, ICU monitoring systems, intelligent healthcare devices, biomedical device selection, patient safety, and healthcare technology integration.
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	MTE	ETE	TS	PO Primary

		(25)	(25)	(50)		
CO1	Understand human physiology, biomedical systems, sensors, transducers, and signal acquisition principles.	✔	✔	✔	TS1	PO1, PO2, PO4
CO2	Explore biomedical electrodes, amplifiers, electro-physiological measurements, and electrical safety concepts.	✔	✔	✔	TS2	PO1, PO2, PO3, PO4
CO3	Apply biomedical instrumentation techniques for physiological and non-electrical parameter measurements.	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Analyze medical imaging systems, biotelemetry, and patient monitoring technologies.	✔	✔	✔	TS4	PO2, PO4, PO5
CO5	Evaluate diagnostic, monitoring, and therapeutic biomedical equipment used in healthcare applications.	✔	—	✔	TS5	PO1, PO2, PO5, PO6
CO6	Design and interpret biomedical instrumentation solutions for modern healthcare systems.	✔	—	✔	TS6	PO2, PO3, PO5, PO12

⚠ *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										2	2	
CO2	3	2		1	2							2	2	
CO3	3	3	2	2	2							3	2	
CO4	2	3	2	3	3							2	3	2
CO5	2	3	2	2	3	2	1	2				2	3	3

CO6	2	3	3	3	3	2	1	2				3	3	3
Avg	2.5	2.7	2.3	2.5	2.5	2.0	1.5	2.5	2.0	2.0	1.0	2.2	2.3	2.3

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	M											M	M	
CO2	H	M			M								M	M	
CO3	H	H	M	M	M								H	M	
CO4	M	H	M	H	H								M	H	M
CO5	M	H	M	M	H	M		M					M	H	H
CO6	M	H	H	H	H	M	M	M				M	H	H	H

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

S.No	Activity	Hours	COs / TS	Evaluation Criteria
1	**Assignment Writing** (5 assignments covering physiology, transducers, biomedical sensors, electro-physiological measurements, physiological parameter measurements, medical imaging, patient monitoring, and therapeutic biomedical equipment)	**5 assignments × 4 hrs each. Total = 20 hrs**	**CO1–CO5TS 1–TS5**	Evaluated based on assignment submission, conceptual understanding, instrumentation principles, physiological measurement interpretation, healthcare applications, and technical analysis.
2	**Technical Video-Based Learning** related to biomedical instrumentation, ECG/EEG/EMG systems, physiological monitoring, medical imaging technologies, patient monitoring systems, and therapeutic medical devices	Video viewing: **5 hrs.** Report preparation: **5 hrs** Presentation: **5 hrs** **Total = 15 hrs**	**CO2, CO3, CO4TS2, TS3, TS4**	Report and presentation evaluated based on understanding of biomedical instrumentation concepts, physiological measurements, medical technologies, healthcare applications, and self-learning outcomes.
3	**Real-World Biomedical Instrumentation Case Studies** (e.g., ECG monitoring systems, ICU patient monitoring, MRI/CT imaging applications, pacemakers, ventilators, dialysis systems, wearable healthcare devices, intelligent healthcare systems)	Data collection /study: **6 hrs** Report preparation: **4 hrs** **Total = 10 hrs**	**CO4, CO5, CO6TS4, TS5, TS6**	Evaluated based on technical depth, healthcare relevance, instrumentation analysis, research quality, patient safety considerations, ethical understanding, and application-oriented interpretation.
	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 basic concepts and facts.	**A1 – Receiving:** Awareness and attention.	**P1 – Perception:** Recognize and interpret cues.
L2 – Understand: Explain concepts and principles.	**A2 – Responding:** Active participation.	**P2 – Set:** Readiness to act.
L3 – Apply: Use knowledge in practical situations.	**A3 – Valuing:** Appreciate and value learning.	**P3 – Guided Response:** Perform with guidance.
L4 – Analyze: Examine relationships and interpret information.	**A4 – Organizing:** Integrate values into decision-making.	**P4 – Mechanism:** Demonstrate proficiency.
L5 – Evaluate: Assess and justify decisions.	**A5 – Characterizing:** Internalize professional values.	**P5 – Complex Overt Response:** Skilled performance.
L6 – Create: Design and develop solutions.		**P6 – Adaptation:** Modify skills for new situations.
		P7 – Origination: Create innovative solutions.

★ *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

CSME3302 — 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

AI in Drug Discovery (CSME3200)

School of Computing Science and Engineering (SSCSE) | B.Tech CS&ME | 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:	SCSE — School of Computing Science & Engineering	**Batch:**	2026 – 2030
Program:	B.Tech	**Current Academic Year:**	2028 – 2029
Branch:	CS & ME	**Semester:**	VI
Course Code:	CSME3200	**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**	CSME3200
2	**Course Title**	AI in Drug Discovery
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**	Program Elective — Theory Only (No Laboratory Component)
6	**Course Objectives**	1. Introduce the drug discovery pipeline and the role of artificial intelligence across its stages. 2. Cover cheminformatics foundations including molecular representations, databases, and property prediction. 3. Enable understanding and evaluation of machine learning and deep learning models applied to target identification, virtual screening, and lead optimisation. 4. Develop the ability to critically assess AI-driven de novo design, ADMET prediction, and clinical translation challenges.
7	**Course Outcomes (COs)**	After successful completion of this course, students will be able to: CO1 (Understand – L1/L2): Identify and explain the stages of the traditional and AI-augmented drug discovery pipeline, including target identification, hit discovery, lead optimisation, and ADMET profiling. CO2 (Understand/Apply – L2/L3): Describe molecular representations (SMILES, InChI, molecular graphs, fingerprints), cheminformatics databases, and apply basic property calculation concepts. CO3 (Apply – L3): Apply classical machine learning algorithms (regression, classification, random forests, SVMs) and graph neural networks to molecular property prediction and virtual screening tasks. CO4 (Analyze – L4): Analyze deep learning architectures including CNNs, RNNs, transformers, and generative models (VAE, GAN, diffusion) for de novo molecular design and structure-based drug design. CO5 (Analyze – L4/L5): Analyze AI-based ADMET prediction, multi-target drug design, drug repurposing, and the integration of multi-omics data in target discovery. CO6 (Evaluate – L4/L5): Evaluate the regulatory, ethical, and reproducibility challenges of AI in drug discovery, and appraise real-world case studies of AI-assisted drug development programs.
8	**Course Description**	This course provides the foundation of artificial intelligence methods applied across the drug discovery pipeline. Topics span cheminformatics, machine learning for molecular property prediction, deep generative models for de novo design, structure-based drug design, ADMET profiling, drug repurposing, and multi-omics integration. Regulatory and ethical considerations are addressed throughout, with case studies from industry and academia.
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. Engkvist, O. et al. — Computational Drug Discovery and Design (2nd Ed.), Springer, 2023 2. Lo, Y.C., Rensi, S.E., Torng, W. & Altman, R.B. — Machine Learning in Chemoinformatics and Drug Discovery, Drug Discovery Today, 2018
12	**References**	1. Leach, A.R. & Shoichet, B.K. — Molecular Modelling: Principles and Applications (2nd Ed.), Pearson, 2001 2. Muratov, E.N. et al. — QSAR without borders, Chemical Society Reviews, 2020 3. Stokes, J.M. et al. — A Deep Learning Approach to Antibiotic Discovery, Cell, 2020 4. Jumper, J. et al. — Highly accurate protein structure prediction with AlphaFold, Nature, 2021 5. Bajorath, J. (Ed.) — Chemoinformatics for Drug Discovery, Wiley, 2014

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: Drug Discovery Pipeline & AI Overview	
A	Traditional drug discovery pipeline: target identification, hit generation, lead optimisation, preclinical and clinical phases; timelines and attrition rates	**CO1**
B	Role of AI in drug discovery: overview of ML, deep learning, and generative AI; current landscape of AI-assisted drug programmes (BenevolentAI, Insilico Medicine, Schrödinger)	**CO1**
C	Databases and resources: ChEMBL, PubChem, DrugBank, UniProt, PDB, ZINC; data curation challenges and standards in cheminformatics	**CO1**
	Unit 2: Molecular Representations & Cheminformatics Foundations	
A	Molecular representations: SMILES, InChI, SELFIES; 2D/3D structural descriptors; molecular graphs; chemical fingerprints (ECFP, MACCS, RDKit)	**CO1, CO2**
B	Quantitative Structure–Activity Relationships (QSAR): physicochemical descriptors, Lipinski's Rule of Five, ADMET property concepts; validation strategies (cross-validation, applicability domain)	**CO1, CO2**
C	Molecular similarity and diversity: Tanimoto coefficient, scaffold analysis, clustering of chemical space; property prediction with classical regression and classification methods	**CO1, CO2**
	Unit 3: Machine Learning for Molecular Property Prediction & Virtual Screening	
A	Classical ML algorithms in drug discovery: random forests, gradient boosting (XGBoost), support vector machines; feature selection and importance; benchmark datasets (MoleculeNet)	**CO1, CO2, CO3**
B	Graph Neural Networks (GNNs) for molecular graphs: message-passing neural networks (MPNN), graph convolutional networks (GCN), AttentiveFP; property prediction case studies	**CO1, CO2, CO3, CO4**
C	Virtual screening: structure-based (molecular docking, scoring functions) vs. ligand-based approaches; AI-enhanced docking; consensus scoring; enrichment metrics (ROC-AUC, EF)	**CO1, CO2, CO3, CO4**
	Unit 4: Deep Learning & Generative AI for Molecular Design	
A	Deep learning architectures: CNN for fingerprint-based prediction; RNN and LSTM for SMILES generation; transformer-based models (ChemBERTa, MolBERT, Uni-Mol) for molecular representation learning	**CO1, CO2, CO3, CO5**
B	Generative models for de novo drug design: Variational Autoencoders (VAE), Generative Adversarial Networks (GAN), diffusion models (DiffSBDD); goal-directed generation with reinforcement learning	**CO1, CO2, CO3, CO5**
C	Protein structure prediction and structure-based design: AlphaFold2 and ESMFold — principles and applications; AI-assisted binding site identification; molecular dynamics integration; protein–ligand interaction fingerprints	**CO1, CO2, CO3, CO4, CO5**
	Unit 5: ADMET Prediction, Drug Repurposing, Multi-omics & Regulatory Aspects	
A	AI-based ADMET prediction: solubility, permeability, metabolism, toxicity endpoints; hERG liability; pkCSM, ADMETlab, SwissADME tools; model interpretability (SHAP values, attention maps)	**CO1, CO2, CO3, CO6**
B	Drug repurposing and polypharmacology: knowledge graphs, network-based methods, multi-omics integration (genomics, transcriptomics, proteomics) for target discovery; COVID-19 repurposing case study	**CO1, CO2, CO3, CO4, CO6**
C	Regulatory landscape and ethical dimensions: FDA guidance on AI/ML-based drug discovery; reproducibility crisis, data bias, model explainability requirements; future outlook — challenges and opportunities for AI in pharma	**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 ℹ Only strong/dominant alignments are mapped. This is a theory-only course; Psychomotor mapping is limited to Guided Response (P3) for algorithm/model tracing in CO3. Affective domain (A3) appears for CO4 and CO5 (valuing model performance and translational impact).

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/model tracing). Affective (A3) for CO4 and CO5 (valuing translational performance).

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	Scope and significance of drug discovery; overview of global pharmaceutical R&D challenges and attrition statistics	**UNIT-1**	**9**

DD/MM/YY	Drug discovery stages: target identification, target validation, hit discovery; role of genomics and proteomics		
DD/MM/YY	Lead optimisation, ADMET screening, preclinical testing — concepts and metrics		
DD/MM/YY	Clinical phases I–III overview; regulatory pathways (FDA, EMA); time and cost analysis of drug development		
DD/MM/YY	Introduction to AI in drug discovery: history, key milestones, current industry landscape (Insilico Medicine, BenevolentAI, Schrödinger, Exscientia)		
DD/MM/YY	Categories of AI methods: ML, DL, generative AI, reinforcement learning — mapping to pipeline stages		
DD/MM/YY	Open databases: ChEMBL, PubChem, DrugBank — structure, content, querying; FAIR data principles		
DD/MM/YY	Protein databases: UniProt, PDB, AlphaFold DB; bioassay data: BindingDB, ChEMBL bioactivity		
DD/MM/YY	Data curation challenges: activity cliffs, assay variability, unit conversion errors; data splitting strategies for ML		
DD/MM/YY	Molecular representations: SMILES syntax, canonicalisation, stereochemistry; InChI and InChIKey; SELFIES	**UNIT-2**	**9**
DD/MM/YY	Chemical fingerprints: binary and count fingerprints; ECFP/FCFP (Morgan algorithm), MACCS keys, RDKit topological fingerprints		
DD/MM/YY	Molecular graph representation: atoms as nodes, bonds as edges; atom and bond features; graph libraries (RDKit, DeepChem)		
DD/MM/YY	Physicochemical descriptors: MW, LogP, TPSA, HBA/HBD, rotatable bonds; Lipinski Ro5; Veber and Egan rules		
DD/MM/YY	QSAR fundamentals: dataset curation, descriptor calculation, model building with linear regression and PLS; statistical validation (r^2, q^2LOO, external test set)		
DD/MM/YY	Applicability domain in QSAR: leverage/Williams plot, k-NN distance methods; regulatory acceptance (OECD QSAR Toolbox principles)		
DD/MM/YY	Molecular similarity: Tanimoto coefficient, cosine similarity; similarity searching; scaffold analysis (Murcko framework)		
DD/MM/YY	Chemical space diversity and clustering: k-medoids, hierarchical clustering for compound library design		
DD/MM/YY	Reaction informatics: reaction SMILES, template extraction; introduction to retrosynthesis prediction concepts		
DD/MM/YY	Classical ML for molecular property prediction: random forests — feature importance, OOB error; XGBoost — hyperparameter tuning	**UNIT-3**	**9**
DD/MM/YY	Support vector machines for classification and regression on molecular fingerprints; kernel selection in cheminformatics		
DD/MM/YY	MoleculeNet benchmark: datasets (ESOL, FreeSolv, Lipophilicity, Tox21, BACE, HIV); evaluation metrics (RMSE, MAE, ROC-AUC, PRC-AUC)		
DD/MM/YY	Graph Neural Networks (GNNs): message-passing framework; graph convolutional network (GCN); gated GNN; attention mechanisms		
DD/MM/YY	AttentiveFP and MPNN architectures; readout functions (sum, mean, attention-weighted); training GNNs on molecular graphs		
DD/MM/YY	Virtual screening fundamentals: structure-based docking — scoring functions (empirical, force-field, ML-based); Glide, AutoDock Vina overview		
DD/MM/YY	Ligand-based virtual screening: pharmacophore modelling, shape-based screening; 3D-QSAR (CoMFA, CoMSIA) concepts		
DD/MM/YY	AI-enhanced scoring functions: neural network scoring (GNINA);		

	consensus scoring strategies; enrichment factor (EF), BEDROC metrics		
DD/MM/YY	Practical aspects of virtual screening campaigns: library preparation, protonation states, docking validation; retrospective vs. prospective validation		
DD/MM/YY	Deep learning for drug discovery: CNNs on molecular images; RNNs and LSTMs for sequential SMILES generation	**UNIT-4**	**9**
DD/MM/YY	Transformer models in cheminformatics: attention mechanism; BERT pre-training; ChemBERTa, MolBERT, Uni-Mol — molecular property prediction applications		
DD/MM/YY	Variational Autoencoders (VAE) for molecular generation: latent space interpolation; property-guided optimisation (JTVAE)		
DD/MM/YY	Generative Adversarial Networks (GAN) for molecular design: MolGAN; normalising flows; diffusion models (DDPM, DiffSBDD, DiffDock)		
DD/MM/YY	Reinforcement learning for goal-directed molecular generation: REINVENT, REINFORCE, proximal policy optimisation; multi-objective reward shaping (QED, SA score, docking score)		
DD/MM/YY	Protein structure prediction: AlphaFold2 architecture — evoformer, structure module; applications to drug target identification; limitations		
DD/MM/YY	ESMFold and RoseTTAFold; protein–ligand complex prediction: DiffDock, EquiBind; binding site identification (FPocket, SiteMap)		
DD/MM/YY	Structure-based de novo design: fragment-based AI methods; 3D-generative models (liGAN, SBDD-Diffusion); practical design cycles		
DD/MM/YY	Molecular dynamics and AI integration: MD-based free energy perturbation concepts; neural network potentials (ANI, NequIP); coarse-grained simulations in lead optimisation		
DD/MM/YY	ADMET prediction using AI: solubility (ESOL model), Caco-2 permeability, CYP450 metabolism, plasma protein binding — model architectures and accuracy	**UNIT-5**	**9**
DD/MM/YY	Toxicity prediction: hERG cardiotoxicity, Ames mutagenicity, hepatotoxicity; ProTox-II, pkCSM, ADMETlab 2.0; uncertainty quantification in toxicity models		
DD/MM/YY	Model interpretability in drug discovery: SHAP values, integrated gradients, attention maps; scaffold attribution; regulatory expectations on explainability		
DD/MM/YY	Drug repurposing: network pharmacology, knowledge graph embeddings (RotatE, TransE); case study — baricitinib for COVID-19		
DD/MM/YY	Multi-omics integration for target discovery: transcriptomics (RNA-Seq), proteomics, CRISPR screen data; graph-based multi-omics fusion		
DD/MM/YY	Polypharmacology and multi-target drug design: target interaction networks, selectivity profiling, AI-based selectivity prediction		
DD/MM/YY	Regulatory aspects of AI/ML in drug discovery: FDA discussion paper on AI (2023), data quality requirements, model documentation (IDMP, eCTD); EU AI Act implications		
DD/MM/YY	Ethical considerations: bias in training data, representation of diverse populations, IP issues in generative AI; reproducibility and open science		
DD/MM/YY	Case Studies: (i) Halicin — AI-driven antibiotic discovery (MIT/McMahon Lab); (ii) Insilico Medicine INS018_055 — first AI-designed drug in Phase II; course synthesis and future directions		

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 aligned to Bloom's progression (L1–L4) — correspond directly to the six COs. They define precisely what competency is 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	**Drug Discovery Pipeline & AI Landscape Recall**	Recall the stages of the drug discovery pipeline, key databases, AI tool categories, and the historical context of AI in pharma; identify the appropriate AI method or data resource for a given stage	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	**Molecular Representation & Cheminformatics Explanation**	Describe and compare molecular representation schemes, fingerprint types, physicochemical descriptors, and QSAR validation strategies; explain chemical similarity metrics and their role in virtual screening	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	**ML/GNN Algorithmic Application & Virtual Screening Implementation**	Apply classical ML and GNN models to molecular property prediction tasks; trace model training, compute evaluation metrics (RMSE, AUC, EF); apply virtual screening protocols step-by-step	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	**Deep Learning & Generative Model Analysis**	Analyze deep learning architectures (transformers, VAEs, GANs, diffusion models) for de novo drug design; compare performance of generative models on drug-likeness and synthesisability criteria; evaluate structure-based AI design strategies	CO4 | L4	MTE Sec B | ETE Sec B
TS5	**ADMET & Multi-omics Advanced Analytics Evaluation**	Analyze AI-based ADMET prediction models; evaluate interpretability methods (SHAP, attention); assess drug repurposing and multi-omics integration approaches for target identification	CO5 | L4–L5	ETE Sec B/C
TS6	**Regulatory, Ethics & Case Study Appraisal**	Evaluate regulatory frameworks (FDA AI guidance, EU AI Act) and ethical considerations (bias, reproducibility, IP); appraise real-world AI drug discovery case studies for scientific and commercial feasibility	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 Pipeline Recall	TS2 Cheminformatics	TS3 ML/GNN Application	TS4 DL & Generative Analysis	TS5 ADMET & Multi-omics	TS6 Regulatory & Ethics

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 problem-based assignments, a technical literature review report, and a critical case study — mirroring 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, CO2, CO3, CO4	TS1, TS2, TS3, TS4
Technical Literature Review Report	1 Report + Presentation	**5**	CO2, CO3	TS2, TS3
Critical 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	Drug discovery pipeline: map AI tools to each stage; compare databases (ChEMBL vs. PubChem); identify data quality issues in a given dataset extract	CO1	TS1	6h SL	Report + evaluation; accuracy of pipeline mapping and data critique
Assignment 2	Molecular representation: encode 10 drug molecules as SMILES; compute RDKit fingerprints; calculate Tanimoto similarity matrix; cluster compounds	CO2	TS2	6h SL	Correct SMILES, fingerprint computation, similarity table, clustering diagram
Assignment 3	ML model building: apply random forest and GNN to a MoleculeNet dataset; compute RMSE/AUC; interpret feature importance; compare model performance	CO2, CO3	TS2, TS3	6h SL	Correct metric computation; model comparison table; written interpretation
Assignment 4	Generative model analysis: trace VAE latent space interpolation for two seed molecules; compute QED and SA scores for generated structures; evaluate drug-likeness	CO3, CO4	TS3, TS4	6h SL	Step-by-step trace; QED/SA score table; critical evaluation of outputs
Assignment 5	ADMET & repurposing: use ADMETlab/pkCSM to predict ADMET profile for 5	CO3, CO4, CO5	TS3, TS4, TS5	6h SL	ADMET table with commentary; SHAP interpretation; repurposing

	compounds; interpret SHAP plots; assess one drug repurposing case (knowledge graph pathway)				pathway analysis
Literature Review Report	Review a peer-reviewed paper on GNN-based property prediction or transformer models in drug discovery (≥2022); structured critical review + class presentation	CO2, CO3	TS2, TS3	9h SL	Report: scientific accuracy, critical analysis, clarity. Presentation: 10 min with Q&A
Critical Case Study	In-depth analysis of a real AI drug discovery programme (e.g., Halicin antibiotic discovery; Insilico INS018_055; COVID-19 repurposing); cover methods, results, limitations, regulatory pathway	CO4, CO5, CO6	TS4, TS5, TS6	6h SL	Technical depth, critical appraisal of AI methodology, regulatory and ethical commentary

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

ℹ MTE covers Units 1–3 (CO1–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 — Drug Discovery Pipeline & AI Landscape Recall TS2 — Molecular Representation & Cheminformatics Explanation	CO1, CO2	Short-answer: describe drug discovery stages, identify databases, compare fingerprint types, explain QSAR validation, define Tanimoto similarity, state Lipinski Ro5 and its limitations
Section B	**15**	TS3 — ML/GNN Algorithmic Application TS4 — Deep Learning & Generative Model Analysis	CO2, CO3, CO4	Numerical/analytical problems: compute Tanimoto similarity; trace RF feature importance calculation; interpret confusion matrix and ROC-AUC; explain MPNN message-passing step; trace VAE latent space property optimisation
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 — Pipeline & AI Landscape Recall TS2 — Cheminformatics Explanation	CO1, CO2	Short questions (all units): define fingerprint types, recall database content, explain SMILES encoding, describe molecular graph features, state QSAR applicability domain, list ADMET parameters
Section B	**30**	TS3 — ML/GNN Application TS4 — DL & Generative	CO3, CO4, CO5	Medium/long questions: compute model evaluation metrics; trace

		Analysis TS5 — ADMET & Multi-omics Evaluation		GNN message-passing; compare GAN vs. diffusion model outputs on QED/SA criteria; analyse ADMET prediction results with SHAP; evaluate multi-omics network for target identification
Section C	**15**	TS5 — ADMET & Advanced Analytics TS6 — Regulatory & Ethics Appraisal	CO5, CO6	Evaluation questions: appraise regulatory requirements for AI models in drug submission; critique algorithmic bias in a toxicity predictor; evaluate a case study (Halicin/Insilico) for scientific rigour, reproducibility, and regulatory readiness
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	Understand drug discovery pipeline stages, AI landscape, databases, and data curation	✔	✔	✔	**TS1**	PO1, PO2, PO3, PO4
CO2	Describe molecular representations, cheminformatics foundations, and QSAR principles	✔	✔	✔	**TS2**	PO1, PO3, PO4
CO3	Apply ML and GNN models for molecular property prediction and virtual screening	✔	✔	✔	**TS3**	PO1, PO2, PO3, PO4
CO4	Analyze deep learning and generative AI architectures for drug design	✔	✔	✔	**TS4**	PO9, PO10, PO11
CO5	Analyze ADMET prediction, interpretability, repurposing, and multi-omics methods	✔	—	✔	**TS5**	PO1, PO2, PO8, PO9, PO10
CO6	Evaluate regulatory/ethical dimensions and appraise AI drug discovery 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

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	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	

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

S.No	Activity	Hours	COs / TS	Evaluation Criteria
1	**Problem-based Numerical/Analytical Assignments (5 assignments, one per unit focus area)**	5 assignments × 4 hrs each Total = 20 hrs	CO1–CO4 TS1–TS4	Evaluated based on submission; correctness, steps shown, model comparison, and scientific reasoning
2	**Technical Literature Review (peer-reviewed paper on GNN property prediction or transformer/generative models in drug discovery, ≥2022)**	Paper reading: 4 hrs Report preparation: 4 hrs Presentation: 3 hrs Total = 11 hrs	CO2, CO3 TS2, TS3	Report + Presentation: scientific accuracy, critical analysis, key takeaways, personal reflection on applicability
3	**Critical Case Study Report (in-depth study of a real AI drug discovery programme: Halicin, Insilico INS018_055, BenevolentAI baricitinib repurposing, or equivalent)**	Data collection/study: 10 hrs Report preparation: 4 hrs Total = 14 hrs	CO4, CO5, CO6 TS4, TS5, TS6	Technical depth, AI methodology critique, ADMET commentary, regulatory pathway analysis, ethical appraisal
	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:	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:

Design, develop, and produce new artefacts		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 and model tracing). Affective domain (A3) appears for CO4 and CO5, reflecting valuing of model performance and translational impact in drug discovery.

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, literature 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 25 + ETE 50 = 100; 40% overall minimum required

CSME3200 — 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

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:**	2028–2029
Branch:	CS & ME	**Semester:**	VI
Course Code:	CSME3201	**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**	CSME3201
2	**Course Title**	**Clinical Decision Support System**
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**	**CO1:** Explain the fundamentals of healthcare informatics, healthcare data, and Clinical Decision Support Systems (CDSS). **CO2:** Apply data preprocessing, machine learning, and analytics techniques to healthcare datasets. **CO3:** Analyze intelligent CDSS components for disease prediction and clinical decision-making. **CO4:** Evaluate AI-driven CDSS based on performance, interpretability, ethics, and regulatory requirements. **CO5:** Design CDSS solutions using cloud computing, IoT, Explainable AI (XAI), and healthcare data pipelines. **CO6:** Assess security, privacy, ethical issues, and emerging technologies in modern healthcare decision support systems. .
7	**Course Outcomes (COs)**	After successful completion of this course, students will be able to:

		CO1 (Understand – L1/L2): Understand the fundamentals of healthcare informatics, clinical workflows, Electronic Health Records (EHR), and the architecture and types of Clinical Decision Support Systems. CO2 (Apply – L2/L3): Apply data mining and machine learning techniques on healthcare datasets for disease prediction, patient risk analysis, and clinical data analytics. CO3 (Analyze – L3/L4): Analyze knowledge-based and intelligent clinical decision support models including expert systems, recommendation systems, and NLP-based clinical applications.
8	**Course Description**	Clinical Decision Support Systems (CDSS) is an interdisciplinary course that combines healthcare informatics, data analytics, machine learning, and artificial intelligence to support clinical decision-making and patient care. The course covers healthcare data management, Electronic Health Records (EHR), predictive analytics, intelligent diagnostic systems, expert systems, and AI-based healthcare applications along with security, ethical, and privacy considerations in modern healthcare environments.
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. Biomedical Informatics — Edward H. Shortliffe and James J. Cimino 2. Healthcare Data Analytics — Chandan K. Reddy and Charu C. Aggarwal 3. Clinical Decision Support Systems — Eta S. Berner
12	**References**	1. Deep Medicine — Eric Topol 2. Artificial Intelligence in Healthcare — Adam Bohr and Kaveh Memarzadeh

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 Healthcare Informatics and CDSS	
A	Introduction to healthcare systems, Digital healthcare ecosystem, Electronic Health Records (EHR) , Electronic Medical Records (EMR) ,Healthcare data types	**CO1**
B	Fundamentals of Clinical Decision Support Systems, Architecture of CDSS, Types of CDSS	**CO1**
C	Clinical workflow integration, Benefits and limitations of CDSS	**CO1**
	Unit 2: Data Analytics and Machine Learning in Healthcare	
A	Medical data preprocessing, Missing clinical data handling, Feature selection in healthcare datasets, Healthcare data mining techniques, Classification algorithms: Decision Trees, Naive Bayes, SVM, Random Forest	**CO1, CO2**

B	Clustering in healthcare, Predictive analytics, Disease prediction models, Risk stratification, Evaluation metrics: Accuracy, Precision, Recall, F1-score, ROC-AUC	**CO1, CO2**
C	Casestudy: Diabetes dataset, Heart disease dataset, Cancer prediction dataset	**CO1, CO2**
	Unit 3: Intelligent Clinical Decision Support Systems	
A	Rule-based expert systems, Knowledge representation, Clinical guidelines and protocols, Inference engines, Recommendation systems in healthcare, NLP in clinical text analysis, Medical ontology basics: SNOMED CT, ICD, HL7	**CO2**
B	Intelligent alert systems, Drug interaction systems, AI-assisted diagnosis systems	**CO2, CO3, CO4**
C	ICU monitoring systems, Sepsis prediction, Radiology AI systems	**CO2, CO3, CO4**
	Unit 4: Design and Development of CDSS	
A	CDSS system architecture, Data pipelines in healthcare, Integration with hospital information systems	**CO1, CO2, CO3, CO5**
B	Cloud-based healthcare systems, IoT and wearable healthcare monitoring, Real-time clinical decision systems	**CO1, CO2, CO3, CO5**
C	Explainable AI (XAI) in healthcare, Human-centered AI design, Dashboard and visualization systems, Model deployment concepts	**CO1, CO2, CO3, CO5**
	Unit 5: Security, Ethics, and Future Trends in CDSS	
A	Healthcare data privacy, HIPAA basics, Security in healthcare systems	**CO1, CO2, CO3, CO6**
B	Ethical AI in medicine, Bias and fairness in healthcare AI, Trustworthy AI, Regulatory considerations, Federated learning in healthcare, Generative AI in medicine	**CO1, CO2, CO3, CO4, CO6**
C	Digital twins in healthcare, Personalized medicine, Future of autonomous healthcare systems	**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 healthcare systems, Digital healthcare ecosystem	UNIT-1	9
DD/MM/YY	Electronic Health Records (EHR) , Electronic Medical Records (EMR)		
DD/MM/YY	Healthcare data types		
DD/MM/YY	Fundamentals of Clinical Decision Support Systems		
DD/MM/YY	Architecture of CDSS, Types of CDSS		
DD/MM/YY	Architecture of CDSS, Types of CDSS		
DD/MM/YY	Clinical workflow integration, Benefits and limitations of CDSS		

DD/MM/YY	Clinical workflow integration, Benefits and limitations of CDSS		
DD/MM/YY	Revision		
DD/MM/YY	Medical data preprocessing, Missing clinical data handling	UNIT-2	9
DD/MM/YY	Feature selection in healthcare datasets, Healthcare data mining techniques		
DD/MM/YY	Classification algorithms: Decision Trees, Naive Bayes, SVM, Random Forest		
DD/MM/YY	Classification algorithms: Decision Trees, Naive Bayes, SVM, Random Forest		
DD/MM/YY	Classification algorithms: Decision Trees, Naive Bayes, SVM, Random Forest		
DD/MM/YY	Clustering in healthcare, Predictive analytics		
DD/MM/YY	Clustering in healthcare, Predictive analytics		
DD/MM/YY	Disease prediction models, Risk stratification		
DD/MM/YY	Disease prediction models, Risk stratification		
DD/MM/YY	Evaluation metrics: Accuracy, Precision, Recall, F1-score, ROC-AUC	UNIT-3	
DD/MM/YY	Rule-based expert systems, Knowledge representation		9
DD/MM/YY	Clinical guidelines and protocols, Inference engines,		
DD/MM/YY	Recommendation systems in healthcare, NLP in clinical text analysis,		
DD/MM/YY	Medical ontology basics: SNOMED CT, ICD, HL7		
DD/MM/YY	Intelligent alert systems, Drug interaction systems		
DD/MM/YY	AI-assisted diagnosis systems		
DD/MM/YY	ICU monitoring systems, Sepsis prediction		
DD/MM/YY	Radiology AI systems		
DD/MM/YY	CDSS system architecture, Data pipelines in healthcare	UNIT-4	9
DD/MM/YY	Integration with hospital information systems		
DD/MM/YY	Cloud-based healthcare systems, IoT and wearable healthcare monitoring		
DD/MM/YY	Real-time clinical decision systems		
DD/MM/YY	Real-time clinical decision systems		
DD/MM/YY	Explainable AI (XAI) in healthcare, Human-centered AI design		

DD/MM/YY	Explainable AI (XAI) in healthcare, Human-centered AI design		
DD/MM/YY	Dashboard and visualization systems, Model deployment concepts		
DD/MM/YY	Dashboard and visualization systems, Model deployment concepts		
DD/MM/YY	Healthcare data privacy, HIPAA basics	UNIT-5	9
DD/MM/YY	Healthcare data privacy, HIPAA basics		
DD/MM/YY	Security in healthcare systems		
DD/MM/YY	Ethical AI in medicine, Bias and fairness in healthcare AI, Trustworthy AI, Regulatory considerations		
DD/MM/YY	Federated learning in healthcare, Generative AI in medicine		
DD/MM/YY	Digital twins in healthcare, Personalized medicine		
DD/MM/YY	Digital twins in healthcare, Personalized medicine		
DD/MM/YY	Future of autonomous healthcare systems		
DD/MM/YY	Future of autonomous healthcare 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	**Conceptual Understanding**	To remember and understand fundamental concepts, definitions, principles, terminologies, and theoretical foundations of the subject.	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	Analytical Thinking	To analyze problems, interpret data, compare techniques, and evaluate system behavior using logical reasoning and critical thinking.	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	Application of	To apply theoretical concepts, algorithms,	CO3 | L3	CA | MTE

	Knowledge	tools, and methodologies to solve domain-specific problems and real-world applications.		Sec B | ETE Sec B
TS4	Design and Development Skills	To design models, frameworks, architectures, workflows, and intelligent solutions based on subject knowledge and engineering principles.	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	Research, Innovation and Evaluation	To investigate emerging technologies, evaluate system performance, validate outcomes, and explore innovative approaches in the domain.	CO5 | L4–L5	ETE Sec B/C
TS6	Professional, Ethical and Societal Awareness	To understand ethical, security, privacy, legal, societal, and professional responsibilities associated with technology and its applications.	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	Fundamentals of Healthcare Informatics and CDSS Architecture	CO1	TS1	5h SL	Understanding of healthcare concepts, CDSS types, architecture diagrams, and clarity of explanation
Assignment 2	Healthcare Data Analytics and EHR Processing	CO2	TS2	5h SL	Data preprocessing, analytical interpretation, and understanding of healthcare datasets
Assignment 3	Machine Learning Techniques for Disease Prediction	CO2, CO3	TS2, TS3	5h SL	Correct implementation of ML models, result analysis, and application accuracy
Assignment 4	Design of Intelligent Clinical Decision Support Systems	CO3, CO4	TS3, TS4	5h SL	System design approach, workflow modeling, innovation, and technical presentation
Assignment 5	Explainable AI, Ethics, and Security in Healthcare Systems	CO3, CO4, CO5	TS3, TS4, TS5	5h SL	Critical evaluation, ethical analysis, AI explainability, and solution quality
Video Learning Report	AI Applications in Modern Healthcare and CDSS	CO2, CO3	TS2, TS3	9h SL	Concept understanding, summary quality, technical insights, and analytical discussion
Case Study Report	Real-world Clinical Decision Support System Case Study	CO4, CO5, CO6	TS4, TS5, TS6	6h SL	Case analysis, problem-solving approach, evaluation of outcomes, ethics, and report presentation

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 Understanding TS2 — Analytical Thinking**	**CO1, CO2**	Short-answer questions: define healthcare informatics, explain EHR/EMR concepts, identify types of CDSS, explain healthcare data preprocessing, describe basic machine learning concepts in healthcare

Section B	**15**	**TS3 — Application of Knowledge TS4 — Design and Development Skills**	**CO2, CO3, CO4**	Analytical and application-based questions: apply ML techniques for disease prediction, analyze intelligent clinical systems, design CDSS workflows, compare healthcare AI models, evaluate clinical decision-making approaches
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 Understanding TS2 — Analytical Thinking**	**CO1, CO2**	Short questions (all units): definitions of healthcare informatics and CDSS, types of CDSS, EHR/EMR concepts, healthcare data types, machine learning basics, explain clinical workflows and predictive analytics concepts
Section B	**25**	TS3 — Application of Knowledge TS4 — Design and Development Skills TS5 — Research and Evaluation Skills	**CO3, CO4, CO5**	Medium-answer/application questions: disease prediction using ML models, healthcare data preprocessing, expert systems, NLP in clinical text analysis, CDSS architecture design, explainable AI techniques, ethical and security analysis in healthcare AI
Section C	**10**	TS5 — Research and Evaluation Skills TS6 — Professional, Ethical and Societal Awareness	**CO5, CO6**	Long/evaluation questions: analysis of AI-driven healthcare systems, healthcare privacy and security frameworks, fairness and bias in clinical AI, federated learning in healthcare, real-world CDSS case study analysis, future trends in intelligent healthcare systems
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 healthcare informatics, EHR systems, and fundamentals of CDSS	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Apply healthcare data analytics and machine learning techniques for	✔	✔	✔	TS2	PO1, PO3, PO4

	clinical applications					
CO3	Analyze intelligent clinical systems including expert systems, NLP, and recommendation systems	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Design and develop AI-enabled clinical decision support solutions and healthcare analytics systems	✔	✔	✔	TS4	PO9, PO10, PO11
CO5	Evaluate ethical, privacy, security, and explainable AI aspects in healthcare systems	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Analyze healthcare data integration, interoperability, and emerging intelligent healthcare technologies	✔	—	✔	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	-	-	-	2	1	1	1	3	2	1
CO2	3	3	3	3	2	-	-	1	2	2	2	3	3	2
CO3	3	3	3	3	3	1	-	-	2	2	2	3	3	2
CO4	3	3	3	3	3	-	-	2	3	3	3	3	3	3
CO5	2	3	2	2	-	-	-	3	3	2	2	2	2	1
CO6	3	3	2	2	2	-	-	3	2	3	3	3	3	2
Avg	**2.83**	**3**	**2.50**	**2.50**	**2**	**–**	**–**	**2.17**	**2.17**	**2.17**	**2.17**	**2.83**	**2.67**	**1.83**

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/Analytical Assignment Writing (5 assignments based on healthcare analytics, machine learning models, CDSS workflows, and AI-based clinical applications)**	5 assignments × 3 hrs each Total = 15 hrs	CO1–CO4 TS1–TS4	Evaluated based on conceptual understanding, analytical approach, implementation methodology, interpretation of healthcare data, and comparative analysis of AI techniques
2	**Technical Video-Based Learning related to Clinical Decision Support Systems, Healthcare AI, EHR Analytics, and Intelligent Healthcare Applications**	Video viewing: 3 hrs Report preparation: 3 hrs Presentation: 3 hrs Total = 9 hrs	CO2, CO3 TS2, TS3	Report and presentation evaluated based on understanding of healthcare AI concepts, clinical applications, technical analysis, key learning outcomes, and presentation quality
3	**Real-World Case Studies (e.g., AI-assisted diagnosis systems, hospital CDSS implementations, wearable healthcare monitoring, explainable AI in healthcare)**	Data collection/study: 4 hrs Report preparation: 2 hrs Total = 6 hrs	CO4, CO5, CO6 TS4, TS5, TS6	Evaluated based on depth of case analysis, innovation, healthcare problem-solving approach, ethical considerations, technical findings, and analytical conclusions
	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 L2 — Understand: Explain ideas, concepts, and principles	A1 — Receiving: Awareness and willingness to attend A2 — Responding: Active participation and reaction	P1 — Perception: Sensory cues guide motor activity P2 — Set: Mental, physical readiness to act

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	A3 — Valuing: Commitment and assigning value to content A4 — Organizing: Integrating values into a personal system A5 — Characterizing: Internalized value system	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 (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

CSME3201— 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 for IoT (CSOT3206)

Sharda School of Computing Science & Engineering (SSOCSE) | B.Tech CS & ME | 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:	Sharda School of Computing Science & Engineering (SSOCSE)	**Batch:**	2026-2030
Program:	B.Tech	**Current Academic Year:**	2028-2029
Branch:	CS & ME	**Semester:**	VI
Course Code:	CSOT3206	**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**	CSOT3206
2	**Course Title**	Data Analytics for IoT
3	**Credits**	3
4	**Contact Hours (L-T-P-SL)**	3-0-0-3 (Theory: 45hrs Classroom + 45 hrs Self Learning = 60 hrs total)
5	**Course Status**	**Core — Theory Only (No Laboratory Component)**
6	**Course Objectives**	1. Introduce the fundamentals of Data Analytics and Internet of Things (IoT). 2. Understand IoT data generation, storage, processing, and visualization techniques. 3. Learn data preprocessing and machine learning methods for IoT applications. 4. Develop analytical models using real-time IoT datasets. 5. Explore cloud-based analytics and edge computing for IoT systems. 6. Build practical applications using IoT analytics tools and platforms.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** | CO1 | Understand the architecture and components of IoT systems and analytics platforms. | | CO2 | Apply data preprocessing and statistical techniques to IoT datasets. | | CO3 | Analyze IoT data using machine learning and predictive analytics methods. | | CO4 | Implement cloud and edge analytics solutions for IoT

		applications. | | CO5 | Design IoT analytics projects using modern tools and frameworks. |
8	**Course Description**	* Basic knowledge of Programming * Fundamentals of Database Management Systems * Introduction to Computer Networks * Basic Statistics and Probability
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. Raj Kamal, “Internet of Things: Architecture and Design Principles”, McGraw Hill. 2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things: A Hands-On Approach”. 3. Han, Kamber, and Pei, “Data Mining: Concepts and Techniques”, Morgan Kaufmann.
12	**References**	1. Trevor Hastie, Robert Tibshirani, “The Elements of Statistical Learning”. 2. Judith Hurwitz, “Big Data for Dummies”, Wiley Publications. 3. Foster Provost and Tom Fawcett, “Data Science for Business”.

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 Data Analytics and IoT	
A	Defining Data Analytics and Internet of Things (IoT) IOT data and bigdata IoT Architecture and Components * Sensors, Actuators, and Smart Devices * IoT Communication Protocols	**CO1**
B	* Introduction to Data Analytics * Types of Analytics: Descriptive, Predictive, Prescriptive * Data Lifecycle in IoT	**CO1**
C	IOT Analytics Challenges in IoT Data Analytics * Applications of IoT Analytics	**CO1**
	Unit 2: IoT, clod and bigdata integration for IoT analytics, Data Collection and Preprocessing	
A	* Cloud based IoT platform Data Acquisition from IoT Devices * WAZIUP Software platform, Streaming and Real-Time Data * Structured and Unstructured Data	**CO1, CO2**

	* iKaaS software platform, Data Cleaning and Data Integration	
B	* Data Transformation and Normalization * Missing Data Handling * Feature Selection and Extraction	**CO1, CO2**
C	* Data Storage Techniques * Time-Series Data in IoT	**CO1, CO2**
	Unit 3: Development Tools for IoT Analytics Applications - Statistical Analysis and Machine Learning for IoT	
A	* The VITAL Architecture for IoT Analytics-Statistical Methods for Data Analysis * VITAL Development, Correlation and Regression * VITAL Nodes Classification and Clustering Techniques * Decision Trees, Naive Bayes, and SVM	**CO1, CO2, CO3**
B	* K-Means Clustering * Predictive Analytics for IoT * Anomaly Detection in IoT Systems	**CO1, CO2, CO3, CO4**
C	* Introduction to Deep Learning for IoT * Performance Evaluation Metrics	**CO1, CO2, CO3, CO4**
	Unit 4: An Open-Source Framework for IoT Analytics as a Service.	
A	* Architecture for IoT Analytics as-a-service, Sensing as-a-service Infrastructure Anatomy, Cloud Computing for IoT * Edge and Fog Computing * Big Data Concepts * Hadoop and Spark Overview	**CO1, CO2, CO3, CO5**
B	* Distributed Data Processing * Real-Time Analytics Frameworks * Data Visualization Techniques	**CO1, CO2, CO3, CO5**
C	* Dashboard Design for IoT Analytics * Security and Privacy in IoT Analytics	**CO1, CO2, CO3, CO5**
	Unit 5: Data Analytics in Smart Buildings, IoT Analytics Applications and Case Studies	
A	* Addressing Energy Efficiency in smart Buildings, Smart City Analytics * IoT based Information Management system for Energy, Healthcare IoT Analytics * Industrial IoT (IIoT)	**CO1, CO2, CO3, CO6**
B	* Agriculture and Environmental Monitoring * Smart Transportation Systems	**CO1, CO2, CO3, CO4, CO6**
C	* Energy Analytics and Smart Grid * IoT Analytics using Python	**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	Fundamentals of Data Analytics and Internet of Things (IoT),	UNIT-1	9
DD/MM/YY	IoT Architecture and Components, Types of Analytics: Descriptive, Predictive, Prescriptive		
DD/MM/YY	IoT Architecture and Components, Types of Analytics: Descriptive, Predictive, Prescriptive		
DD/MM/YY	Sensors, Actuators, and Smart Devices, IoT Communication Protocols, Introduction to Data Analytics		
DD/MM/YY	Sensors, Actuators, and Smart Devices, IoT Communication Protocols, Introduction to Data Analytics		
DD/MM/YY	Data Lifecycle in IoT, Challenges in IoT Data Analytics		
DD/MM/YY	Data Lifecycle in IoT, Challenges in IoT Data Analytics		
DD/MM/YY	Applications of IoT Analytics		
DD/MM/YY	Applications of IoT Analytics		
DD/MM/YY	Data Acquisition from IoT Devices, Streaming and Real-Time Data, Structured and Unstructured Data	UNIT-2	9
DD/MM/YY	Data Acquisition from IoT Devices, Streaming and Real-Time Data, Structured and Unstructured Data		
DD/MM/YY	Data Cleaning and Data Integration, Data Transformation and Normalization		
DD/MM/YY	Data Cleaning and Data Integration, Data Transformation and Normalization		
DD/MM/YY	Missing Data Handling		
DD/MM/YY	Feature Selection and Extraction		
DD/MM/YY	Data Storage Techniques		
DD/MM/YY	Time-Series Data in IoT		
DD/MM/YY	Time-Series Data in IoT		
DD/MM/YY	Statistical Methods for Data Analysis, Correlation and Regression	UNIT-3	9
DD/MM/YY	Classification and Clustering Techniques		
DD/MM/YY	Decision Trees, Naive Bayes, and SVM		
DD/MM/YY	K-Means Clustering		

DD/MM/YY	Predictive Analytics for IoT		
DD/MM/YY	Anomaly Detection in IoT Systems		
DD/MM/YY	Introduction to Deep Learning for IoT		
DD/MM/YY	Performance Evaluation Metrics		
DD/MM/YY	Performance Evaluation Metrics		
DD/MM/YY	Cloud Computing for IoT, Edge and Fog Computing, Big Data Concepts	UNIT-4	9
DD/MM/YY	Hadoop and Spark Overview		
DD/MM/YY	Distributed Data Processing		
DD/MM/YY	Real-Time Analytics Frameworks, Data Visualization Techniques		
DD/MM/YY	Dashboard Design for IoT Analytics		
DD/MM/YY	Dashboard Design for IoT Analytics		
DD/MM/YY	Security and Privacy in IoT Analytics		
DD/MM/YY	Security and Privacy in IoT Analytics		
DD/MM/YY	Revision		
DD/MM/YY	Smart City Analytics, Healthcare IoT Analytics, Industrial IoT (IIoT)	UNIT-5	9
DD/MM/YY	Agriculture and Environmental Monitoring		
DD/MM/YY	Smart Transportation Systems		
DD/MM/YY	Energy Analytics and Smart Grid, IoT Analytics using Python		
DD/MM/YY	Energy Analytics and Smart Grid, IoT Analytics using Python		
DD/MM/YY	Case Studies and Mini Projects		
DD/MM/YY	Case Studies and Mini Projects		
DD/MM/YY	Emerging Trends in IoT Analytics		
DD/MM/YY	Emerging Trends in IoT 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	Understanding of IoT concepts and architecture	Ability to explain IoT components, architecture, and communication models	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	Knowledge of data acquisition methods	Understanding sensor data collection and communication protocols	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	Big data analytics concepts	Understanding Hadoop, Spark, and distributed computing	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	Understanding machine learning algorithms	Ability to explain classification, clustering, and prediction techniques	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	Knowledge of stream analytics	Understanding real-time data processing concepts	CO5 | L4–L5	ETE Sec B/C
TS6	Understanding IoT security concepts	Ability to explain security threats and privacy issues	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, CO4	TS1, TS2, TS3
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 Introduction to Data Analytics and IoT	CO1	TS1	5h SL	Report submission + evaluation
Assignment 2	IoT Data Collection and Preprocessing	CO2	TS2	5h SL	Numerical problems on process management
Assignment 3	Statistical Analysis and Machine Learning for IoT	CO2, CO3	TS2, TS3	5h SL	Numerical computation + comparison
Assignment 4	Cloud, Edge, and Big Data Analytics for IoT	CO3, CO4	TS3, TS4	5h SL	Step-by-step numerical trace required
Assignment 5	IoT Analytics Applications and Case Studies	CO3, CO4, CO5	TS3, TS4, TS5	5h SL	Algorithm application + performance analysis
Video Learning Report	Technical video on IoT Analytics using Python (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	Smart City Analytics case study (e.g. Energy Analytics and Smart Grid); 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.*

Section	Marks	Theory Skill Dimensions	COs	Question Type & Guidance

			Assessed	
Section A	**10**	TS1 — Fundamentals of Internet of Things (IoT), IoT Architecture and Components, Sensors, Actuators, and Smart Devices, IoT Communication Protocol TS2---Introduction to Data Analytics, Types of Analytics: Descriptive, Predictive, Prescriptive, Data Lifecycle in IoT, Challenges in IoT Data Analytics, Applications of IoT Analytics	**CO1, CO2**	Short-answer: IoT Communication Protocols Introduction to Data Analytics Types of Analytics: Descriptive, Predictive, Prescriptive
Section B	**15**	TS3 — Smart City Analytics, Healthcare IoT Analytics, Industrial IoT (IIoT), Agriculture and Environmental Monitoring TS4--- Smart Transportation Systems, Energy Analytics and Smart Grid, IoT Analytics using Python	**CO2, CO3, CO4**	Numerical problems: Data collection using IoT devices, Data preprocessing using Python, Visualization of IoT datasets using Matplotlib/Power BI/Tableau, Classification using Decision Tree algorithm.
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 — Introduction to IoT and Data Analytics TS2 — IoT Data Collection and Preprocessing	**CO1, CO2**	Short questions (all units): Fundamentals of Internet of Things (IoT) IoT Architecture and Components Sensors, Actuators, and Smart Devices IoT Communication Protocols Introduction to Data Analytics Types of Analytics: Descriptive, Predictive, Prescriptive Data Lifecycle in IoT Challenges in IoT Data Analytics Applications of IoT Analytics Data Acquisition from IoT Devices Streaming and Real-Time Data Structured and Unstructured Data Data Cleaning and Data Integration Data Transformation and Normalization Missing Data Handling

				Feature Selection and Extraction Data Storage Techniques
Section B	**25**	TS3 — Statistical Analysis and Machine Learning for IoT TS4 — Cloud, Edge, and Big Data Analytics for IoT TS5 — IoT Analytics Applications and Case Studies	**CO2, CO3, CO4, CO5**	Medium questions: Statistical Methods for Data Analysis Correlation and Regression Classification and Clustering Techniques Decision Trees, Naive Bayes, and SVM K-Means Clustering Predictive Analytics for IoT Anomaly Detection in IoT Systems Introduction to Deep Learning for IoT Performance Evaluation Metrics Cloud Computing for IoT Edge and Fog Computing Big Data Concepts Hadoop and Spark Overview Distributed Data Processing Real-Time Analytics Frameworks Data Visualization Techniques Dashboard Design for IoT Analytics Security and Privacy in IoT Analytics
Section C	**10**	TS5 — IoT Analytics Applications and Case Studies	**CO5, CO6**	Long/evaluation questions: Smart City Analytics Healthcare IoT Analytics Industrial IoT (IIoT) Agriculture and Environmental Monitoring Smart Transportation Systems Energy Analytics and Smart Grid IoT Analytics using Python Case Studies and Mini Projects Emerging Trends in IoT Analytics
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	Introduce the fundamentals of Internet of Things (IoT) and Data Analytics.	✔	✔	✔	TS1	PO1, PO2, PO4
CO2	Understand IoT data generation, storage, processing, and visualization techniques.	✔	✔	✔	TS2	PO1, PO3, PO4
CO3	Learn data preprocessing and machine learning methods for IoT applications.	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Develop analytical models using	✔	✔	✔	TS4	PO9, PO10, PO11

	real-time IoT datasets.					
CO5	Explore cloud-based analytics and edge computing for IoT systems.	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Build practical applications using IoT analytics tools and platforms.	✔	—	✔	TS6	PO1, 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
CO2	3	2	3	3	–	–	–	2		2	1	2	3	2
CO3	3		3	3	–	–	–	1	1	1	3		2	1
CO4	2	2	2	2	1	–	–	2	3		3	2	2	2
CO5	2	2	3	–	–	–	–	3		1	2	3	–	–
CO6	3	2	–	–	–	–	–	–	–	2	3		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	

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 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. Hadoop and Spark Overview, Distributed Data Processing)**	Video viewing: 3 hrs Report preparation: 3 hrs Presentation: 3 hrs 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. Real-Time Analytics Frameworks, Data Visualization Techniques, Dashboard Design for IoT Analytics)**	Data collection/study: 4 hrs Report preparation: 2 hrs 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 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 (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

CSOT3206 — 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

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

1. Course Identification

School:	SSCSE	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2028–2029
Branch:	CS & ME	**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: **CO1 (Remember – L1):** Technical, Aptitude & Reasoning Foundations 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. **CO2 (Understand – L2):** Analytical Systems, Communication & Workflow Understanding 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. **CO3 (Apply – L3):** Application Development, Quantitative Problem Solving & Professional Communication 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. **CO4 (Analyze – L4):** Critical Thinking, Data Analysis & Verbal Reasoning 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.

		CO5 (Evaluate – L5): Technical Evaluation, Decision-Making & Workplace Effectiveness 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. **CO6 (Create – L6):** Integrated Technical Solutions & Employability Development 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. 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 2. A Modern Approach to Verbal & Non-Verbal Reasoning – R.S. Aggarwal 3. Russell, S. & Norvig, P. (2022). Artificial Intelligence: A Modern Approach (4th ed.). Pearson. [Data Science Track] 4. Flanagan, D. (2020). JavaScript: The Definitive Guide (7th ed.). O'Reilly Media. [Full Stack Track] 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 2. How to Prepare for Logical Reasoning for CAT – Arun Sharma 3. Word Power Made Easy – Norman Lewis 4. English Grammar in Use – Raymond Murphy 5. Communication Skills – Sanjay Kumar & Pushp Lata 6. Soft Skills – Alex K. 7. Harrison, M. (2023). Langchain: Develop LLM Applications with Python. Manning Publications. [Data Science Track] 8. Banks, A. & Porcello, E. (2020). Learning React (2nd ed.). O'Reilly Media. [Full Stack Track] 9. Sedgewick, R. & Wayne, K. (2011). Algorithms (4th ed.). Addison-Wesley. [Data Structures] 10. Okeke, T. (2023). Building REST APIs with Node.js and Express. Apress. [Full Stack Track] 11. LangChain Official Documentation – https://docs.langchain.com 12. LangGraph Documentation – https://langchain-ai.github.io/langgraph/ 13. CrewAI Documentation – https://docs.crewai.com 14. Node.js Official Documentation – https://nodejs.org/en/docs/ 15. Express.js Guide – https://expressjs.com/en/guide/ 16. MongoDB Manual – https://www.mongodb.com/docs/manual/ 17. LeetCode – Data Structures & Algorithms Practice – https://leetcode.com 18. Docker Official Documentation – https://docs.docker.com Online Resources • British Council Learning English • Toastmasters International

		• IndiaBIX Aptitude & Reasoning • GeeksforGeeks Aptitude Preparation • 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 OR 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 OR 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 OR File System (fs) Module, Path Module, Environment Variables (.env), Nodemon, Backend Debugging Workflow	**CO2**
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 OR 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 OR 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 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 OR 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 OR 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 OR 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 OR 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 OR 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 OR 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 OR 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 OR 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		✔	✔	✔	✔	✔

	OR 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 OR 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 OR 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 OR 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

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: 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

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	–	–	–	–	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: 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	A1 — Receiving: Awareness and willingness to participate A2 — Responding: Active participation and engagement A3 — Valuing: 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	P1 — Perception: Use sensory cues to guide actions P2 — Set: Mental and physical readiness to perform tasks P3 — Guided 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

SKP3601 — 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: SET		**Batch: 2026-2030**
Program: B.Tech		**Current Academic Year: 2028-2029**
Branch: Mechanical Engineering		**Semester: VI**
1	Course Code	BST3351

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 a 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. CO2: Explain the primary function of Planning with its process. Also, how forecasting is done in organizations with various techniques are used. CO3: Use of organizing by studying different types of organization and also using decentralization and span of control in organizations. CO4: Analyse jobs, recruitment process, manpower planning, job rotation, training and rewards in various organizations. CO5: Measure motivation and management control concepts to obtain effective control in the management system in organizations. CO6: Develop a proper system in an organization by using all the functions of management.	
7	Course Description	This course gives an overview of engineering management and helps to understand the various functions of management used in an organization. The focus of the course is the development of individual skills and team work.	
8	Outline syllabus		CO Mapping
	Unit 1	Introduction of Management & Organisation	CO1,CO6
	A	Management-Definition of Management & Organisation	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) / ETE	
		Assessment 1 (10) / Assessment 2 (5) / Assignment 1 (5) / Assignment 2 (5) / 75	
	Text book/s*	1. Principles & practice of Mgmt., L.M. Prasad	
	Other References	1. Management Today, Burton & Thakur 2. Principles & Practices of Mgmt., C.B. Gupta 3. Understanding Management, Richard L.Daft 4. Management, Stoner, Freemand & Gilbert 5. Essential of Management, Koontz O' Donnel	

1.3.5 Program Outcome Vs Courses Mapping Table:

CO	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	1	1	0	0	0	1	0	1	0	1	1	0	0	1
CO 2	0	2	1	0	0	0	0	0	0	0	1	0	0	1
CO 3	0	1	2	0	0	1	0	0	1	0	1	0	0	2
CO 4	0	2	2	0	0	1	0	0	1	0	2	0	0	2
CO 5	0	1	2	0	0	1	0	1	1	0	2	0	0	2
CO 6	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

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

School: SSCSE		**Batch :2026-2030**	
Program: B.Tech		**Current Academic Year: 2028-2029**	
Branch: CSE		**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. 2. To understand the significance of problem and its scope. 3. Students will make decisions within a framework.	
6	Course Outcomes	Students will be able to: CO1: Identify and formulate problem statement. CO2: Design relational database schema. CO3: Develop the solution by using different aspects of programming language. CO4: Classify and understand various test techniques for verification and validation of project. CO5: Analyze and make use of modern for solving real word problems. 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. References, Test cases if any. 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	-	2	-	1	1	2	-	2	1	2	2	3
CO2	3	2	2	2	2	-	1	2	-	2	1	2	1	1
CO3	3	2	2	2	2	3	1	2	-	2	1	2	2	-
CO4	3	3	2	2	3	-	1	2	-	-	1	2	2	2
CO5	3	2	-	-	3	-	1	2	-	-	1	2	2	-
CO6	-	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 VI	Credits : 23
Course Code	Course Name
CSME3301	Deep Learning and Reinforcement Learning in Medical data
CSME3100	Embeded system and wearable devices
CSME3302	Biomedical Instrmentation
	Program Elective-3
CSME3200	AI in drug discovery
CSME3201	Clinical Decision Support System
CSOT3206	Data Analytics for IoT
SKP3601	Strategic professionalism and Computational Informatics
BST3351	Management for Engineers
CSCR3601	Project Based Learning (PBL) -4 (Product Based)
	Open Elective – 1

COURSE PLAN

Modelling and Simulation of Biomedical Systems (CSME4200)

School of Computing Engineering Science Engineering (SSCSE) | B.Tech CS &ME | 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:**	2029-2030
Branch:	CS & ME	**Semester:**	VII
Course Code:	CSME4200	**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**	CSME4200
2	**Course Title**	**Modelling and simulation of a biomedical system**
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**	**Elective — Theory Only (No Laboratory Component)**
6	**Course Objectives**	• This course introduces the principles of modelling, simulation, and analysis of biomedical systems and physiological processes. • Enable students to understand mathematical foundations, including differential equations, dynamical systems, and computational methods used in biomedical engineering. • Develop the ability to model biological and physiological systems using deterministic, stochastic, and computational approaches. • Familiarise students with biomedical signal analysis, numerical simulation techniques, and system identification methods.

		• Introduce students to simulation tools and computational platforms used in healthcare, diagnostics, and biomedical applications. • Develop analytical and problem-solving skills for evaluating biomedical models and interpreting simulation results.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Remember– L1): Understand the fundamental concepts, principles, and challenges associated with modelling and simulation of biomedical systems. CO2 (Understand– L2): Explore mathematical and computational methods including differential equations, linear systems, and numerical techniques used in biomedical modelling. CO3 (Apply – L3): Apply simulation tools and computational techniques to develop and analyze models of physiological and biomedical systems. CO4 (Analyze – L4): Analyze biomedical signals and evaluate the performance, stability, and behavior of biomedical systems using signal processing and system analysis methods. CO5 (Evaluate – L5): Evaluate optimization methods, nonlinear dynamics, and control strategies used in biomedical engineering applications. CO6 (Create – L6): Design and interpret computational biomedical models for healthcare, diagnostics, physiological processes, and biomedical device applications.
8	**Course Description**	This course introduces the principles of modelling and simulation of biomedical systems with emphasis on physiological processes, biomedical signal analysis, computational methods, and healthcare applications. The course covers mathematical modelling techniques, differential equations, numerical analysis, system identification, optimization methods, biomedical signal processing, and simulation using computational tools such as MATLAB and Simulink. Students will explore applications in diagnostics, physiological system analysis, biomedical device modelling, and healthcare simulations.
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. Suresh R. Devasahayam — *Signals and Systems in Biomedical Engineering: Physiological Systems Modeling and Signal Processing*, Springer, 2019. 2. Willem Van Meurs — *Modeling and Simulation in Biomedical Engineering*, McGraw Hill, 2011.
12	**References**	1. Michael C.K. Khoo — *Physiological Control Systems: Analysis, Simulation and Estimation*, Wiley, 2018. 2. Lennart Ljung — *System Identification: Theory for the User*, Prentice Hall. 3. Stanley Dunn, Alkis Constantinides — *Numerical Methods in Biomedical Engineering*, Elsevier. 4. Z.C. Yang — *Finite Element Analysis for Biomedical Engineering Applications*, CRC Press, 2019. 5. Joseph J. Feher — *Quantitative Human Physiology: An Introduction*, Academic Press. 6. IEEE Transactions on Biomedical Engineering.

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 Biomedical Systems and Modelling	
A	Introduction to Biomedical Systems; Physiological Processes; Concepts of Modelling and Simulation	**CO1**
B	System Properties; Linear and Nonlinear Biomedical Systems; Dynamic System Behaviour	**CO1**
C	Mathematical Foundations of Biomedical Modelling; Deterministic and Stochastic Models	**CO1, CO2**
	Unit 2: Mathematical Modelling and Numerical Methods	
A	Differential Equations in Biomedical Systems; Ordinary and Partial Differential Equations	**CO2**
B	Numerical Methods for Biomedical Simulation; Stability and Accuracy of Numerical Models	**CO2**
C	MATLAB and Simulink for Biomedical Modelling; Simulation of Physiological Systems	**CO2**
	Unit 3: Biomedical Signal Processing and System Identification	
A	Physiological Signals: ECG, EEG, EMG; Signal Characteristics and Noise Analysis	**CO3**
B	Fourier Transform, Wavelet Transform, Laplace Transform, Filtering Techniques	**CO3**
C	System Identification, Parameter Estimation, Signal Analysis and Interpretation	**CO3**
	Unit 4: Optimization and Nonlinear Biomedical Systems	
A	Feedback Systems and Biomedical Control Systems; Stability Analysis	**CO4**
B	Optimization Techniques in Biomedical Engineering; Constrained and Unconstrained Optimization	**CO4**
C	Nonlinear Biomedical Systems; Oscillators; Complex Dynamics and Model Validation	**CO4**
	Unit 5: Applications of Biomedical Modelling and Simulation	
A	Computational Models in Healthcare; Drug Discovery and Personalized Medicine	**CO5**

B	Medical Image Analysis, Biomedical Device Simulation, Hemodynamic and Blood Flow Modelling	**CO5, CO6**
C	Virtual Surgery, Patient-Specific Implant Design, Ethical Considerations in Biomedical Simulation	**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	Topics to be Covered/Title	UNIT	Total Lectures
DD/MM/YY	Introduction to Biomedical Systems; Concepts of Modelling and Simulation	UNIT-1	9
DD/MM/YY	Physiological Processes and Biomedical System Behaviour		
DD/MM/YY	Linear and Nonlinear Biomedical Systems; Dynamic System Properties		
DD/MM/YY	Deterministic and Stochastic Biomedical Models		
DD/MM/YY	Differential Equations in Biomedical Systems	UNIT-2	9
DD/MM/YY	Ordinary and Partial Differential Equations for Physiological Modelling		
DD/MM/YY	Numerical Methods and Stability Analysis		
DD/MM/YY	MATLAB Fundamentals for Biomedical Applications		
DD/MM/YY	Simulink Modelling of Biomedical Systems		
DD/MM/YY	Simulation of Cardio-Respiratory and Blood Flow Systems		
DD/MM/YY	Introduction to Physiological Signals: ECG, EEG, EMG	UNIT-3	9

DD/MM/YY	Signal Characteristics, Noise Analysis, and Filtering Techniques		
DD/MM/YY	Fourier Transform and Frequency Domain Analysis		
DD/MM/YY	Wavelet Transform and Biomedical Signal Processing		
DD/MM/YY	Laplace Transform and System Analysis		
DD/MM/YY	System Identification and Parameter Estimation		
DD/MM/YY	Biomedical Signal Interpretation and Case Studies		
DD/MM/YY	Applications of Signal Processing in Healthcare Systems		
DD/MM/YY	Feedback Systems and Biomedical Control Systems	UNIT-4	9
DD/MM/YY	Stability Analysis of Biomedical Systems		
DD/MM/YY	Optimization Techniques in Biomedical Engineering		
DD/MM/YY	Constrained and Unconstrained Optimization Methods		
DD/MM/YY	Nonlinear Biomedical Systems and Oscillators		
DD/MM/YY	Complex Dynamics and Model Validation Techniques		
DD/MM/YY	Computational Models in Healthcare and Diagnostics	UNIT-5	9
DD/MM/YY	Drug Discovery and Personalized Medicine Applications		
DD/MM/YY	Medical Image Analysis and Biomedical Device Simulation		
DD/MM/YY	Hemodynamic and Blood Flow Modelling		
DD/MM/YY	Virtual Surgery and Patient-Specific Implant Design		
DD/MM/YY	Ethical Considerations and Future Trends in Biomedical Simulation		

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	**Conceptual Understanding of Biomedical Systems**	Recall and understand fundamental concepts of biomedical systems, physiological processes, modelling principles, deterministic and stochastic systems, and simulation methodologies	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	**Mathematical Modelling & Numerical Interpretation**	Explain and apply mathematical foundations including differential equations, linear systems, numerical methods, and computational modelling approaches used in biomedical engineering	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	**Computational Simulation & Implementation**	Apply MATLAB, Simulink, and computational tools to develop, simulate, and interpret biomedical system models and physiological processes	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	**Biomedical Signal Analysis & System Evaluation**	Analyze physiological signals such as ECG, EEG, and EMG using signal processing methods including Fourier, Wavelet, and filtering techniques; evaluate biomedical system behaviour and performance	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	**Optimization & Nonlinear Biomedical System Evaluation**	Analyze optimization techniques, nonlinear dynamics, feedback systems, and stability of biomedical models; evaluate performance and efficiency under varying conditions	CO5 | L4–L5	ETE Sec B/C
TS6	**Healthcare Applications & Biomedical Model Interpretation**	Analyze healthcare computational models, biomedical device simulations, medical imaging applications, and patient-specific biomedical systems; evaluate real-world biomedical engineering applications	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 Understanding	TS2 Mathematical Modelling & Numerical Interpretation	TS3 Computational Simulation & Implementation	TS4 Biomedical Signal Analysis & System Evaluation	TS5 Optimization & Nonlinear System Evaluation	TS6 Healthcare Applications & Biomedical Model Interpretation
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 2 (Numerical / Problem-based)	2 assignments	**10**	CO1, CO2, CO3, CO4,CO5,CO6	TS1, TS2, TS3, TS4
Assessment	2 Assessments	**15**	CO1,CO2,CO3,CO4,CO5	TS2, TS3
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: Biomedical systems, physiological processes, modelling and simulation fundamentals. Mathematical modelling using differential equations and numerical methods	CO1, CO2	TS1	5h SL	Report submission + conceptual understanding evaluation. Numerical problem solving + modelling interpretation
Assignment 2	MATLAB and Simulink based biomedical system simulation. Biomedical signal processing: ECG/EEG/EMG analysis using Fourier and filtering techniques. Optimization and nonlinear biomedical system analysis	CO3, CO4, CO5, CO6	TS2	5h SL	Simulation implementation + computational analysis Signal analysis + interpretation of results
Case Study Report	Real-world biomedical engineering case study (e.g.,	CO4, CO5,	TS4, TS5,	6h SL	Technical depth, comparative analysis,

	cardiac modelling, blood flow simulation, medical image analysis, implant design)	CO6	TS6		research quality, and application-oriented interpretation

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	**8**	TS1 — Conceptual Understanding of Biomedical Systems TS2 — Mathematical Modelling & Numerical Interpretation	**CO1, CO2**	Short-answer questions: define biomedical modelling concepts, explain physiological systems, describe deterministic and stochastic models, differential equations, numerical methods, and simulation principles
Section B	**7**	TS3 — Computational Simulation & Implementation TS4 — Biomedical Signal Analysis & System Evaluation	**CO2, CO3, CO4**	Numerical and analytical problems: biomedical system modelling, MATLAB/Simulink-based interpretation, signal analysis using Fourier/Wavelet transforms, filtering techniques, and interpretation of physiological signals
TOTAL	**15**	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	**20**	TS1 — Conceptual Understanding of Biomedical Systems TS2 — Mathematical Modelling & Numerical Interpretation	**CO1, CO2**	Short-answer questions from all units: biomedical system concepts, physiological processes, deterministic/stochastic models, differential equations, modelling techniques, and numerical methods
Section B	**25**	TS3 — Computational Simulation & Implementation TS4 — Biomedical	**CO3, CO4, CO5**	Medium-answer numerical and analytical questions: biomedical simulations, MATLAB/Simulink modelling, Fourier/Wavelet

		Signal Analysis & System Evaluation TS5 — Optimization & Nonlinear System Evaluation		analysis, signal filtering, optimization methods, stability analysis, and nonlinear biomedical system evaluation
Section C	**15**	TS5 — Optimization & Nonlinear System Evaluation TS6 — Healthcare Applications & Biomedical Model Interpretation	**CO5, CO6**	Long-answer and case-study-based questions: healthcare computational models, blood flow and hemodynamic modelling, biomedical device simulation, medical image analysis, patient-specific implant modelling, virtual surgery, ethical considerations, and comparative evaluation of biomedical applications
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 (25)	ETE (50)	TS	PO Primary
CO1	Understand fundamental concepts, principles, and challenges of biomedical system modelling and simulation	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Explore mathematical and computational methods used in biomedical modelling	✔	✔	✔	TS2	PO1, PO3, PO4
CO3	Apply computational tools and simulation techniques for physiological and biomedical systems	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Analyze biomedical signals and evaluate biomedical system behaviour using signal processing methods	✔	✔	✔	TS4	PO9, PO10, PO11
CO5	Evaluate optimization techniques, nonlinear systems, and biomedical control strategies	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Design and interpret healthcare computational models and biomedical engineering applications	✔	—	✔	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	1	–	–	2	1	1	–	3	2	1
CO2	3	3	2	3	2	–	–	1	1	1	–	3	3	1
CO3	3	3	3	3	3	–	–	1	1	2	1	3	3	2
CO4	2	3	2	3	2	–	–	2	2	3	1	2	3	2
CO5	2	2	3	2	2	–	–	3	2	2	2	2	2	2
CO6	3	2	3	2	2	1	1	2	2	3	2	3	2	3
Avg	**2.67**	**2.67**	**2.50**	**2.50**	**2.00**	**1.00**	**1.00**	**1.83**	**1.50**	**2.00**	**1.50**	**2.67**	**2.50**	**1.83**

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	M	M			M		M		H	M	
CO2	H	H	M	H	M			M		M		H	H	
CO3	H	H	H	H	H			M	M	M	M	H	H	M
CO4	M	H	M	H	M			M	M	H	M	M	H	M
CO5	M	M	H	M	M			H	M	M	M	M	M	M
CO6	H	M	H	M	M	M	M	M	M	H	M	H	M	H

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

S.No	Activity	Hours	COs / TS	Evaluation Criteria

1	**Numerical Assignment Writing (2 assignments, problem-based, covering biomedical modelling, differential equations, signal processing, optimization, and healthcare simulation)**	2 assignments × 10 hrs each Total = 20 hrs	CO1–CO4 TS1–TS4	Evaluated based on assignment submission, correctness of mathematical modelling, simulation interpretation, analytical steps, and comparison of biomedical system performance
2	**Technical Video-Based Learning related to biomedical modelling and simulation (e.g., physiological signal processing, MATLAB/Simulink applications, medical image analysis, computational healthcare systems)**	Video viewing: 5 hrs Report preparation: 5 hrs Presentation: 5 hrs Total = 15 hrs	CO2, CO3 TS2, TS3	Report + Presentation based on technical learning outcomes; must include key biomedical concepts, computational approaches, simulation techniques, and personal reflections
3	**Real-World Biomedical Engineering Case Studies (e.g., cardiac modelling, blood flow simulation, biomedical device modelling, virtual surgery, patient-specific implant systems)**	Data collection/study: 6 hrs Report preparation: 4 hrs Total = 10 hrs	CO4, CO5, CO6 TS4, TS5, TS6	Evaluated based on technical depth, research quality, biomedical relevance, data interpretation, fact finding, and analytical conclusions
	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 (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

CSME4200 — 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

Block Chain in Medical Data Management (CSME4201)

School of Computing Science and Engineering (SSCSE) | B.Tech CS & ME | 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 and Engineering	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2029-2030
Branch:	CS & ME	**Semester:**	VII
Course Code:	CSME4201	**Course Type:**	Program Elective

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**	CSME4201
2	**Course Title**	**Block Chain in Medical Data Management**
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 fundamentals of blockchain technology and its applications in secure medical data management. • Healthcare data management challenges related to privacy, security, and interoperability. • Blockchain concepts and smart contracts for secure storage and sharing of electronic health records. • Blockchain frameworks and consensus mechanisms for efficient and trustworthy healthcare systems. • Blockchain-based healthcare solutions that ensure data integrity, transparency, and regulatory compliance.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Understand – L1/L2): Understand the fundamental concepts, architecture, and

		working principles of blockchain technology in medical data management. CO2 (Explore – L2/L3): Explore blockchain-based healthcare applications, electronic health records (EHRs), decentralized systems, and healthcare data-sharing frameworks. CO3 (Apply – L3/L4): Apply blockchain technologies, smart contracts, and consensus mechanisms to develop secure and transparent medical data management solutions. CO4 (Analyze – L4/L5): Analyze the security, privacy, interoperability, scalability, and regulatory challenges associated with blockchain-enabled healthcare systems. CO5 (Evaluate – L5/L6): Evaluate the effectiveness of blockchain frameworks, cryptographic techniques, and decentralized healthcare applications in ensuring data integrity and patient privacy. CO6 (Create – L5/L6): Design blockchain-enabled healthcare solutions for secure medical record management, patient-centric data sharing, and trusted healthcare ecosystems.
8	**Course Description**	This course introduces the fundamentals of blockchain technology and its applications in secure medical data management. It covers blockchain architecture, cryptographic techniques, consensus mechanisms, smart contracts, and decentralized healthcare systems for managing electronic health records (EHRs). The course emphasizes data privacy, security, interoperability, and regulatory compliance in healthcare. Students will explore real-world healthcare use cases and design blockchain-enabled solutions for transparent, efficient, and patient-centric medical data management.
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. Blockchain Basics, 2nd Edition, Apress, 2020. 2. Blockchain and Healthcare: Innovations and Challenges, CRC Press, 2022.
12	**References**	1. Mastering Blockchain, 4th Edition, Packt Publishing, 2023. 2. Blockchain Technology: Concepts and Applications, Wiley India, 2021. 3. Blockchain, Artificial Intelligence and Financial Services, Springer, 2021. (Useful for understanding blockchain architectures and secure data management concepts applicable to healthcare.)

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 Blockchain and Healthcare Data Management	
A	Introduction to Blockchain, Evolution of Blockchain, Distributed Ledger Technology (DLT)	**CO1**
B	Blockchain Architecture, Types of Blockchain (Public, Private, Consortium), Cryptographic Hash Functions,	**CO1**
C	Digital Signatures, Challenges in Traditional Healthcare Data Management, Electronic Health Records (EHRs), Need for Blockchain in Healthcare.	**CO1**

	Unit 2: Blockchain Technologies and Smart Contracts	
A	Blockchain Components, Blocks and Transactions, Consensus Mechanisms (PoW, PoS, PBFT.	**CO2**
B	Smart Contracts, Decentralized Applications (DApps), Ethereum Platform.	**CO2**
C	Hyperledger Fabric, Blockchain Development Tools, Security Features in Blockchain.	**CO3**
	Unit 3: Blockchain Applications in Medical Data Management	
A	Blockchain-based Electronic Health Records (EHRs), Secure Medical Data Sharing, Patient-Centric Healthcare Systems.	**CO3**
B	Identity Management, Healthcare Interoperability, IoMT (Internet of Medical Things).	**CO3**
C	Telemedicine, Clinical Trial Management, Pharmaceutical Supply Chain Management.	**CO4**
	Unit 4: Security, Privacy, and Regulatory Compliance	
A	Data Privacy and Confidentiality, Access Control Mechanisms, Cryptographic Security, GDPR, HIPAA	**CO4**
B	Healthcare Data Standards (HL7, FHIR), Blockchain Scalability, Performance Issues,	**CO5**
C	Security Threats and Countermeasures, Ethical and Legal Challenges.	**CO5**
	Unit 5: Emerging Trends and Case Studies	
A	AI and Blockchain in Healthcare, Federated Learning with Blockchain, Cloud-Based Healthcare Systems.	**CO5**
B	Edge Computing, Healthcare Analytics, Wearable Devices,	**CO6**
C	Blockchain Case Studies in Hospitals and Healthcare Organizations, Future Research Directions and Emerging Applications.	**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	Topics to be Covered/Title	UNIT	Total Lectures
DD/MM/YY	Introduction to Medical Data Management and Healthcare Information Systems	UNIT-1	9
DD/MM/YY	Evolution and Fundamentals of Blockchain Technology		
DD/MM/YY	Blockchain Architecture and Distributed Ledger Technology (DLT)		
DD/MM/YY	Types of Blockchain: Public, Private, and Consortium		
DD/MM/YY	Cryptographic Hash Functions and Digital Signatures		

DD/MM/YY	Blocks, Transactions, and Merkle Trees		
DD/MM/YY	Electronic Health Records (EHRs) and Their Challenges		
DD/MM/YY	Need for Blockchain in Healthcare Systems		
DD/MM/YY	Revision and Discussion		
DD/MM/YY	Blockchain Components and Network Architecture	UNIT-2	9
DD/MM/YY	Consensus Mechanisms: PoW, PoS, PBFT		
DD/MM/YY	Smart Contracts: Concepts and Applications		
DD/MM/YY	Ethereum Blockchain and Smart Contract Development		
DD/MM/YY	Hyperledger Fabric for Healthcare Applications		
DD/MM/YY	Decentralized Applications (DApps)		
DD/MM/YY	Blockchain Development Tools and Platforms		
DD/MM/YY	Security Features in Blockchain Networks		
DD/MM/YY	Revision and Case Study		
DD/MM/YY	Blockchain-based Electronic Health Records (EHRs)	UNIT-3	9
DD/MM/YY	Secure Medical Data Sharing Using Blockchain		
DD/MM/YY	Patient-Centric Healthcare Systems		
DD/MM/YY	Identity and Access Management in Healthcare		
DD/MM/YY	Healthcare Interoperability (HL7, FHIR)		
DD/MM/YY	Internet of Medical Things (IoMT)		
DD/MM/YY	Telemedicine and Remote Patient Monitoring		
DD/MM/YY	Pharmaceutical Supply Chain Management		
DD/MM/YY	Revision and Applications		
DD/MM/YY	Data Privacy and Confidentiality in Healthcare	UNIT-4	9
DD/MM/YY	Cryptographic Security Techniques		
DD/MM/YY	Access Control and Identity Managemen		
DD/MM/YY	GDPR, HIPAA, and Healthcare Regulations		
DD/MM/YY	Blockchain Scalability and Performance Issues		
DD/MM/YY	Security Threats and Attack Prevention		

DD/MM/YY	Ethical and Legal Issues in Healthcare Blockchain		
DD/MM/YY	Healthcare Data Standards and Compliance		
DD/MM/YY	Revision and Discussion		
DD/MM/YY	Artificial Intelligence and Blockchain in Healthcare	UNIT-5	9
DD/MM/YY	Federated Learning and Blockchain		
DD/MM/YY	Cloud and Edge Computing in Healthcare		
DD/MM/YY	Healthcare Analytics and Predictive Medicine		
DD/MM/YY	Wearable Devices and Remote Healthcare Monitoring		
DD/MM/YY	Case Studies of Blockchain in Healthcare		
DD/MM/YY	Emerging Trends and Future Research Directions		
DD/MM/YY	Mini Project/Presentation on Blockchain-based Healthcare Solutions		
DD/MM/YY	Revision 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–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	Blockchain Fundamentals and Healthcare Data Management	Recall and understand the fundamental concepts of blockchain, distributed ledger technology, cryptographic principles, healthcare data management, and Electronic Health Records (EHRs).	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	Blockchain Architecture and Smart Contracts	Explain blockchain architecture, consensus mechanisms, smart contracts, decentralized applications, and blockchain platforms used in healthcare systems.	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A

TS3	Blockchain Applications in Medical Data Management	Apply blockchain technologies to develop secure medical data-sharing solutions, patient-centric healthcare systems, healthcare interoperability, and Electronic Health Record (EHR) management.	CO2 | L3–L4	CA | MTE Sec B | ETE Sec B
TS4	Healthcare Security, Privacy, and Regulatory Compliance	Analyze healthcare security, data privacy, cryptographic mechanisms, interoperability standards, scalability issues, and regulatory compliance in blockchain-enabled healthcare systems.	CO2 | L4–L5	MTE Sec B | ETE Sec B
TS5	Blockchain-enabled Healthcare Systems and Emerging Technologies	Evaluate blockchain frameworks, healthcare analytics, IoMT, cloud healthcare, AI integration, and decentralized healthcare applications for secure and efficient medical data management.	CO5 | L5–L6	CA | ETE Sec B/C
TS6	Design of Secure Blockchain-based Healthcare Solutions	Design blockchain-enabled healthcare ecosystems integrating smart contracts, decentralized architectures, patient-centric data sharing, ethical considerations, and regulatory requirements for real-world healthcare applications.	CO5 | 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 Understanding	TS2 Mathematical Modelling & Numerical Interpretation	TS3 Computational Simulation & Implementation	TS4 Biomedical Signal Analysis & System Evaluation	TS5 Optimization & Nonlinear System Evaluation	TS6 Healthcare Applications & Biomedical Model 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 2 (Case study / Problem-based)	2 assignments	**10**	CO1, CO2, CO3, CO4, CO5, CO6	TS1, TS2, TS3, TS4, TS5, TS6
Assessment	2 Assessments	**15**	CO2, CO3	TS2, TS3
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	Fundamentals of blockchain technology, distributed ledger technology (DLT), blockchain architecture, cryptographic hash functions, digital signatures, and healthcare data management concepts.	CO1	TS1	4h SL	Report submission, conceptual understanding, blockchain architecture explanation, and healthcare relevance.
Assignment 2	Blockchain architecture, consensus mechanisms (PoW, PoS, PBFT), smart contracts, Ethereum, Hyperledger Fabric, and decentralized healthcare applications.	CO2	TS2	4h SL	System design, application analysis, interoperability evaluation, and healthcare solution development.
Assignment 3	Blockchain-based Electronic Health Records (EHRs), secure medical data sharing, patient-centric healthcare systems, healthcare interoperability (HL7/FHIR), and IoMT applications.	CO3	TS3	4h SL	Security analysis, privacy evaluation, regulatory compliance assessment, and problem-solving ability.
Assignment 4	Healthcare security, privacy, cryptographic techniques, GDPR, HIPAA, blockchain scalability, performance analysis, and security threats in healthcare blockchain systems.	CO4	TS4	4h SL	Technology evaluation, innovation analysis, comparative study, and healthcare application assessment.
Assignment 5	AI-enabled healthcare, blockchain analytics, cloud and edge computing, wearable healthcare devices, decentralized healthcare ecosystems, and emerging blockchain applications.	CO5	TS5	4h SL	Learning outcomes, technical understanding, self-reflection, presentation quality, and application-oriented analysis.
Video Learning Report	Technical video learning on human physiology, biomedical instrumentation, physiological signal monitoring, or AI-driven healthcare systems (minimum 3 hrs) with structured report and presentation	CO2, CO3	TS2, TS3	15h SL	Learning outcomes, technical understanding, self-reflection, and presentation quality
Case Study Report	Real-world blockchain healthcare case study (e.g.,	CO4, CO5,	TS4, TS5,	10h SL	Technical depth, comparative analysis,

	blockchain-based EHR systems, pharmaceutical supply chain, patient identity management, healthcare IoT, AI-integrated blockchain healthcare, or telemedicine applications).	CO6	TS6		research quality, security evaluation, ethical understanding, innovation, and application-oriented interpretation.

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	8	TS1 – Blockchain Fundamentals and Healthcare Data Management	CO1, CO2, CO3	Short-answer and conceptual questions on blockchain fundamentals, distributed ledger technology, blockchain architecture, cryptographic hash functions, digital signatures, healthcare data management, Electronic Health Records (EHRs), consensus mechanisms, smart contracts, Ethereum, Hyperledger Fabric, and blockchain applications in healthcare.
		TS2 – Blockchain Architecture and Smart Contracts		
		TS3 – Blockchain Applications in Medical Data Management		
Section B	7	TS1 – Blockchain Fundamentals and Healthcare Data Management	CO1, CO2, CO3, CO4	Explanatory, analytical, and case-based questions on secure medical data sharing, blockchain-enabled Electronic Health Records (EHRs), healthcare interoperability (HL7/FHIR), IoMT applications, cryptographic security, access control, healthcare privacy, HIPAA, GDPR, blockchain scalability, and regulatory compliance.
		TS2 – Blockchain Architecture and Smart Contracts		
		TS3 – Blockchain Applications in Medical Data Management TS4 – Healthcare Security, Privacy, and Regulatory Compliance		
TOTAL	15	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	20	TS1 – Blockchain Fundamentals and Healthcare Data Management TS2 – Blockchain Architecture and Smart Contracts	CO1, CO2	Short-answer, conceptual, and diagram-based questions on blockchain fundamentals, distributed ledger technology, blockchain architecture, cryptographic hash functions, digital signatures, consensus mechanisms, smart contracts, Ethereum, Hyperledger Fabric, and healthcare data management concepts.
Section B	25	TS3 – Blockchain Applications in Medical Data Management TS4 – Healthcare Security, Privacy, and Regulatory Compliance TS5 – Blockchain-enabled Healthcare Systems and Emerging Technologies	CO3, CO4, CO5, CO6	Analytical, explanatory, and application-oriented questions on Electronic Health Records (EHRs), healthcare interoperability, IoMT, blockchain-based healthcare applications, cryptographic security, GDPR, HIPAA, scalability, AI-enabled healthcare systems, cloud healthcare, wearable devices, and healthcare analytics.
Section C	15	TS3 – Blockchain Applications in Medical Data Management TS4 – Healthcare Security, Privacy, and Regulatory Compliance TS5 – Blockchain-enabled Healthcare Systems and Emerging Technologies TS6 – Design of Secure Blockchain-based Healthcare Solutions-	CO3, CO4, CO5, CO6	Case study, problem-solving, and design-oriented questions involving blockchain-based Electronic Health Records (EHRs), secure medical data sharing, smart contracts, decentralized healthcare ecosystems, pharmaceutical supply chain management, telemedicine, AI-integrated blockchain healthcare, privacy, ethics, and regulatory compliance.
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 (25)	ETE (50)	TS	PO Primary
CO1	Understand the fundamental concepts, architecture, and working principles of blockchain technology in medical data management.	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Explore blockchain-based healthcare applications, electronic health records (EHRs), decentralized systems, and healthcare data-sharing frameworks.	✔	✔	✔	TS2	PO1, PO3, PO4

CO3	Apply blockchain technologies, smart contracts, and consensus mechanisms to develop secure and transparent medical data management solutions.	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Analyze the security, privacy, interoperability, scalability, and regulatory challenges associated with blockchain-enabled healthcare systems.	✔	✔	✔	TS4	PO9, PO10, PO11
CO5	Evaluate the effectiveness of blockchain frameworks, cryptographic techniques, and decentralized healthcare applications in ensuring data integrity and patient privacy.	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Design blockchain-enabled healthcare solutions for secure medical record management, patient-centric data sharing, and trusted healthcare ecosystems.	✔	—	✔	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						2	1	
CO2	3	2				1						2	2	
CO3	3	3	2	2	1	2						2	2	1
CO4	2	3	2	2	1	2						2	2	1
CO5	2	3	2	2	3	3	1	2				2	3	3
CO6	2	3	3	3	3	3	2	3	2	2	1	3	3	3
Avg	2.5	2.7	2.3	2.5	2.5	2.0	1.5	2.5	2.0	2.0	1.0	2.2	2.3	2.3

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	M											M		
CO2	H	M											M	M	
CO3	H	H	M	M									M	M	
CO4	M	H	M	H	H								M	H	M
CO5	M	H	M	M	H	M		M					M	H	H
CO6	M	H	H	H	H	M	M	H	M	M		M	H	H	H

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

S.No	Activity	Hours	COs / TS	Evaluation Criteria
1	**Assignment Writing** (5 assignments covering blockchain fundamentals, distributed ledger technology, blockchain architecture, smart contracts, Electronic Health Records (EHRs), healthcare interoperability, blockchain security, privacy, and healthcare applications.)	**5 assignments × 4 hrs each Total = 20 hrs**	CO1–CO3 TS1–TS3	**Assignment Writing** (5 assignments covering blockchain fundamentals, distributed ledger technology, blockchain architecture, smart contracts, Electronic Health Records (EHRs), healthcare interoperability, blockchain security, privacy, and healthcare applications.)
2	**Technical Video-Based Learning** related to blockchain technology, Ethereum, Hyperledger Fabric, smart contracts, cryptographic security, Electronic Health Records (EHRs), healthcare interoperability, IoMT, AI-enabled healthcare, and decentralized healthcare systems.	**Video Viewing: 5 hrs Report Preparation: 5 hrs Presentation: 5 hrs Total = 15 hrs**	CO2, CO3, CO4 TS2, TS3, TS4	Report and presentation evaluated based on understanding of blockchain platforms, healthcare applications, cryptographic security, interoperability standards, regulatory compliance, and self-learning outcomes.
3	**Real-World Blockchain Healthcare Case Studies** (e.g., blockchain-based Electronic Health Records, pharmaceutical supply chain management, patient identity management, telemedicine, IoMT security, AI-integrated blockchain healthcare, and healthcare data privacy.	**Case Study & Data Collection: 6 hrs Report Preparation: 4 hrs Total = 10 hrs**	CO4, CO5, CO6 TS4, TS5, TS6	Evaluated based on technical depth, analytical thinking, research quality, healthcare relevance, blockchain solution design, ethical and regulatory considerations, and innovation.
	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 the fundamental concepts of blockchain, distributed ledger technology, cryptographic techniques, healthcare data management, and Electronic Health Records (EHRs). **L2 — Understand:** Explain blockchain architecture, consensus mechanisms, smart contracts, healthcare interoperability, and decentralized healthcare systems. **L3 — Apply:** Apply blockchain concepts, smart contracts, and cryptographic techniques to solve healthcare data management problems. **L4 — Analyze:** Analyze blockchain-enabled healthcare systems for security, privacy, interoperability, scalability, and regulatory compliance. **L5 — Evaluate:** Evaluate blockchain frameworks, consensus algorithms, healthcare applications, and emerging technologies for secure medical data management. **L6 — Create:** Design innovative blockchain-enabled healthcare ecosystems integrating smart contracts, AI, IoMT, cloud computing, and regulatory compliance for real-world medical applications	A1 — Receiving: Demonstrate awareness of blockchain technologies and their significance in secure healthcare data management. A2 — Responding: Participate in discussions, demonstrations, and activities related to blockchain-enabled healthcare applications. A3 — Valuing: Appreciate the importance of data privacy, security, transparency, and ethical healthcare practices using blockchain technology. A4 — Organizing: Integrate blockchain principles with healthcare standards and ethical guidelines to support secure medical data management. A5 — Characterizing: Demonstrate professional commitment toward secure, ethical, and patient-centric healthcare data management.	P1 — Perception: Recognize blockchain platforms, healthcare datasets, and development tools through observation and exploration. P2 — Set: Demonstrate readiness to use blockchain development environments and healthcare blockchain platforms. P3 — Guided Response: Develop simple blockchain-based healthcare applications through guided practice and implementation exercises. P4 — Mechanism: Implement blockchain solutions using smart contracts, healthcare data models, and decentralized applications with increasing proficiency. P5 — Complex Overt Response: Develop efficient blockchain-enabled healthcare applications for secure Electronic Health Records (EHRs), medical data sharing, and healthcare interoperability. P6 — Adaptation: Modify and optimize blockchain solutions to address diverse healthcare requirements and security challenges. P7 — Origination: Create novel blockchain-based healthcare solutions that improve patient privacy, data integrity, interoperability, and intelligent healthcare services.

★ *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

CSME4201 — 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

Smart Contracts (CSAI4001)

Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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:**	2029–2030
Branch:	CS & ME	**Semester:**	VII
Course Code:	CSAI4001	**Course Type:**	Program Elective

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**	**Smart Contracts**
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:** CO1 (Apply – L1/L2/L3): Develop smart contract, solidarity, Ethereum based application. CO2 (Explore – L2/L3): Compare bitcoin, Ethereum, Hyperledger and various cryptocurrencies concept. CO3 (Apply – L2/L3): Discuss decentralization and crowdfunding systems. CO4 (Analyze – L4/L5): Explain smart contracts, their technical capabilities, practical applications, limitations and security constraints. CO5 (Analyze – L4/L5): Discuss the most prominent smart contract platform and Ethereum. 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 • Mastering Bitcoin by Andreas Antonopoulos, O'Reilly Publishing 2014 978-0691171692
12	**References**	1. Ethereum White Paper Vitalik Buterin Online 2014. 2. Ethereum Documentation (https://ethereum.org/en/developers/docs/) 3. Solidity Documentation (https://docs.soliditylang.org/) 4. Mastering Bitcoin Andreas M. Antonopoulos O'Reilly Media 2014 ISBN: 9781449374044 5. Mastering Ethereum Andreas M. Antonopoulos, Gavin Wood O'Reilly Media 2018 ISBN: 9781491971949 6. Blockchain Basics Daniel Drescher Apress Publishing 2017 ISBN: 9781484226032 7. Introducing Ethereum and Solidity Chris Dannen Apress Publishing 2017 ISBN: 9781484225349 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)

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	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		
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	UNIT-2	9
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		
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	UNIT-3	9
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)		
DD/MM/YY	Decentralized Applications	UNIT-4	9
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		
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	UNIT-5	9
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	Asses sment

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,TS 2,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,TS 2,TS3,T S4,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 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 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 TS4 — Smart Contract Analysis & Security Evaluation 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 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 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 (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

Healthcare Data Analytics (CSME4202)

Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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:**	2029–2030
Branch:	CS & ME	**Semester:**	VII
Course Code:	CSME4202	**Course Type:**	Program Elective

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**	CSME4202
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 bio signals		
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.

Section	Marks	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	**10**	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
Section B	**15**	TS3 — Analytical Application & Model Implementation TS4 — Predictive Model Analysis & Performance Evaluation	CO2, CO3, CO4	Numerical problems: compute regression coefficients, evaluate classification model using confusion matrix, calculate sensitivity/specificity/AUC; compare model performance on given dataset; apply risk stratification logic
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 — 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
Section B	**30**	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
Section C	**15**	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
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	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,	✔	—	✔	**TS6**	PO1, PO2, PO10, PO11

	ethics, and real-world case studies				

⚠ 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.

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	

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
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

CSME4202 — 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

Natural Language Processing for Clinical Data (CSME4203)

*School of Engineering & Technology (SET) | **B. Tech CS & ME** | 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 — School of Smart Computing Science & Engineering	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2029-2030
Branch:	CS & ME	**Semester:**	VII
Course Code:	CSME4203	**Course Type:**	Program Elective

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**	CSME4203
2	**Course Title**	**Natural Language Processing for Clinical Data**
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**	**Specialization Elective — Theory Only (No Laboratory Component)**
6	**Course Objectives**	1. Introduce the concepts of Natural Language Processing in healthcare and clinical environments. 2. Develop understanding of clinical text processing, electronic health records, and biomedical language resources. 3. Apply NLP techniques for extraction, classification, and interpretation of clinical information. 4. Analyse machine learning and deep learning approaches for biomedical NLP. 5. Design intelligent clinical NLP applications for healthcare decision support.
7	**Course Outcomes (COs)**	CO1 (Understand – L1/L2): Define foundational clinical NLP concepts, the distinct structural nature of healthcare text data, and essential clinical data standards. CO2 (Explore – L2/L3): Explain and navigate specialized biomedical ontologies, terminologies, standardized clinical corpora, and lexical resource frameworks. CO3 (Apply – L3): Apply specialized clinical preprocessing, clinical note section segmentation, and context/negation verification algorithms. CO4 (Analyze – L4): Analyze and evaluate approaches for medical named entity recognition (CNER), clinical relation extraction, and medical text classification. CO5 (Analyze – L4/L5): Analyze domain-specific deep learning architectures and transformer-based models optimized for clinical data processing. CO6 (Create – L5/L6): Design scalable, end-to-end intelligent healthcare pipelines and phenotyping systems using clinical NLP methods.
8	**Course Description**	This course provides a comprehensive introduction to the foundational concepts, resources, and algorithms required to process unstructured textual data in the healthcare domain. Unlike general NLP, clinical NLP must deal with heavily abbreviated, ungrammatical, and highly sensitive patient data. The course covers medical terminologies (UMLS, SNOMED-CT), privacy regulations (HIPAA de-identification), clinical text preprocessing, negation/uncertainty detection, clinical relation extraction, phenotyping, and the deployment of advanced transformer models (ClinicalBERT, BioBERT) to extract actionable clinical insights.
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. Carsten Eickhoff, Imre Solti — *Clinical Natural Language Processing: An Introduction*,

		Springer. 2. Dina Demner-Fushman, Kevin Bretonnel Cohen, John Pestian — *Biomedical Natural Language Processing*, John Benjamins Publishing Company.
12	**References**	1. Jurafsky, D. & Martin, J.H. — *Speech and Language Processing*, Pearson. 2. Charu C. Aggarwal & Cheng Xiang Zhai — *Mining Text Data*, Springer. 3. * Selected publications from i2b2/n2c2 Clinical NLP Shared Tasks.

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 Clinical NLP & Healthcare Narratives	
A	Introduction to Clinical NLP: Evolution, application landscapes, and importance; Comparing clinical narratives vs. general English text; Technical challenges: non-standard abbreviations, typos, telegraphic grammar, and shorthand acronyms.	**CO1**
B	Privacy, Security, and Ethical Considerations in Healthcare NLP; HIPAA regulations and Protected Health Information (PHI); De-identification frameworks: Safe Harbor vs. Expert Determination methods; Overview of automated de-identification tools.	**CO1**
C	Standardized Clinical Corpora: Introduction to open-access clinical data repositories; Understanding and navigating the MIMIC (MIMIC-III, MIMIC-IV) database; Legacy of the i2b2 and n2c2 Clinical NLP Shared Tasks; Clinical annotation schemas and inter-annotator agreement metrics.	**CO1**
	Unit 2: Biomedical Terminologies, Knowledge Bases & Ontologies	
A	Introduction to medical lexicons and standardized health data terminologies: Hierarchical structural design of ICD-9, ICD-10, and ICD-11 coding systems; Framework and deployment of SNOMED-CT, LOINC, and RxNorm.	**CO2**
B	The Unified Medical Language System (UMLS): Architecture and components; Exploring the Metathesaurus, Semantic Network, and Specialist Lexicon; Working with Concept Unique Identifiers (CUIs), Type Unique Identifiers (TUIs), and lexical relationships.	**CO2**
C	Knowledge Extraction Tools & Semantic Engines: Conceptual overview, parsing mechanics, and hands-on mapping pipelines using MetaMap; Introduction to Apache cTAKES (clinical Text Analysis and Knowledge Extraction System) and CLAMP.	**CO2**
	Unit 3: Clinical Text Preprocessing & Context Verification	
A	Specialized Clinical Preprocessing: Text normalization challenges specific to electronic health records; Sentence boundary detection in semi-structured clinical reports; Section segmentation strategies (History of Present Illness, Medications, Past Medical History).	**CO3**
B	Clinical Named Entity Recognition (CNER): Algorithmic strategies for extracting medical concepts; Tokenization for medical terms; Identifying diseases, symptoms, medications, dosages, administration routes, and surgical procedures.	**CO3**

C	Context and Negation Processing: The critical impact of context in medical notes; Negation detection algorithms: Rule-based systems (NegEx algorithm), dependency-based variants, and the ConText algorithm; Assertion status verification (Present, Absent, Conditional, Hypothetical).	CO3
	Unit 4: Advanced Clinical Extraction, Phenotyping & Classification	
A	Clinical Relation Extraction: Semantic dependency linking; Mapping medications to their respective dosages, frequencies, and administration routes; Linking medical conditions to specific anatomical body locations; Introduction to clinical temporal relation extraction.	CO4
B	Digital Phenotyping and Cohort Identification: Using unstructured medical text to discover latent patient cohorts; Building rule-based phenotype algorithms (e.g., eMERGE network paradigms) vs. machine learning-driven phenotyping classifiers.	CO4
C	Clinical Text Classification and Automation: Computer-Assisted Coding (CAC); Machine learning implementations (SVM, Logistic Regression, Random Forests) for automated ICD billing code assignment; Clinical triage prioritization systems from emergency notes.	CO4
	Unit 5: Deep Learning, Transformers & Applications in Healthcare	
A	Sequence Modeling for Clinical Text: Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) models adapted for clinical sequence labeling; Conditional Random Fields (CRF) combined with neural models for clinical NER.	CO5
B	Biomedical and Clinical Transformers: The paradigm shift from general language models to domain-specific variants; Structural architectures and training objectives of BioBERT, ClinicalBERT, GatorTRON, and long-context clinical transformers.	CO5. CO6
C	Clinical NLP Application Design: Developing actionable Clinical Decision Support Systems (CDSS); Real-time surveillance systems for Adverse Drug Events (ADEs); Lifecycle management, implementation gaps, and deployment pipelines in hospital systems.	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	Course Orientation & Intro to Clinical Natural Language Processing	UNIT-1	7
DD/MM/YY	General English vs. Clinical Narratives: Linguistic Divergence		
DD/MM/YY	Structural Challenges: Abbreviations, Typos, and Shorthand Syntax		
DD/MM/YY	Healthcare Privacy & Information Security: Ethics of Patient Text		
DD/MM/YY	HIPAA Regulations and Protected Health Information (PHI) Foundations		
DD/MM/YY	Automated De-identification Architectures: Safe Harbor vs. Expert Determination methods; Overview of automated de-identification tools.		
DD/MM/YY	Clinical Benchmarks: MIMIC Database Architecture & i2b2/n2c2 Tasks, Clinical annotation schemas and inter-annotator agreement metrics.		
DD/MM/YY	Standardized Medical Vocabularies & Healthcare Coding Concepts	UNIT-2	9
DD/MM/YY	Structural Architecture of ICD-9, ICD-10, and ICD-11 Taxonomies		
DD/MM/YY	SNOMED-CT: Hierarchical Relationships and Concept Models		
DD/MM/YY	LOINC and RxNorm: Standardizing Laboratory and Drug Information		
DD/MM/YY	Unified Medical Language System (UMLS): Core Knowledge Components		
DD/MM/YY	UMLS Metathesaurus, Semantic Network, and Concept Identifiers (CUIs)		
DD/MM/YY	Semantic Knowledge Parsing: MetaMap Concept Mapping Engine		
DD/MM/YY	Clinical Semantic Frameworks: Overview of Apache cTAKES Pipelines		
DD/MM/YY	Comprehensive Workbench Solutions: Introduction to CLAMP		
DD/MM/YY	Specialized Preprocessing: Clinical Normalization Strategies	UNIT-3	8
DD/MM/YY	Clinical Note Section Segmentation: Structural Boundaries & Scopes		
DD/MM/YY	Clinical Named Entity Recognition (CNER): Foundations & Tokens		
DD/MM/YY	Extracting Diseases, Clinical Signs, Symptoms, and Manifestations		
DD/MM/YY	Extracting Medication Entities: Dosages, Frequencies, and Routes		
DD/MM/YY	Importance of Contextual Ambiguity in Clinical Records		
DD/MM/YY	Negation Detection Algorithms: Rule-based NegEx Implementations		
DD/MM/YY	Dependency-based Context Processing & Assertion Status Systems		
DD/MM/YY	Clinical Relation Extraction: Inter-entity Semantic Linking	UNIT-4	9

DD/MM/YY	Mapping Medications to Administration Signatures and Attributes		
DD/MM/YY	Linking Medical Findings and Pathologies to Anatomical Sites		
DD/MM/YY	Introduction to Clinical Temporal Extraction and Timeline Modeling		
DD/MM/YY	Digital Phenotyping: Defining Clinical Cohorts via Text Mining		
DD/MM/YY	Rule-Based Phenotyping Algorithms: The eMERGE System Design		
DD/MM/YY	Automated Computer-Assisted Coding (CAC) Concepts		
DD/MM/YY	Machine Learning Implementations for Automated ICD Assignment		
DD/MM/YY	Clinical Triage Classification Systems Using Emergency Records		
DD/MM/YY	Sequence Labeling Architectures for Healthcare Data	UNIT-5	12
DD/MM/YY	Neural Sequence Architectures: BiLSTM-CRF for Clinical NER		
DD/MM/YY	Paradigm Shifts in Biomedicine: Evolution of Language Representations		
DD/MM/YY	BioBERT: Domain-Specific Pre-training on Biomedical Literature		
DD/MM/YY	ClinicalBERT: Transfer Learning from Electronic Health Records		
DD/MM/YY	Large-Scale Clinical Models: Structural Overview of GatorTRON		
DD/MM/YY	Handling Massive Clinical Reports: Long-Context Transformers		
DD/MM/YY	Fine-Tuning Transformer Models on Downstream Clinical Tasks		
DD/MM/YY	Designing Actionable Clinical Decision Support Systems (CDSS)		
DD/MM/YY	Pharmacovigilance: Automated Adverse Drug Event (ADE) Surveillance		
DD/MM/YY	Deployment Bottlenecks, Model Drifts, and Explainability Hurdles		
DD/MM/YY	Summary: The Future of Generative AI and LLMs in Patient Care		

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 Clinical Narratives	Recall and explain chaenges unique to clinical language, data standards, and healthcare information privacy rules.	CO1	CA, MTE Sec A, ETE Sec A
TS2	Biomedical Resource and Ontology Mapping	Explain and map concepts across biomedical ontologies, terminologies (UMLS, SNOMED-CT), and use parser components.	CO2	CA, MTE Sec A, ETE Sec A
TS3	Clinical Preprocessing & Negation Parsing	Apply specialized clinical preprocessing, clinical text segmentation, and negation/context-checking algorithms.	CO3	CA, MTE Sec B, ETE Sec B
TS4	Clinical Extraction & Medical Classification	Analyze and execute medical named entity recognition (CNER), relation extraction pipelines, and automated text classification.	CO4	CA, MTE Sec B, ETE Sec B
TS5	Clinical Deep Learning & Transformer Analysis	Analyze sequence architectures, domain-adapted transformer layers (ClinicalBERT), and specialized embedding matrices.	CO5	ETE Sec B/C
TS6	Clinical Pipeline Design & Application Evaluation	Design end-to-end clinical NLP architectures, digital phenotyping software, and decision support apps.	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 Clinical Narratives	TS2 Biomedical Resource and Ontology Mapping	TS3 Clinical Preprocessing & Negation Parsing	TS4 Clinical Extraction & Medical Classification	TS5 Clinical Deep Learning & Transformer Analysis	TS6 Clinical Pipeline Design & Application Evaluation
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	Clinical sublanguages, text challenges, manual PHI de-identification exercises.	CO1	TS1	5h SL	Structural accuracy, complete HIPAA constraint validation.
Assignment 2	Structural navigation of UMLS, parsing semantic types, and tracing MetaMap mappings.	CO2	TS2	5h SL	CUI accuracy, ontological path precision.
Assignment 3	Tracing clinical note segmentation workflows, executing CNER tokens, and running NegEx evaluation.	CO3	TS3	5h SL	Precise scope validation for negation markers.
Assignment 4	Formulating clinical relation extraction tuples and analytical steps for automated ICD-10 indexing.	CO4	TS4	5h SL	F1-score evaluation metrics, extraction correctness.

Assignment 5	Analytical deep learning parameter traces, transformer layer checks, and attention map audits on clinical text.	CO5, CO6	TS5, TS6	5h SL	Depth of mathematical/structural model parsing.
Video Learning Report	Advanced Clinical Pipeline Systems: Multi-stage cTAKES or CLAMP system configuration and execution.	CO3, CO4	TS3, TS4	10h SL	Technical presentation clarity, pipeline workflow evaluation.
Mini NLP Case Study	Automated Cohort Selection / Phenotyping Architecture over synthetic clinical corpora (MIMIC mimicry).	CO5, CO6	TS5, TS6	10h SL	Comprehensive engineering design depth, validation strategy.

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 Clinical Narratives, TS2 Biomedical Resource and Ontology Mapping	CO1, CO2	Definitions, structural text contrasts, HIPAA safety checks, UMLS graph traversal questions.
Section B	**10**	TS3 Clinical Preprocessing & Negation Parsing, TS4 Clinical Extraction & Medical Classification	CO3, CO4	Note section partitioning traces, clinical regex parsing, NegEx logical sequence execution, and entity classification problems.
TOTAL	**15**	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 foundational open questions.
Section B	**25**	TS3, TS4, TS5	CO3, CO4, CO5	Medium analytical, preprocessing calculation, entity classification, and deep transformer model tracing tasks.

Section C	**20**	TS5, TS6	CO5, CO6	Long comprehensive system blueprint design questions, phenotype algorithm engineering, and clinical application safety deployment plans.
TOTAL	**60**	**TS1–TS6 (all)**	**CO1–CO6**	Scaled from a 100-mark base paper if necessary. Minimum 24/60 raw score 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 clinical NLP fundamentals	✔	✔	✔	TS1	PO1
CO2	Explain ontologies and lexical resources	✔	✔	✔	TS2	PO5
CO3	Apply clinical preprocessing and negation checking	✔	✔	✔	TS3	PO3, PO5
CO4	Analyze medical recognition and relation extraction	✔	✔	✔	TS4	PO2, PO5
CO5	Analyze sequence architectures and transformers	✔	—	✔	TS5	PO2
CO6	Design healthcare pipelines and phenotype systems	✔	—	✔	TS6	PO1, PO2, PO3, PO4, PO5, PO8

⚠ **CO***5 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	**Clinical Extraction Practice Assignments & Note Parsing**	5 assignments × 5 hrs each, Total = 25 hrs	CO1–CO4 TS1–TS4	Evaluated based on analytical workflow correctness, handling edge-case clinical acronyms, and accuracy of tracing parsing steps.
2	**Video-based Learning Module: Anatomy of ClinicalBERT, GatorTRON, and Healthcare Large Language Models**	Video viewing: 5 hrs, Report prep: 3 hrs, Presentation: 2 hrs, Total = 10 hrs	CO2, CO3 TS2, TS3	Report + Presentation based on video learning outcomes; must effectively unpack pre-training transformer logic, masking metrics, and performance limits.
3	**Clinical Case Studies, System Benchmarks & Framework Review**	Data analysis: 7 hrs, Report prep: 3 hrs, Total = 10 hrs	CO4, CO5, CO6 TS4, TS5, TS6	Assessment based on architectural depth, analysis of error patterns, safety mitigation reviews, and data lifecycle management logic.
	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 (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

CSME4203 — 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

Ethical AI in Medicine (CSME4204)

SSCSE-Sharda School of Computing Science & Engineering | B.Tech CS & ME | Semester VII | Batch 2025–2029

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:**	2029-2030
Branch:	CS & ME	**Semester:**	V
Course Code:	CSME4204	**Course Type:**	Core — Theory Only

2. Course Details

B.Tech CS & ME

📚 **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**	CSME4204
2	**Course Title**	**Ethical AI in Medicine**
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 course introduces the core ethical issues arising from artificial intelligence (AI), generative models, and large language models (LLMs) in clinical practice. It provides an understanding of the tension between ethical relativism and context-specificity in healthcare delivery. Develop the ability to analyze algorithmic biases, data discrepancies, and systemic discrimination using real-world clinical case studies. Familiarize students with accountability structures, machine paternalism, and threats to patient autonomy and consent models. Enable students to evaluate technical and philosophical methodologies, such as collective reflective equilibrium, to build ethical public policies for medical deployment.
7	**Course Outcomes (COs)**	1. CO1 (Understand – L1/L2): Identify and understand fundamental ethical principles, medical AI goals, and the structural vector-forces driving clinical ethics. 2. CO2 (Explore – L2/L3): Explore the boundaries between ethical relativism and context-specificity alongside foundational models of consent. 3. CO3 (Apply – L3): Apply conceptual frameworks to isolate data biases, including label, minority, missing data, and in formativeness biases in diagnostic algorithms. 4. CO4 (Analyze – L4): Analyze algorithmic metrics (sensitivity, specificity, false-positives) and evaluate patient-centered care trends against machine paternalism. 5. CO5 (Analyze – L4/L5): Analyze advanced socio-technical threats, including clinical deskilling, de-identification vulnerabilities, and catastrophic dual-use bio-weapons. 6. CO6 (Evaluate – L5): Evaluate and build balanced public policy frameworks using collective reflective equilibrium, blending public intuition with normative ethical theories.
8	**Course Description**	This course investigates the multi-faceted ethical domain governing the integration of artificial intelligence within medical systems. The curriculum explores critical dimensions of patient privacy, data de-identification, machine paternalism, legal/clinical accountability, and the validation of "black-box" models. Moving beyond technical capabilities, it teaches advanced methodologies like collective reflective equilibrium to harmonize public preference with normative ethical frameworks, preparing engineers to build safe, just, and compliant healthcare technology
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**	Niklas Lidströmer and Eldon Y. Li, Artificial Intelligence in Medicine, Springer Nature, 2022.
12	**References**	1. Jessica Morley and Luciano Floridi, The Ethics of AI in Health Care: An Updated Mapping Review, Springer, 2024. 2. Barry Furrow, Thomas Greaney, Sandra Johnson, Timothy Jost, and Robert Schwartz, Health Law, Bioethics, and Human Rights with Artificial Intelligence Systems, West Academic Publishing, 2025. 3. Eric Topol, Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Hachette, 2019.

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: Fundamentals of Medical AI & Ethical Vectors	
A	Introduction to medical AI, generative systems, and LLMs in clinical contexts. The physics of ethics: calculating ethical direction using vector forces of reason.	**CO1, CO2,CO3**
B	Universal human rights versus ethical relativism; the imperative of context-specificity in medical judgments	**CO1, CO2,CO3**
C	Overview of the therapeutic chain: tracing systemic risks from pre-consultation, to diagnosis, treatment selection, and long-term disease management.	**CO1,CO2,CO3**
	Unit 2: Algorithmic Injustice & Data Bias Case Studies	
A	Selective deployment, demographic exclusions (male vs. female modeling), and effectiveness as a justification for differential treatment	**CO3, CO2, CO4**
B	Dataset skewing, European CE self-certification vs. US FDA regulatory blocks, and marketing a diagnostic device as a "search journey".	**CO3, CO2, CO4**
C	Healthcare disparities, past institutional exploitation and label bias via financial proxies. Taxonomy of data bias: minority, missing data, and informativeness bias.	**CO2, CO3, CO4**
	Unit 3: Data Privacy, Autonomy & Machine Paternalism	
A	Big data privacy and confidentiality risks; re-identification vulnerabilities linked to individual uniqueness. Governance: Singapore's TRUST platform, blockchain security, and consistency standards across	**CO1, CO4,CO6**

	consumer vs. medical data	
B	Advanced Consent Architectures: Broad consent, meta-consent, and dynamic interactive online platforms	**CO1, CO4, CO6**
C	Patient Autonomy vs. Machine Paternalism: Shared decision-making models (informative, interpretive, deliberative). Value-laden metrics (longevity vs. quality of life) and value-flexible AI designs.	**CO1, CO4, CO6**
	Unit 4: Accountability, Interpretability & Socio-Technical Risks	
A	Clinical and legal responsibility: tracing fault between treating clinicians and software designers; definitions of culpable ignorance, praise, and blame	**CO5, CO6**
B	Epistemic vs. moral trust; accountability boundaries of autonomous tools. The "Black Box" dilemma: explanation vs. normative justification; interpretable machine learning constraints (e.g., embryo selection standards).	**CO5, CO6**
C	Dehumanization and Deskilling: Professional obsolescence, human-in-the-loop dependencies, and clinical degradation. Existential threats: Catastrophic dual-use scenarios and synthetic biological weapon synthesis.	**CO5, CO6**
	Unit 5: Advanced Autonomy Engineering & Policy Frameworks	
A	Neural network fine-tuning for specialization: "ConsentGPT" applications, and personalized text narrative generation for clinical co-creation	**CO4,CO5, CO6**
B	Constructing patient preference predictors from electronic health records, choice experiments, and behavioral telemetry for substituted judgments.	**CO4, CO5, CO6**
C	Public Policy Synthesis: The Moral Machine experiment data trends. Resource rationing algorithms (ventilators, ICU beds, vaccines). Policy toolkit engineering: Collective Reflective Equilibrium, preference laundering/screening, and seeking overlapping consensus.	**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-oriented Cloud Security course: Cognitive domain is primary. Psychomotor domain (P3) is limited to implementation and practical analysis of cloud security mechanisms, intrusion detection, and firewall configuration. Affective domain (A3) reflects valuing security, monitoring, and efficient protection mechanisms in cloud environments.

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	Course Introduction: The Evolving Role of Artificial Intelligence, Generative Models, and LLMs in Modern Healthcare.	UNIT-1	9
DD/MM/YY	Structural Goals of Medical AI: Balancing Clinical Diagnostics, Prognostics, and Automated Treatment Strategies.		
DD/MM/YY	The Physics of Ethics: Modeling Ethical Decisions as Vector Forces of Reason with Direction and Strength.		
DD/MM/YY	Calculating Ethical Trajectories: Weighing Competing Vectors of Reason in Complex Clinical Scenarios.		
DD/MM/YY	Deconstructing Ethical Relativism: Universal Human Rights vs. Cultural and Generational Norms		
DD/MM/YY	The Imperative of Context-Specificity: Analyzing How Changing Contexts Shift Medical Actions from Wrong to Right.		
DD/MM/YY	Mapping the Therapeutic Chain: Tracing AI Risks and Ethics from Pre-Consultation to Direct Clinical Diagnosis.		
DD/MM/YY	The Treatment Lifecycle: Tracing Ethical Implications in Treatment Recommendation, Selection, and Execution.		
DD/MM/YY	Long-Term Disease Management: Analyzing AI Interventions in Chronic Prevention, Surveillance, and Continuing Care		
DD/MM/YY	Introduction to Algorithmic Injustice: Core Principles of Equality, Fairness, and Group Categorization in Big Data	UNIT-2	9
DD/MM/YY	The Metrics of Discrimination: Evaluating When Demographic Grouping Triggers Legal and Moral Protection.		
DD/MM/YY	Assessing Demographic Exclusions and Selective Deployment		
DD/MM/YY	Efficacy as an Ethical Justification: When Population Performance Disparities Are Morally Permissible		
DD/MM/YY	Deep Dive into Dataset Skewing, Underrepresented Skin Types, and Validation Realities.		
DD/MM/YY	Market Strategies vs. Medical Realities: Regulatory Navigation		
DD/MM/YY	Exposing Race-Based Discrimination and Historical Distrust in Care Allocation.		
DD/MM/YY	Technical Deconstruction of Label Bias: Analyzing How Financial Proxies Distort True Clinical Healthcare Needs		

DD/MM/YY	Taxonomies of Algorithmic Data Bias: Analyzing Minority Bias, Missing Data Bias, and Informativeness Disparities.		
DD/MM/YY	The Big Data Privacy Conundrum: Information Security Risks and Vulnerabilities in Extensive Medical Data Repositories.	UNIT-3	9
DD/MM/YY	The Limits of De-identification: Analyzing Computational Risks of Re-identification Linked to Individual Uniqueness.		
DD/MM/YY	Healthcare Data Governance: Analyzing Centralized Frameworks and Decentralized Ledger (Blockchain) Protections.		
DD/MM/YY	The Consistency Principle: Comparing Privacy Standards Across Medical Systems vs. Commercial Social Data.		
DD/MM/YY	The Evolution of Patient Consent: Traditional Models and Their Failure Modes in Large-Scale Data Aggregations.		
DD/MM/YY	Advanced Consent Architectures: Implementing Broad Consent, Meta-Consent, and Dynamic Interactive Portals.		
DD/MM/YY	Deconstructing Medical Paternalism: Informative, Interpretive, Deliberative, and Shared Decision-Making Frameworks.		
DD/MM/YY	The Mechanics of Machine Paternalism: Auditing Embedded Developer Values and System Optimization Criteria.		
DD/MM/YY	Value Optimization Discrepancies: Analyzing Systems Like IBM Watson for Oncology Ranking Longevity Over Quality of Life		
DD/MM/YY	Introduction to Clinical and Legal Responsibility: Defining Accountability Mechanics in AI-Assisted Errors	UNIT-4	9
DD/MM/YY	The Legal and Moral Distribution of Blame: Isolating Fault Between Treating Clinicians and Software Designers.		
DD/MM/YY	Culpable Ignorance in Automated Medicine: System Validation Mandates and Expected Standards of Clinical Care.		
DD/MM/YY	Human Trust vs. Machine Reliance: Differentiating Epistemic (Knowledge) and Moral Trust in Algorithmic Output.		
DD/MM/YY	The "Black Box" Dilemma: Explanatory Limitations of Deep Learning and Large Language Models. Explanation vs. Normative Justification		
DD/MM/YY	Designing Interpretable Machine Learning: Constraints and Recommendations via Embryo Selection Quality Frameworks		
DD/MM/YY	The Threat of Professional Deskilling: Over-reliance on Automated Reporting Tools and Cognitive Skill Degradation		
DD/MM/YY	Catastrophic Dual-Use Vulnerabilities		
DD/MM/YY	Weaponization Risks of Automated Drug Discovery and Synthetic Bio-Threats		

DD/MM/YY	Advanced Model Specialization: Fine-Tuning Neural Network Layers for Target Procedures and Surgical Settings.	UNIT-5	9
DD/MM/YY	Conversational Automated Consent: Designing Interfaces for Deeper Patient Comprehension		
DD/MM/YY	Co-Creation and Personalized Academic Models: Generating Research, Grant Applications, and Managing Attribution Norms		
DD/MM/YY	Managing Attribution Norms. Patient Profile Aggregation: Building Digital Values Profiles from EHRs, Biobanks, and Behavioral Telemetry.		
DD/MM/YY	Developing Automated Patient Preference Predictors for Navigating Substituted Judgments.		
DD/MM/YY	The Implications of Training Personalized Models on Historic Normative Philosophies.		
DD/MM/YY	Analyzing Public Allocations data from Global Metrics Like the Moral Machine Experiment.		
DD/MM/YY	Automation Architectures for Rationing Ventilators, ICU Beds, and Vaccines.		
DD/MM/YY	Designing Frameworks Using Collective Reflective Equilibrium, Preference Laundering, and Overlapping Consensus		

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	Ethical AI Principles & Clinical Vector Modeling	Analyze clinical AI requirements, identify ethical vector forces, evaluate context-specificity, and map baseline risks across the patient therapeutic care chain	CO1 | L4–L5	CA | MTE Sec A | ETE Sec A
TS2	Algorithmic Injustice &	Determine and analyze technical data biases (label, minority, missing data,	CO2 | L4–L5	CA | MTE Sec B | ETE Sec

	Data Bias Diagnostics	informativeness) and evaluate clinical disparities using demographic validation case studies		B
TS3	Data Governance & Complex Consent Design	Apply structural healthcare data governance protocols (TRUST platform, blockchain) and deploy advanced multi-tier consent mechanics (broad, meta-, and dynamic models)	CO3 | L3–L4	CA | MTE Sec B | ETE Sec B
TS4	Autonomy Verification & Paternalism Auditing	Audit algorithmic optimization metrics to diagnose machine paternalism, translate software output into patient-centered values, and handle the "black-box" interpretability dilemma	CO4 | L3	CA | Practical | ETE Sec B
TS5	Socio-Technical Risk Management & Liability Execution	Isolate clinical and legal liability lines between medical practitioners and AI software developers, executing risk evaluations for deskilling and catastrophic dual-use bio-threats	CO5 | L2–L4	MTE Sec B | ETE Sec C
TS6	Policy Engineering & Equilibrium Optimization	Design and develop balanced public policy architectures by synthesizing mass preference telemetry with normative ethical frameworks using collective reflective equilibrium	CO6 | L5–L6	ETE Sec C | Project/Case Study

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			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	Cyber security requirements, organizational threats, vulnerabilities, and security posture analysis	CO1	TS1	5h SL	Report submission + conceptual evaluation
Assignment 2	Software vulnerability assessment, cyber exploitation risks, and implementation of security solutions	CO2	TS2	5h SL	Short-answer and conceptual analysis
Assignment 3	Security monitoring, auditing techniques, troubleshooting methods, and diagnostic analysis of cyber security systems	CO3	TS2, TS3	5h SL	Security mechanism implementation + comparative analysis
Assignment 4	Implementation of cyber security solutions, information assurance practices, and cyber/computer forensic tools	CO4	TS3, TS4	5h SL	Analytical report + security evaluation
Assignment 5	Risk assessment, risk treatment methods, key risk indicators, and organizational risk management strategies	CO5	TS4, TS5, TS6	5h SL	Threat analysis + comparative performance evaluation
Video Learning	Technical video on network security, system security,	CO3, CO4,	TS2,	10h	Report: learning outcomes, key concepts, self-reflection.

Report	cloud security, digital forensics, IDS/IPS, or security architecture (minimum 3 hrs) with structured report and presentation	CO6	TS3	SL	Presentation: 10 min
Case Study Report	Real-world cyber security case study such as ransomware attacks, enterprise security architecture, cloud security breaches, risk management frameworks, or forensic investigations with detailed analysis	CO1, CO5, CO6	TS4, TS5, TS6	10h 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 — Ethical AI Principles & Vector Modelling	CO1	Analytical and evaluative questions
Section B	**15**	TS2 — Algorithmic Injustice & Bias Diagnostics	CO2	Scenario-based and analytical problems involving identification of software assessment
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	20	TS1 — Ethical AI Principles & Vector Modelling TS2 — Algorithmic Injustice & Bias Diagnostics	CO1, CO2	Short-answer questions on clinical AI requirements, identifying ethical vector forces, assessing context-specificity, parsing technical data biases (label, minority, missing data, informativeness), and baseline clinical risk profiling

Section B	25	TS3 — Data Governance & Consent Design TS4 — Autonomy Verification & Paternalism Auditing TS5 — Socio-Technical Risk Management	CO3, CO4, CO5	Medium-level analytical and application questions on structural data governance (TRUST platform, blockchain), implementing multi-tier consent mechanics (broad, meta-, dynamic), auditing software optimization parameters to mitigate machine paternalism, navigating "black-box" interpretability, and calculating medical liability boundaries
Section C	15	TS5 — Socio-Technical Risk Management TS6 — Policy Engineering & Equilibrium Optimization	CO5, CO6	Long analytical and evaluative questions involving organizational risk mitigation for clinical deskilling and dual-use biosecurity hazards, modeling algorithmic resource rationing, parsing mass preference telemetry (Moral Machine data trends), and synthesizing robust public health policies using collective reflective equilibrium
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 (25)	ETE (50)	TS	PO Primary
CO1	Explain the fundamental ethical frameworks, regulatory standards, and data privacy principles	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Identify and analyze potential sources of algorithmic bias, data underrepresentation, and dataset drift that can lead to clinical disparities and unequal patient outcomes.	✔	✔	✔	TS2	PO1, PO2, PO3, PO4
CO3	Apply algorithmic fairness techniques, anonymization methods, and de-biasing strategies to healthcare datasets to ensure equitable and privacy-preserving AI model development.	✔	✔	✔	TS3	PO1, PO3, PO4, PO5
CO4	Evaluate AI-driven diagnostic and predictive systems for clinical explainability (XAI), transparency, and reliability, balancing model performance with a clinician's need for	✔	✔	✔	TS4	PO2, PO4, PO9, PO10

	interpretability					
CO5	Assess the legal liability, accountability structures, and risk profiles associated with AI-assisted clinical decision-making, medical malpractice, and autonomous medical devices	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Design an ethical governance framework or deployment protocol for a medical AI system that prioritizes patient autonomy, informed consent, safety, and human-in-the-loop oversight	✔	—	✔	TS6	PO1, PO2, PO4, 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	1	-	-	-	-	-	-	3	3	2	1
CO2	3	3	2	2	2	-	-	-	-	-	3	3	3	-
CO3	3	3	2	3	3	2	2	2	2	2	2	3	2	3
CO4	2	2	1	1	2	2	2	2	-	1	2	2	2	2
CO5	2	3	2	2	3	3	2	1	2	2	1	2	2	3
CO6	3	3	3	2	3	3	3	2	2	3	3	3	3	3
Avg	2.67	2.83	2.00	1.83	2.16	1.66	1.5	1.16	1.00	1.33	2.33	2.66	2.33	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	PO12	PSO1	PSO2	PSO3
CO1	H	H	M								H	H	M		H
CO2	H	H	M	M	M						H	H	H		H
CO3	H	H	M	H	H	M	M	M	M	M	M	H	M	H	H
CO4	M	M			M	M	M	M			M	M	M	M	M
CO5	M	H	M	M	H	H	M		M	M		M	M	H	M
CO6	H	H	H	M	H	H	H	M	M	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 (5 assignments, problem-based, one per unit focus area)**	5 assignments × 3 hrs each Total = 15 hrs	CO1–CO4 TS1–TS4	Evaluated based on the assignment submitted;
2	**Mini Literature Review on a Technical Topic**	Video viewing: 7 hrs Report preparation: 7 hrs Presentation: 6 hrs Total = 20 hrs	CO2, CO3 TS2, TS3	Report + Presentation based on video learning outcomes;
3	**Open-Source Project Contribution (GitHub based)**	Data collection/study: 5 hrs Report preparation: 5 hrs 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	A1 — Receiving: Awareness and willingness to attend	P1 — Perception: Sensory cues guide motor activity

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	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	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 (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

CSME4204— Ethical AI in Medicine

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

Explainable AI in Medicine (CSME4205)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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 — School of Computing Science & Engineering	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2029-2030
Branch:	CS & ME	**Semester:**	VII
Course Code:	CSME4205	**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**	CSME4205
2	**Course Title**	**Explainable AI in Medicine**

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**	**Elective — Theory Only (No Laboratory Component)**
6	**Course Objectives**	This course introduces the fundamental principles and significance of Explainable Artificial Intelligence (XAI) in healthcare and medicine, emphasizing the need for transparency and trust in AI-driven clinical systems. It develops students' understanding of interpretable machine learning models and post-hoc explanation techniques used to explain complex medical AI predictions. The course also examines critical issues such as fairness, bias, accountability, transparency, and ethical considerations in AI-based healthcare applications. Furthermore, it enables learners to interpret, evaluate, and assess medical AI models through modern XAI frameworks, practical tools, and real-world healthcare case studies.
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Remember/Understand – L1/L2): Define and explain the foundations, significance, and challenges of Explainable AI in healthcare systems. CO2 (Understand/Apply – L2/L3): Identify and apply interpretable machine learning methods and explainability techniques for medical datasets. CO3 (Apply – L3): Implement feature attribution and local/global explanation techniques for AI-based medical diagnosis systems. CO4 (Analyze – L4): Analyze the transparency, reliability, fairness, and bias of AI models used in medicine. CO5 (Evaluate – L5): Evaluate explainability frameworks and healthcare AI applications using ethical, legal, and clinical perspectives. CO6 (Create/Analyze – L5/L6): Design explainable workflows and reporting strategies for trustworthy AI-enabled healthcare decision support systems.
8	**Course Description**	This course focuses on Explainable Artificial Intelligence (XAI) techniques and their application in healthcare and medicine. It introduces interpretable machine learning models, explanation methods, ethical AI principles, fairness analysis, and medical case studies involving diagnostic and predictive 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**	Explainable AI in Healthcare and Medicine by Arash Shaban-Nejad, Martin Michalowski, and David L.
12	**References**	1. Samek, W., Montavon, G., Vedaldi, A. — Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Springer. 2. Barredo Arrieta, A. et al. — Explainable Artificial Intelligence (XAI): Concepts, Taxonomies, Opportunities and Challenges toward Responsible AI. 3. Rudin, C. — Stop Explaining Black Box Machine Learning Models for High Stakes Decisions and Use Interpretable Models Instead.

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 / Activity	CO Mapping
	Unit 1: Foundations of Explainable AI in Medicine	
A	AI in Healthcare: Overview, applications, opportunities, and challenges	**CO1**
B	Need for Explainability in Medicine; transparency, accountability, trust	**CO1**
C	Explainable AI vs Black-Box Models; interpretability concepts	**CO1**
	Unit 2: Interpretable Machine Learning Models	
A	Decision Trees, Rule-Based Systems, Linear Models	**CO1, CO2**
B	Feature Engineering and Clinical Data Representation	**CO2**
C	Model Performance vs Interpretability Trade-off	**CO2, CO4**
	Unit 3: Post-hoc Explainability Techniques	
A	Local and Global Explanation Methods	**CO2, CO3**
B	SHAP, LIME, Feature Importance, Partial Dependence Plots	**CO2, CO3, CO4**
C	Explainability for Deep Learning in Medical Imaging	**CO3, CO4**
	Unit 4: Ethics, Fairness, and Trustworthy AI in Healthcare	
A	Bias in Medical Datasets and AI Systems	**CO4**
B	Fairness Metrics, Accountability, Transparency	**CO4, CO5**
C	Ethical, Legal, and Regulatory Perspectives in Healthcare AI	**CO5**
	Unit 5: Explainable Clinical Decision Support Systems	
A	Explainable Diagnosis and Prognosis Models	**CO3, CO5, CO6**
B	XAI in Electronic Health Records (EHRs) and Medical Imaging	**CO4, CO5, CO6**
C	Design of Trustworthy and Human-Centered Medical AI Systems	**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	Unit	Total Lectures
DD/MM/YY	Introduction to Artificial Intelligence in Healthcare	Unit 1	9
DD/MM/YY	Evolution and Scope of AI in Medicine		
DD/MM/YY	Applications of AI in Diagnosis and Treatment		
DD/MM/YY	AI in Medical Imaging and Clinical Decision Support		
DD/MM/YY	Opportunities and Challenges of AI in Healthcare		
DD/MM/YY	Need for Explainability in Medical AI Systems		
DD/MM/YY	Transparency, Accountability, and Trust in Healthcare AI		
DD/MM/YY	Explainable AI vs Black-Box Models		
DD/MM/YY	Interpretability Concepts and Terminologies		
DD/MM/YY	Introduction to Interpretable Machine Learning	Unit 2	9
DD/MM/YY	Decision Trees: Concepts and Applications in Medicine		
DD/MM/YY	Rule-Based Expert Systems for Clinical Decision Making		
DD/MM/YY	Linear Regression and Logistic Regression Models		
DD/MM/YY	Comparison of Interpretable Models		
DD/MM/YY	Feature Engineering in Healthcare Data		
DD/MM/YY	Clinical Data Representation Techniques		
DD/MM/YY	Handling Missing and Imbalanced Medical Data		
DD/MM/YY	Model Accuracy vs Interpretability Trade-off		
DD/MM/YY	Introduction to Post-hoc Explainability	Unit 3	10
DD/MM/YY	Local Explanation Methods		
DD/MM/YY	Global Explanation Methods		
DD/MM/YY	Feature Importance Techniques		
DD/MM/YY	LIME: Local Interpretable Model-Agnostic Explanations		
DD/MM/YY	SHAP: Shapley Additive Explanations		
DD/MM/YY	Partial Dependence Plots and ICE Plots		
DD/MM/YY	Explainability in Ensemble Learning Models		
DD/MM/YY	Explainability for Deep Neural Networks		
DD/MM/YY	XAI Techniques in Medical Imaging Systems		
DD/MM/YY	Introduction to Ethical AI in Healthcare	Unit 4	8
DD/MM/YY	Sources of Bias in Medical Datasets		
DD/MM/YY	Bias Detection and Mitigation Techniques		
DD/MM/YY	Fairness Metrics in Healthcare AI		

DD/MM/YY	Accountability and Transparency in AI Systems		
DD/MM/YY	Privacy, Security, and Patient Data Protection		
DD/MM/YY	Ethical Challenges in AI-driven Clinical Decisions		
DD/MM/YY	Legal and Regulatory Frameworks for Healthcare AI		
DD/MM/YY	Clinical Decision Support Systems (CDSS): Overview	**Unit 5**	**9**
DD/MM/YY	Explainable Diagnosis Models		
DD/MM/YY	Explainable Prognosis and Risk Prediction Models		
DD/MM/YY	XAI in Electronic Health Records (EHRs)		
DD/MM/YY	XAI Applications in Medical Imaging Diagnostics		
DD/MM/YY	Human-Centered AI Design Principles		
DD/MM/YY	Designing Trustworthy Medical AI Systems		
DD/MM/YY	Case Studies on Explainable AI in Healthcare		
DD/MM/YY	Course Review, Emerging Trends, and Future Directions in XAI Medicine		

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 XAI**	Recall and explain core XAI terminology, concepts, and healthcare relevance	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	**Interpretable Model Application**	Apply interpretable ML techniques to healthcare datasets	CO2 | L2	CA | MTE Sec A | ETE Sec A
TS3	**Explainability Technique Implementation**	Apply SHAP, LIME, saliency maps, and feature importance methods	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	**Bias and Fairness Analysis**	Analyze fairness, transparency, and reliability of AI systems	CO4 | L4	MTE Sec B | ETE Sec B

TS5	**Ethical and Clinical Evaluation**	Evaluate ethical, legal, and regulatory dimensions of healthcare AI	CO5 | L5	ETE Sec B/C
TS6	**Explainable Workflow Design**	Design trustworthy explainable AI workflows and reporting systems	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 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	Percentage	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	Foundations of XAI in Medicine, Interpretable ML Models	CO2, CO3	TS2, TS3	5h SL	Concept clarity and literature understanding, Model analysis and comparative study
Assignment 2	SHAP and LIME Applications, Fairness and Bias in Healthcare AI	CO4, CO5, CO6	TS4, TS5, TS6	5h SL	Explanation quality and implementation steps, Analytical depth and ethical reasoning

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	Percentage	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	**5**	TS1 — Conceptual Understanding of XAI TS2 — Interpretable Model Application	**CO1, CO2**	Short-answer and conceptual questions covering AI in healthcare, explainability concepts, transparency, interpretability, interpretable ML models, and clinical data representation.
Section B	**10**	TS3 — Explainability Technique Implementation TS4 — Bias and Fairness Analysis	**CO2, CO3, CO4**	Analytical and application-based questions involving SHAP, LIME, feature importance, local/global explanations, explainability in medical imaging, and interpretation of fairness-related outcomes.
TOTAL	**15**	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	Percentage	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	**15**	TS1 — Conceptual Understanding of XAI TS2 — Interpretable Model Application	**CO1, CO2**	Short-answer conceptual questions related to XAI foundations, interpretable machine learning models, explainability concepts, transparency, and clinical AI systems

Section B	**25**	TS3 — Explainability Technique Implementation TS4 — Bias and Fairness Analysis TS5 — Ethical and Clinical Evaluation	**CO3, CO4, CO5**	Medium-answer analytical and application-based questions involving SHAP, LIME, feature attribution, fairness analysis, ethical AI, explainability in medical imaging, and evaluation of trustworthy healthcare AI
Section C	**20**	TS5 — Ethical and Clinical Evaluation TS6 — Explainable Workflow Design	**CO5, CO6**	Long-answer and case-study-based questions on explainable clinical decision support systems, healthcare AI governance, workflow design, and trustworthy human-centered AI systems
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 (25)	ETE (50)	TS	PO Primary
CO1	Understand the foundations, concepts, and significance of Explainable AI in Medicine	✔	✔	✔	TS1	PO1, PO2
CO2	Apply interpretable machine learning techniques to healthcare datasets	✔	✔	✔	TS2	PO2, PO3
CO3	Implement explainability techniques such as SHAP, LIME, and feature attribution methods	✔	✔	✔	TS3	PO3, PO4
CO4	Analyze transparency, fairness, reliability, and bias in healthcare AI systems	✔	✔	✔	TS4	PO8, PO9
CO5	Evaluate ethical, legal, and clinical perspectives of explainable healthcare AI	✔	—	✔	TS5	PO8, PO10
CO6	Design trustworthy and explainable healthcare AI workflows and decision-support systems	✔	—	✔	TS6	PO11, PO12

⚠ *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	-	-	-	1	1	1	1	3	2	1
CO2	3	3	3	2	-	-	-	1	1	1	1	3	3	2
CO3	3	3	3	3	-	-	-	1	2	1	2	3	3	2
CO4	2	2	2	3	-	-	-	3	3	2	2	2	2	2
CO5	2	2	2	2	-	-	-	3	3	3	2	2	2	1
CO6	2	2	3	3	1	-	-	2	2	3	3	3	3	2
Avg	2.50	2.50	2.50	2.50	1.00	-	-	1.83	2.00	1.83	1.83	2.67	2.50	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	H	M	M	-	-	-	M	M	M	M	H	M	M
CO2	H	H	H	M	-	-	-	M	M	M	M	H	H	M
CO3	H	H	H	H	-	-	-	M	M	M	H	H	H	M
CO4	M	M	M	H	-	-	-	H	H	M	M	M	M	M
CO5	M	M	M	M	-	-	-	H	H	H	M	M	M	M
CO6	M	M	H	H	M	-	-	M	M	H	H	H	H	M

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

S.No	Activity	Hours	COs / TS	Evaluation Criteria
1	**Assignment Writing and Explainability Exercises (5 assignments covering XAI concepts,**	5 Assignments × 4 hrs each = **20 hrs**	CO3, CO4 TS3, TS4	Evaluated based on conceptual understanding, interpretation quality, analytical reasoning, and correctness

	interpretable models, SHAP/LIME analysis, fairness evaluation, and healthcare AI workflows)			of explanations
2	**Real-World Healthcare AI Case Study (e.g., explainable diagnosis systems, medical imaging AI, EHR-based prediction systems, fairness analysis in healthcare AI)**	25 hrs	CO5, CO6 TS5, TS6	Evaluated on technical depth, ethical evaluation, fairness analysis, reliability assessment, and recommendations, and Q&A
	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 (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

CSME4205 — 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

Rehabilitation Engineering (CSME4206)

School of Engineering & Technology (SET) | B.Tech CS & ME | 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:	SET — School of Engineering & Technology	**Batch:**	2026-2030
Program:	B.Tech	**Current Academic Year:**	2029-2030
Branch:	CS & ME	**Semester:**	VII
Course Code:	CSME4206	**Course Type:**	Program Elective

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**	CSME4206
2	**Course Title**	**Rehabilitation Engineering**
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 enable the student to •Explain the need for medical aids. •Understand the sensory rehabilitation systems.

		•Learn the use of orthopedic prosthetics and orthotics in rehabilitation. •Understand virtual reality in rehabilitation •Have an understanding of rehabilitation medicine and advocacy
7	**Course Outcomes (COs)**	**After successful completion of this course, students will be able to:** CO1 (Understand – L1/L2): Identify the challenges and understand the fundamental concepts of rehabilitation engineering including impairments, disabilities, rehabilitation care, activities of daily living, and community-based rehabilitation. CO2 (Explore – L2/L3): Explore sensory augmentation and substitution techniques including visual, auditory, and tactual rehabilitation systems such as hearing aids, cochlear implants, and assistive technologies. CO3 (Apply – L3): Understand and apply engineering concepts in motor rehabilitation including artificial limbs, orthotics, prosthetics, myoelectric systems, and Functional Electrical Stimulation (FES) techniques. CO4 (Analyze – L4/L5): Analyze the effectiveness of advanced rehabilitation technologies including virtual reality, haptics, robotics, and mobility rehabilitation systems. CO5 (Analyze – L4/L5): Analyze physiological and psychological rehabilitation therapies and evaluate methods used for functional recovery, emotional support, and cognitive rehabilitation. CO6 (Evaluate – L2/L5): Understand rehabilitation advocacy, legal provisions, educational and occupational support systems, and evaluate the accessibility and effectiveness of rehabilitation technologies in day-to-day life.
8	**Course Description**	The Rehabilitation Engineering course introduces the application of engineering principles in healthcare and assistive technology for individuals with disabilities. It covers rehabilitation concepts, sensory augmentation and substitution systems, prosthetics and orthotics, Functional Electrical Stimulation (FES), Virtual Reality (VR), haptics, and rehabilitation robotics. The course also addresses physiological and psychological rehabilitation therapies, rehabilitation advocacy, legal provisions, and accessibility support systems to enhance functional recovery and quality of life.
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. Joseph D Bronzino, “The Biomedical Engineering Handbook”. 2nd edition, CRC Press,2000. 2. Robinson C.J, “Rehabilitation Engineering”, CRC Press, 2006
12	**References**	1. Sashi S Kommu, “Rehabilitation Robotics”, 1st edition, CRC Press, 2007. 2. Sunder, “Textbooks of Rehabilitation”, Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007. 3. Horia- Nocholai Teodorecu, L.C.Jain, “Intelligent systems and technologies in rehabilitation Engineering”, CRC; December 2000 4. Etienne Grandjean, Harold Oldroyd, “Fitting the task to the man”, Taylor & Francis, 1988. 5. Keswick. J., “What is Rehabilitation Engineering, Annual Reviews of Rehabilitation”,Springer Verlag, New York, 1982. 6. Warren E. Finn, Peter G. Lopressor, “Handbook of Neuroprosthetic Methods”,CRC, 2002.

		7. Roy A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering" CRC Press, 2000

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 REHABILITATION	
A	Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function	**CO1**
B	Rehabilitation: Rehabilitation team – members and their functions.	**CO1**
C	Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects	**CO1**
	Unit 2: ENGINEERING CONCEPTS IN SENSORY AUGMENTATION AND SUBSTITUTION	
A	Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution.	**CO2**
B	Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution.	**CO2**
C	Tactual system- Tactual augmentation, Tactual substitution.	**CO2**
	Unit 3: ORTHOPEDIC PROSTHETICS AND ORTHOTICS	
A	Engineering concepts in motor rehabilitation, Artificial limbs, Body-powered orthotics and prosthetics, Externally powered and controlled orthotics and prosthetics	**CO3**
B	Myoelectric hand prosthetics, Myoelectric arm prosthetics, Functional Electrical Stimulation (FES) systems	**CO3, CO4**
C	Restoration of hand function using FES, Restoration of standing and walking, Hybrid Assistive Systems (HAS)	**CO3, CO4**
	Unit 4: VIRTUAL REALITY	
A	Introduction to Virtual Reality, Virtual Reality based rehabilitation	**CO4**
B	Hand motor recovery systems with Phantom haptics, Applications of	**CO4, CO5**

	haptics in rehabilitation	
C	Robotics in rehabilitation, Virtual Reality applications in mobility rehabilitation	**CO4, CO5**
	Unit 5: REHABILITATION MEDICINE AND ADVOCACY	
A	Physiological aspects of function recovery, Rehabilitation therapy fundamentals	**CO5**
B	Psychological aspects of rehabilitation therapy, Emotional and cognitive support in rehabilitation	**CO5, CO6**
C	Legal aspects involved in choosing rehabilitation devices, Provisions available in education, Provisions available in jobs and day-to-day life activities	**CO6**

4. Topic-wise Bloom's Taxonomy Level Mapping

Here is the **Topic-wise Bloom's Taxonomy Level Mapping** for the Rehabilitation Engineering syllabus:

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.

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	Topics to be Covered/Title	UNIT	Total Lectures
DD/MM/YY	Definition of Rehabilitation Engineering; Impairments, Disabilities and Handicaps	UNIT-1	9
DD/MM/YY	Primary and Secondary Disabilities; Activities of Daily Living (ADL)		
DD/MM/YY	Appropriate Technology and Residual Function		
DD/MM/YY	Rehabilitation Team – Members and their Functions		
DD/MM/YY	Rehabilitation Care – Need for Proper Delivery of Rehabilitation Care		
DD/MM/YY	Community Based Rehabilitation and its Aspects		
DD/MM/YY	Introduction to Sensory Augmentation and Substitution	UNIT-2	9
DD/MM/YY	Visual System: Visual Augmentation		
DD/MM/YY	Tactual Vision Substitution and Auditory Vision Substitution		
DD/MM/YY	Auditory System: Auditory Augmentation and Hearing Aids		
DD/MM/YY	Cochlear Implants; Visual Auditory and Tactual Auditory Substitution		
DD/MM/YY	Tactual System: Tactual Augmentation and Tactual Substitution		
DD/MM/YY	Engineering Concepts in Motor Rehabilitation	UNIT-3	9
DD/MM/YY	Artificial Limbs; Body-Powered Orthotics and Prosthetics		
DD/MM/YY	Externally Powered and Controlled Orthotics and Prosthetics		
DD/MM/YY	Myoelectric Hand and Arm Prosthetics		
DD/MM/YY	Functional Electrical Stimulation (FES) Systems		
DD/MM/YY	Restoration of Hand Function, Standing and Walking using FES; Hybrid Assistive Systems (HAS)		
DD/MM/YY	Introduction to Virtual Reality and VR-based Rehabilitation	UNIT-4	9
DD/MM/YY	Hand Motor Recovery Systems with Phantom Haptics		
DD/MM/YY	Applications of Haptics in Rehabilitation		
DD/MM/YY	Robotics in Rehabilitation		
DD/MM/YY	Virtual Reality Applications in Mobility Rehabilitation		
DD/MM/YY	Case Studies and Emerging Trends in VR Rehabilitation Systems		
DD/MM/YY	Physiological Aspects of Function Recovery	UNIT-5	9
DD/MM/YY	Rehabilitation Therapy Fundamentals		
DD/MM/YY	Psychological Aspects of Rehabilitation Therapy		
DD/MM/YY	Emotional and Cognitive Support in Rehabilitation		
DD/MM/YY	Legal Aspects in Choosing Rehabilitation Devices		

DD/MM/YY	Provisions Available in Education, Jobs and Day-to-Day Life Activities		

Total Classroom Contact: 45 Hours across 5 Units

Self-Learning Activities: 45 Hours

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	Rehabilitation Concepts & Disability Identification	Recall fundamental concepts of rehabilitation engineering including impairments, disabilities, handicaps, activities of daily living, rehabilitation care, and community-based rehabilitation	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	Sensory Augmentation & Assistive System Understanding	Explain sensory augmentation and substitution techniques related to visual, auditory, and tactual systems; interpret the working principles of hearing aids, cochlear implants, and substitution systems	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	Prosthetics & Rehabilitation System Application	Apply engineering concepts in motor rehabilitation including artificial limbs, orthotics, prosthetics, myoelectric systems, and FES-based rehabilitation systems to practical rehabilitation scenarios	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	Virtual Reality & Haptic Rehabilitation Analysis	Analyze the role of virtual reality, haptics, and robotics in rehabilitation systems; compare rehabilitation approaches used in mobility and motor recovery applications	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	Rehabilitation Therapy & Recovery Evaluation	Analyze physiological and psychological rehabilitation methods; evaluate therapy techniques and cognitive/emotional support mechanisms for functional recovery	CO5 | L4–L5	ETE Sec B/C
TS6	Rehabilitation Advocacy & Assistive Technology Evaluation	Evaluate legal, educational, occupational, and social support systems associated with rehabilitation devices and assistive technologies; assess rehabilitation accessibility in real-life 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 Rehabilitation Concepts Recall	TS2 Sensory System Interpretation	TS3 Prosthetics & Rehabilitation Application	TS4 VR & Rehabilitation Analysis	TS5 Therapy & Recovery Evaluation	TS6 Rehabilitation Advocacy 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

Legend:

- **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 (Conceptual / Application-based)	5 Assignments	15	CO1, CO2, CO3, CO4	TS1, TS2, TS3, TS4
Technical Video Learning Report on Rehabilitation Technologies	1 Report + Presentation	5	CO2, CO3	TS2, TS3
Real-World Rehabilitation Case Study / Assistive Technology 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	Rehabilitation concepts: impairments, disabilities, rehabilitation care, community-based rehabilitation	CO1	TS1	5h SL	Report submission + conceptual understanding evaluation
Assignment 2	Sensory augmentation and substitution systems: visual, auditory and tactual systems	CO2	TS2	5h SL	Explanation of assistive technologies and working principles
Assignment 3	Prosthetics and orthotics: artificial limbs, myoelectric prosthetics, FES systems	CO2, CO3	TS2, TS3	5h SL	Application-based problems and rehabilitation device analysis
Assignment 4	Virtual Reality and haptic rehabilitation systems; robotics in rehabilitation	CO3, CO4	TS3, TS4	5h SL	Comparative analysis and application-oriented study
Assignment 5	Rehabilitation medicine, therapy, legal aspects and rehabilitation advocacy	CO4, CO5, CO6	TS4, TS5, TS6	5h SL	Analytical report with evaluation of rehabilitation support systems
Video Learning Report	Technical video on assistive technologies, prosthetics, VR rehabilitation or FES systems	CO2, CO3	TS2, TS3	9h SL	Report: learning outcomes, technology understanding, self-reflection. Presentation:

	(minimum 3 hrs); structured report + presentation				10 min
Case Study Report	Real-world rehabilitation case study involving prosthetics, rehabilitation robotics, VR therapy or assistive technology applications	CO4, CO5, CO6	TS4, TS5, TS6	6h SL	Technical depth, data collection, comparative analysis 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.*

Section	Marks	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	10	TS1 — Rehabilitation Concepts Recall TS2 — Sensory System Interpretation	CO1, CO2	Short-answer questions: define impairments, disabilities, rehabilitation concepts, explain sensory augmentation and substitution systems, describe hearing aids, cochlear implants and assistive technologies
Section B	15	TS3 — Prosthetics & Rehabilitation Application TS4 — VR & Rehabilitation Analysis	CO2, CO3, CO4	Application and analytical questions: explain prosthetic systems, FES applications, analyze VR and haptic rehabilitation systems, compare rehabilitation technologies and mobility rehabilitation approaches
TOTAL	**25**	**TS1–TS4**	**CO1–CO4**	Units 1–4 only. CO5 and CO6 assessed primarily in ETE through rehabilitation therapy, legal and advocacy-based evaluation 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.*

Section	Marks	Theory Skill Dimensions	COs Assessed	Question Type & Guidance
Section A	15	TS1 — Rehabilitation Concepts Recall TS2 — Sensory System Interpretation	CO1, CO2	Short questions (Units 1–2): definitions of impairments, disabilities and rehabilitation concepts; explanation of rehabilitation care, sensory augmentation and substitution systems, hearing aids, cochlear implants and assistive technologies
Section B	25	TS3 — Prosthetics & Rehabilitation Application TS4 — VR & Rehabilitation Analysis TS5 — Therapy & Recovery Evaluation	CO3, CO4, CO5	Medium questions: applications of prosthetics and orthotics, myoelectric systems, FES systems, virtual reality rehabilitation, robotics in rehabilitation, physiological and psychological rehabilitation therapy analysis
Section C	10	TS5 — Therapy & Recovery Evaluation TS6 — Rehabilitation Advocacy Evaluation	CO5, CO6	Long/evaluation questions: rehabilitation therapy methods, emotional and cognitive support systems, legal aspects of rehabilitation devices, rehabilitation accessibility in education, employment and daily-life applications; case-study based analysis
TOTAL	**50**	**TS1–TS6 (all)**	**CO1–CO6**	Scaled from 100-mark paper if required. 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 fundamental concepts of rehabilitation engineering, disabilities, rehabilitation care and community-based rehabilitation	✔	✔	✔	TS1	PO1, PO2, PO3, PO4
CO2	Explain sensory augmentation and substitution systems used in rehabilitation engineering	✔	✔	✔	TS2	PO1, PO2, PO3, PO4
CO3	Apply engineering concepts in prosthetics, orthotics and rehabilitation assistive systems	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Analyze virtual reality, haptics and robotics applications in rehabilitation systems	✔	✔	✔	TS4	PO9, PO10, PO11
CO5	Evaluate rehabilitation therapies, physiological and psychological recovery mechanisms	✔	—	✔	TS5	PO1, PO2, PO8, PO9, PO10
CO6	Understand legal, educational and social advocacy aspects related to rehabilitation technologies	✔	—	✔	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	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	–	–	–	2	1	1	1	3	2	2
CO2	3	3	3	2	–	–	–	2	2	1	1	3	2	2
CO3	3	3	3	3	1	–	–	1	2	2	2	3	3	2
CO4	2	2	3	3	2	–	–	2	3	3	3	2	3	2
CO5	2	2	2	2	–	–	–	3	3	2	2	2	2	1
CO6	2	2	1	1	–	1	–	3	2	3	3	2	2	1
Avg	**2.5**	**2.5**	**2.33**	**2.17**	**1.50**	**1.00**	**–**	**2.17**	**2.17**	**2.00**	**2.00**	**2.50**	**2.33**	**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	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	

Legend:

- **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 × 3 hrs each 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 Report preparation: 3 hrs Presentation: 3 hrs 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 Report preparation: 2 hrs 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 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 (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

REHABILITATION ENGINEERING

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

Medical Robotics (surgical robots, rehab robots) (CSME4207)

Sharda School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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:**	2029-2030
Branch:	CS & ME	**Semester:**	VII
Course Code:	CSME4207	**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**	CSME4207
2	**Course Title**	**Medical Robotics**
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:** CO1 (Remember – L1) Recall the fundamental concepts, classifications, architectures, and applications of medical robotic systems. CO2 (Understand – L2) Explain robotic sensing, kinematics, medical imaging, navigation, and control mechanisms used in healthcare robotics. CO3 (Apply – L3) Apply robotic transformations, motion planning, rehabilitation algorithms, and robotic control techniques for medical robotic operations. CO4 (Analyze – L4) Analyze surgical robotics, rehabilitation robotics, robotic perception, and human–robot interaction in clinical environments. CO5 (Evaluate – L5) Evaluate AI-based medical robotic systems, intelligent decision-making, safety, and performance optimization techniques in healthcare applications. CO6 (Create – L6) Design intelligent medical robotic solutions integrating sensing, control, imaging, and autonomous healthcare assistance for real-world medical problems.
8	**Course Description**	This course provides a comprehensive introduction to medical robotics with emphasis on surgical robotics, rehabilitation robotics, robotic sensing, intelligent control, and healthcare automation. It covers robotic kinematics, medical imaging, robotic navigation, rehabilitation systems, AI-based robotic perception, human–robot interaction, and intelligent healthcare applications. Students will explore how robotic systems assist clinicians in surgery, therapy, rehabilitation, diagnosis, and patient care using intelligent algorithms and automation techniques. The course also introduces emerging applications of medical robotics in minimally invasive surgery, telemedicine, assistive robotics, and smart healthcare 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. Jacob Rosen et al., Surgical Robotics: Systems Applications and Visions. 2. Vanja Bozovic, Medical Robotics.
12	**References**	1. Russell H. Taylor, A. Menciassi, Medical Robotics and Computer-Integrated Surgery. 2. Bruno Siciliano & Oussama Khatib, Springer Handbook of Robotics. 3. Achim Schweikard, Medical Robotics.

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 MEDICAL ROBOTICS	
A	Introduction to medical robotics, classification of medical robots, robotic architectures, healthcare applications	**CO1**

B	Surgical robots, rehabilitation robots, assistive robots and tele-operated robotic systems	**CO1, CO2**
C	Human–robot interaction, medical ethics, safety standards and clinical requirements	**CO1, CO2**
	Unit 2: ROBOT KINEMATICS, IMAGING AND CONTROL	
A	Coordinate transformations, robotic kinematics, workspace analysis and robotic motion	**CO1, CO2, CO3**
B	Medical imaging systems, image-guided robotics, robotic navigation and localization	**CO1, CO2, CO3**
C	Feedback control systems, PID control, haptic systems and robotic motion control	**CO1, CO2, CO3**
	Unit 3: SURGICAL AND REHABILITATION ROBOTICS	
A	Minimally invasive surgical robots, robotic manipulators and surgical assistance systems	**CO1, CO2, CO3, CO4**
B	Rehabilitation robotics, prosthetics, exoskeleton systems and assistive technologies	**CO1, CO2, CO3, CO4**
C	Robot perception, embedded medical robotic systems and intelligent monitoring systems	**CO1, CO2, CO3, CO4**
	Unit 4: AI AND INTELLIGENT HEALTHCARE ROBOTICS	
A	Probability, statistics and uncertainty handling in healthcare robotics	**CO3, CO4, CO5**
B	Machine learning, computer vision and intelligent decision-making in medical robotics	**CO3, CO4, CO5**
C	Neural networks, adaptive robotic systems and AI-based healthcare assistance	**CO3, CO4, CO5**
	Unit 5: AUTONOMOUS MEDICAL ROBOTS AND FUTURE HEALTHCARE SYSTEMS	
A	Autonomous robotic surgery, telemedicine robotics and remote healthcare systems	**CO4, CO5, CO6**
B	Reinforcement learning, robotic optimization and adaptive healthcare systems	**CO4, CO5, CO6**
C	Multi-agent healthcare robots, swarm robotics and future intelligent healthcare 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 Medical Robotics	UNIT-1	9
DD/MM/YY	Classification of Medical Robots		
DD/MM/YY	Robotic Architectures in Healthcare		
DD/MM/YY	Applications of Medical Robotics		
DD/MM/YY	Surgical Robots		
DD/MM/YY	Rehabilitation Robots		
DD/MM/YY	Assistive and Tele-operated Robots		
DD/MM/YY	Human–Robot Interaction		
DD/MM/YY	Medical Ethics and Safety Standards		
DD/MM/YY	Coordinate Transformations	UNIT-2	9
DD/MM/YY	Robotic Kinematics		
DD/MM/YY	Workspace Analysis		
DD/MM/YY	Medical Imaging Systems		
DD/MM/YY	Image-Guided Robotics		
DD/MM/YY	Robotic Navigation and Localization		
DD/MM/YY	Feedback Control Systems		
DD/MM/YY	PID Control		
DD/MM/YY	Haptic and Motion Control Systems		
DD/MM/YY	Minimally Invasive Surgical Robots	UNIT-3	9
DD/MM/YY	Surgical Manipulators		
DD/MM/YY	Surgical Assistance Systems		
DD/MM/YY	Rehabilitation Robotics		
DD/MM/YY	Prosthetics and Exoskeleton Systems		
DD/MM/YY	Assistive Technologies		
DD/MM/YY	Robot Perception Systems		
DD/MM/YY	Embedded Medical Robotic Systems		

DD/MM/YY	Intelligent Patient Monitoring Systems		
DD/MM/YY	Probability and Statistics in Robotics	UNIT-4	9
DD/MM/YY	Uncertainty Handling in Healthcare Robotics		
DD/MM/YY	Machine Learning for Medical Robotics		
DD/MM/YY	Intelligent Decision-Making Systems		
DD/MM/YY	Computer Vision in Healthcare Robotics		
DD/MM/YY	Neural Networks for Medical Robotics		
DD/MM/YY	Adaptive Robotic Systems		
DD/MM/YY	AI-Based Healthcare Assistance		
DD/MM/YY	Case Studies in Intelligent Medical Robotics		
DD/MM/YY	Autonomous Robotic Surgery	UNIT-5	9
DD/MM/YY	Telemedicine Robotics		
DD/MM/YY	Remote Healthcare Systems		
DD/MM/YY	Reinforcement Learning in Medical Robotics		
DD/MM/YY	Robotic Optimization Techniques		
DD/MM/YY	Adaptive Healthcare Systems		
DD/MM/YY	Multi-Agent Healthcare Robots		
DD/MM/YY	Swarm Robotics in Healthcare		
DD/MM/YY	Case Studies in Healthcare Robotics		

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	Medical Robotics Fundamentals & Conceptual Recall	Recall concepts related to medical robotics, surgical robots, rehabilitation robots, robotic components, medical robotic architectures, and healthcare applications	CO1 | L1–L2	CA | MTE Sec A | ETE Sec A
TS2	Human–Robot Interaction & Control Understanding	Explain robot kinematics, haptic systems, teleoperation, sensing systems, control mechanisms, and safety principles in medical robotics	CO2 | L2–L3	CA | MTE Sec A | ETE Sec A
TS3	Medical Robotic System Application & Integration	Apply robotic motion planning, surgical assistance algorithms, rehabilitation mechanisms, embedded systems, and intelligent control techniques in healthcare robotics	CO3 | L3	CA | MTE Sec B | ETE Sec B
TS4	Intelligent Medical Perception & Analytical Evaluation	Analyze robotic perception, medical imaging integration, navigation systems, localization techniques, and AI-assisted medical robotic decision-making	CO4 | L4–L5	MTE Sec B | ETE Sec B
TS5	Autonomous Healthcare Robotics & AI Evaluation	Evaluate machine learning methods, adaptive rehabilitation systems, autonomous surgical systems, assistive robotics, and intelligent healthcare automation	CO5 | L4–L5	ETE Sec B/C
TS6	Advanced Medical Robotic Design & Innovation	Design and analyze intelligent medical robotic systems integrating AI, autonomous control, rehabilitation assistance, multi-agent coordination, and patient-centered robotic solutions	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: medical robotics fundamentals, surgical robots, rehabilitation systems, robot kinematics, sensing and control mechanisms	CO1, CO2,CO3	TS1,TS2,TS3	5h SL	Report submission + conceptual evaluation
Assignment 2	Unit 3, Unit 4 and Unit 5 concepts: medical imaging integration, intelligent robotic systems, AI in healthcare robotics, rehabilitation automation and autonomous medical systems	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: surgical robotics, rehabilitation robots, teleoperation systems, medical robot architectures 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, medical imaging, AI-assisted diagnosis, intelligent rehabilitation and adaptive healthcare robotics	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 — Medical Robotics Fundamentals & Conceptual Recall	CO1	Short-answer questions: medical robotics concepts, surgical robots, rehabilitation robots, robotic architectures, healthcare applications
TS2 — Human–Robot Interaction & Control Understanding	CO2	Theory/problem-based questions: robot kinematics, teleoperation, haptic systems, sensing mechanisms, robot safety and control
TS3 — Medical Robotic System Application & Integration	CO3	Application-based questions: robot-assisted surgery workflows, rehabilitation robotics, motion planning, robotic assistance systems

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 — Medical Robotics Fundamentals & Conceptual Recall TS2 — Human–Robot Interaction & Control Understanding	CO1, CO2	Short-answer questions: medical robotics concepts, surgical robotic systems, rehabilitation mechanisms, teleoperation, sensing and control principles
TS3 — Medical Robotic System Application & Integration TS4 — Intelligent Medical Perception & Analytical Evaluation TS5 — Autonomous Healthcare Robotics & AI Evaluation	CO3, CO4, CO5	Medium questions: robotic imaging integration, rehabilitation robotics, localization and navigation, AI-assisted diagnosis, intelligent perception, adaptive robotic systems
TS4 — Intelligent Medical Perception & Analytical Evaluation TS5 — Autonomous Healthcare Robotics & AI Evaluation	CO4, CO5	Long analytical questions: intelligent rehabilitation systems, machine learning in healthcare robotics, robotic surgery evaluation, assistive robotic technologies, autonomous healthcare applications

TS6 — Advanced Medical Robotic Design & Innovation	CO6	Design and case-study-based questions on intelligent medical robotic systems, autonomous rehabilitation robots, AI-integrated healthcare robots and future healthcare automation
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 medical robotics fundamentals, architectures and healthcare robotic concepts	✔	✔	✔	TS1	PO1, PO2
CO2	Explain robot motion, teleoperation, sensing and medical control systems	✔	✔	✔	TS2	PO1, PO2, PO3
CO3	Apply robotic assistance, rehabilitation and intelligent medical system techniques	✔	✔	✔	TS3	PO1, PO2, PO3, PO4
CO4	Analyze robotic perception, imaging integration and intelligent healthcare decision making	✔	—	✔	TS4	PO2, PO4, PO5
CO5	Evaluate AI-based healthcare robotics and autonomous rehabilitation systems	✔	—	✔	TS5	PO1, PO2, PO5, PO12
CO6	Design intelligent and autonomous medical robotic systems	✔	—	✔	TS6	PO3, PO4, PO5, PO12

⚠ *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, medical robotic system analysis, robot control mechanisms, rehabilitation workflows, and intelligent healthcare robotics concepts
2	Technical Video-Based Learning related to the subject (e.g., surgical robots, rehabilitation robotics, robotic-assisted surgery, teleoperation systems, AI-enabled healthcare robotics)	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 healthcare workflows, surgical assistance systems, intelligent control mechanisms, and personal reflections
3	Real-World Case Studies (e.g., Da Vinci surgical systems, robotic rehabilitation devices, autonomous medical robots, AI-assisted diagnosis systems, healthcare robotic automation)	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, intelligent healthcare system analysis, analytical conclusions, innovation, and comparative evaluation of medical 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 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 (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

Medical Robotics 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: SET		**Batch: 2026-2030**	
Program: B.Tech.		**Current Academic Year: 2029-30**	
Branch: CSE		**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: CO1: Identify problem statement in engineering and technology in selected field of interest. CO2: Analyze the gathered information required to develop a project. CO3: Apply prior knowledge of mathematics, computer science and engineering. 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. CO5: Prepare the designs requirements, functional and conceptual design. 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. 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	

		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	PO 10	PO 11	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: SET		**Batch: 2026-2030**		
Program: B Tech		**Current Academic Year: 2029-30**		
Branch: CSE		**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. 2. Develop and refine oral and written communication skills. 3. Identify areas for future knowledge and skill development.		
6	Course Outcomes	Students will be able to: CO1. Integrate the concepts and strategies of academic study in a real time environment. CO2. Identify, formulate and model problems and find engineering solutions based on a systems approach. CO3. Develop teamwork and apply prior acquired knowledge in problem solving. CO4. Develop communication, interpersonal and other critical skills required for career growth. CO5. Practice engineer's responsibilities, self-understanding, self-discipline and ethical standards. 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**		
		CA	CE (Viva)	ETE

	Weightage Distribution	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**

Semester VII	Credits : 15
	Program Elective-4
CSME4200	Modelling and simulation of Biomedical system
CSME4201	Blockchain in Medical Data Management
CSAI4003	Smart Contract
	Program Elective-5
CSME4202	HealthCare Data Analytics
CSME4203	Natural Language Processing for Clinical Data
CSME4204	Ethical AI in Medicine
	Program Elective-6
CSME4205	Explainable AI in Medicine
CSME4206	Rehabilitation Engineering
CSME4207	Medical Robotics (surgical robots, rehab robots)
CSCR4600	Capstone – 1
CSCR4700	Summer Internship-II
	Open Elective - 2

School: SET		**Batch: 2026-2030**			
Program: B.Tech.		**Current Academic Year: 2029-2030**			
Branch: CSE		**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 2. Students making decisions within a framework 3. Continuous evaluation of the project 4. A final product to be evaluated for quality			
6	Course Outcomes	Students will be able to: CO1: Demonstrate the implementation of the project. CO2: Identify the test procedure for each implemented module. CO3: Deploy and evaluate the modules to verify the required need of the project. CO4: Use different tools for communication, testing and report writing. CO5: Develop the attitude and ethics of a professional engineer. 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)

Semester 8, Credits: 15	
COURSE CODE	**COURSE NAME**
CSCR4601	Capstone - 2
	Open Elective – 3
	Open Elective – 4

COURSE PLAN

Generative AI (CSMA2300)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | Semester III | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–27
Branch:	CS & ME	**Semester:**	III
Couse Code	CSMA2300	**Course type**	Core – Integrated

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**	CSMA2300
2	**Course Title**	**Generative AI**
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-3
5	**Course Status**	Core
6	**Course Objective**	The objective of this course is to provide students with a comprehensive understanding of generative artificial intelligence and its transformative applications in medical engineering and healthcare. The course introduces the fundamental architectures of generative AI, including Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Diffusion Models, and Transformer-based models, while emphasizing their use in medical imaging, clinical natural language processing, drug discovery, personalized medicine, and genomic data analysis. Students will gain hands-on experience in designing and implementing AI-driven solutions for real-world healthcare challenges, while critically evaluating ethical, regulatory, privacy, and bias-related issues associated with the deployment of generative AI in clinical settings. Through practical exercises and a capstone project, the course aims to develop the technical, analytical, and problem-solving skills required to build responsible and effective generative AI applications for the healthcare domain.
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** CO1: Explain the foundational architectures of generative AI — VAEs, GANs, Diffusion Models, and Transformers — and their relevance to medical data types. CO2: Apply generative AI techniques to synthesise and augment medical imaging data (X-ray, MRI, CT, histopathology) for diagnostic support. CO3: Implement NLP and LLM-based tools for clinical text generation, summarisation, and medical report analysis. CO4: Design generative AI pipelines for drug discovery, personalised medicine, and

		genomic data modelling. CO5: Evaluate ethical, regulatory, and bias-related challenges of deploying generative AI in clinical and hospital environments. CO6:Develop a working prototype integrating generative AI with a medical engineering application as a capstone project. **LAB COs — Assessed via Laboratory Assessment only:** **CO7:** Implement and train generative AI models, including Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), CycleGANs, and Diffusion Models, for medical image synthesis, reconstruction, segmentation, and augmentation. **CO8:** Develop AI-driven healthcare applications using Large Language Models (LLMs), BioBERT, Retrieval-Augmented Generation (RAG), and multimodal models for clinical text processing, medical report generation, named entity recognition, and intelligent medical chatbots. **CO9:** Design, evaluate, and optimize generative AI solutions for biomedical signal processing and healthcare analytics by applying appropriate datasets, performance metrics (e.g., FID, Dice Score, SSIM, PSNR, BLEU, ROUGE, F1 Score), and comparative analysis techniques. **CO10:** Build and deploy end-to-end AI-enabled healthcare prototypes by integrating generative AI models with real-world medical engineering applications, including biomedical signal analysis, edge AI devices, and clinical decision-support systems while considering practical implementation challenges.
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)**	DeepLearning.AI - Generative AI for Everyone (free) · LLMOps Specialisation NPTEL - Deep Learning for Computer Vision · Medical Image Analysis Hugging Face - NLP Course (free) · Diffusers library tutorials Fast.ai - Practical Deep Learning for Coders (free)
11	**References**	1. *Goodfellow I, Bengio Y, Courville A. Deep Learning. MIT Press, 2016.* 2. *Foster D. Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play. O'Reilly Media, 2nd ed., 2023.* 3. *Reference:* Shortliffe, E.H., Cimino, J.J. — *Biomedical Informatics: Computer Applications in Health Care and Biomedicine* (5th Ed.), Springer.

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 and Landscape of Genrative Models (8hrs)**	
A	AI vs ML vs Deep Learning vs Generative AI · History of generative models · Why GenAI matters in medicine · Overview of medical data types (imaging, text, biosignals, genomic) · Indian healthcare context — diagnostic gaps	CO1
B	Autoencoders and Variational Autoencoders (VAEs) · Latent space representation · Encoder-decoder architecture · Applications in anomaly detection in medical scans · Hands-on: VAE on MNIST medical digit dataset	

C	GAN architecture: Generator vs Discriminator · Loss functions · Training instability and mode collapse · Variants: DCGAN, cGAN, CycleGAN, StyleGAN · Medical application overview: synthetic X-ray, skin lesion, retinal image generation. Foundation models in healthcare — Med-PaLM 2, BioGPT, CheXagent · Lab preview: Stable Diffusion for medical image synthesis	
Tools Used	Python, PyTorch/TensorFlow, Hugging Face, Google Colab · Build and train a basic VAE on MNIST · Visualise latent space · Reconstruct chest X-ray patches (NIH ChestX-ray14 dataset)	
Activities	**Objective: To** Introduce students to the evolution of Artificial Intelligence, Machine Learning, Deep Learning, and Generative AI. To Develop an understanding of generative AI architectures such as VAEs, GANs, Diffusion Models, and Transformers. And to Familiarize students with different types of medical data (medical images, clinical text, biosignals, and genomic data) and their significance in healthcare.	
Unit 2	**Generative Medical Imaging (12 hrs)**	
A	Medical Imaging Fundamentals : Types: X-ray, CT, MRI, PET, Ultrasound, Histopathology, Fundus · DICOM format · Imaging challenges: noise, low contrast, artefacts · Current AI in radiology — FDA-approved AI tools overview · Indian telemedicine + imaging gaps in Tier 2/3 cities	CO2, CO6
B	Synthetic Medical Image Generation: GANs for data augmentation · CycleGAN for domain adaptation (CT↔MRI) · Conditional image generation · Pix2Pix for MRI-to-CT synthesis · Evaluation metrics: FID, SSIM, PSNR 3D Medical Image Synthesis Theory 3D GANs and volumetric generation · Point cloud generation for surgical planning ·	
C	GenAI for Image Segmentation & Enhancement Theory Diffusion models for image segmentation · U-Net + generative extensions · Super-resolution of low-quality medical images using SRGAN · Noise reduction in CT and MRI scans · Tumour boundary enhancement · Case study: brain tumour segmentation	
Tools Used	Python, PyTorch/TensorFlow, Hugging Face, Google Colab	
Activities	**Objective:** Enable students to understand medical imaging modalities and challenges in image acquisition and analysis. • Teach the application of generative AI models for medical image synthesis, augmentation, segmentation, enhancement, and domain adaptation.	
Unit 3	**NLP & Large Language Models in Clinical Medicine (12 hrs)**	
A	Clinical NLP Foundations Theory Medical text types: EHR notes, discharge summaries, lab reports, prescriptions · NLP pipeline: tokenisation, NER, relation extraction · Medical ontologies: ICD-10, SNOMED CT, MedDRA · UMLS (Unified Medical Language System) · Challenges: abbreviations, negation, Indian language medical text	CO3, CO6
B	LLMs in Clinical Applications Theory BERT, BioBERT, ClinicalBERT, PubMedBERT · GPT-4, Med-PaLM 2, Meditron · Clinical question answering · Differential diagnosis generation · Drug interaction checking using LLMs · Prompt engineering for clinical tasks. Medical Report & Discharge Summary Generation Theory Automatic radiology report generation · Discharge summary synthesis · Clinical note summarisation · Fine-tuning LLMs on MIMIC-III / Indian clinical datasets · Hallucination problem in medical LLMs · RAG (Retrieval-Augmented Generation) for clinical fact grounding	
C	Conversational AI & Medical Chatbots Theory Chatbot architecture for patient triage · Symptom checking AI (Ada Health, Babylon) · Mental health support chatbots · Indian context: ASHA worker support tools, multilingual medical chatbots · Limitations and safety risks of medical chatbots · Case study: ASD	

	diagnosis support chatbot	
Tools Used	Python, PyTorch/TensorFlow, Hugging Face, Google Colab	
Activities	**Objective:** To Provide knowledge of clinical Natural Language Processing (NLP) techniques and medical ontologies. • Train students to use Large Language Models (LLMs) for medical report generation, summarization, clinical decision support, and intelligent healthcare chatbots. • Develop an understanding of Retrieval-Augmented Generation (RAG), prompt engineering, and multimodal AI for healthcare applications.	
Unit 4	**Wearables, Biosignals & Personalised Health AI (8 hrs)**	
A	Biosignal Types & Medical Wearables Theory ECG, EEG, EMG, EDA, PPG, accelerometry · Wearable devices: smartwatches, patches, implantables · Signal acquisition challenges: noise, motion artefacts, electrode drift · Indian wearable health market · Low-cost biosignal acquisition hardware (ESP32, AD8232) . Generative AI for Biosignal Synthesis Theory GAN-based ECG synthesis (CardioGAN) · EEG data augmentation for BCI and neurological disorder detection · Synthetic patient data generation for rare conditions · Time-series diffusion models for biosignals · Evaluation metrics: DTW, MMD · ASD application: synthetic EEG for autism detection	CO4, CO6
B	GenAI for Disease Detection from Biosignals Theory Arrhythmia detection from ECG using transformer + GAN augmentation · Epilepsy seizure prediction from EEG · Sleep disorder analysis from PSG data · Stress and anxiety detection using EDA + HRV · Parkinson's disease gait analysis from accelerometry · ASD detection from multimodal wearable data	
C	Personalised Health Monitoring & Digital Twins Theory Digital twin concept in medicine · Patient-specific physiological model generation · Personalised drug dosage prediction ·	
Tools Used	Python, PyTorch/TensorFlow, Hugging Face, Google Colab	
Activities	**Objective:** Introduce biosignal acquisition techniques and wearable healthcare technologies. • Enable students to apply generative AI models for ECG, EEG, and other biomedical signal synthesis, augmentation, and disease detection. • Develop the capability to design AI-driven personalized healthcare solutions using digital twins and continuous health monitoring systems.	
Unit 5	**Ethics, Regulation, Safety & Future Directions (5 hrs)**	
A	Ethical Principles in Medical AI Beneficence, non-maleficence, autonomy, justice in AI · Bias in medical datasets: gender, race, socioeconomic · Algorithmic fairness metrics · Bias in ASD detection: Indian gender bias case · GDPR, India DPDP Act 2023 and health data WHO Ethics guidelines for AI in health	CO5, CO6
B	Regulatory Frameworks for Medical AI FDA AI/ML-based SaMD (Software as a Medical Device) guidelines · EU AI Act: high-risk AI in healthcare · India: CDSCO AI medical device guidelines 2024 · Clinical validation requirements	

C	Safety, Hallucination & Explainability Theory AI hallucination in clinical settings — risks and mitigation · Explainability methods: SHAP, LIME, Grad-CAM for medical imaging · Human-AI collaboration model· Adversarial attacks on medical AI · Robustness testing · Black-box vs interpretable model trade-off in clinical deployment. Future of GenAI in Medicine Theory Foundation models as medical AI backbone · Multimodal medical AI: image + text + biosignal + genomic ·	
Tools Used	. Python, PyTorch/TensorFlow, Hugging Face, Google Colab	
Activities	**Objective:** To Develop awareness of ethical principles, fairness, transparency, and privacy in AI-enabled healthcare systems. • Familiarize students with national and international regulatory frameworks governing AI-based medical devices and healthcare software. • Enable students to evaluate AI systems for explainability, robustness, safety, and clinical reliability.	

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/Title	UNIT	Total Lectures
DD/MM/YY	AI vs ML vs Deep Learning vs Generative AI · History of generative models · Why GenAI matters in medicine · Overview of medical data types (imaging, text, biosignals, genomic) · Indian healthcare context — diagnostic gaps	UNIT-1	8
DD/MM/YY	Autoencoders and Variational Autoencoders (VAEs) · Latent space representation · Encoder-decoder architecture ·		
DD/MM/YY	Applications in anomaly detection in medical scans · Hands-on: VAE on MNIST medical digit dataset		
DD/MM/YY	GAN architecture: Generator vs Discriminator		
DD/MM/YY	Loss functions · Training instability and mode collapse · Variants: DCGAN, cGAN, CycleGAN, StyleGAN		
DD/MM/YY	Medical application overview: synthetic X-ray, skin lesion, retinal image generation		
DD/MM/YY	. Foundation models in healthcare — Med-PaLM 2, BioGPT, CheXagent ·		
DD/MM/YY	Lab preview: Stable Diffusion for medical image synthesis		
DD/MM/YY	Medical Imaging Fundamentals : Types: X-ray, CT, MRI, PET, Ultrasound, Histopathology, Fundus · DICOM format ·	UNIT-2	12
DD/MM/YY	Imaging challenges: noise, low contrast, artefacts · Current AI in radiology — FDA-approved AI tools overview · Indian telemedicine + imaging gaps in Tier 2/3 cities		
DD/MM/YY	Synthetic Medical Image Generation: GANs for data augmentation · CycleGAN for domain adaptation (CT↔MRI) ·		
DD/MM/YY	Conditional image generation · Pix2Pix for MRI-to-CT synthesis · Evaluation metrics: FID, SSIM, PSNR		
DD/MM/YY	3D Medical Image Synthesis Theory, 3D GANs and volumetric generation ·		
DD/MM/YY	Point cloud generation for surgical planning ·		

DD/MM/YY	GenAI for Image Segmentation & Enhancement Theory		
DD/MM/YY	Diffusion models for image segmentation · U-Net + generative extensions ·		
DD/MM/YY	Super-resolution of low-quality medical images using SRGAN · Noise reduction in CT and MRI scans · Tumour boundary enhancement ·		
DD/MM/YY	Case study: brain tumour segmentation		
DD/MM/YY	Clinical NLP Foundations Theory Medical text types: EHR notes, discharge summaries, lab reports, prescriptions ·	UNIT-3	12
DD/MM/YY	NLP pipeline: tokenisation, NER, relation extraction ·		
DD/MM/YY	Medical ontologies: ICD-10, SNOMED CT, MedDRA · UMLS (Unified Medical Language System) · Challenges: abbreviations, negation, Indian language medical text		
DD/MM/YY	LLMs in Clinical Applications Theory: BERT, BioBERT, ClinicalBERT, PubMedBERT · GPT-4, Med-PaLM 2, Meditron ·		
DD/MM/YY	Clinical question answering · Differential diagnosis generation · Drug interaction checking using LLMs ·		
DD/MM/YY	Prompt engineering for clinical tasks. Medical Report & Discharge Summary Generation Theory		
DD/MM/YY	Automatic radiology report generation · Discharge summary synthesis · Clinical note summarisation ·		
DD/MM/YY	Fine-tuning LLMs on MIMIC-III / Indian clinical datasets · Hallucination problem in medical LLMs · RAG (Retrieval-Augmented Generation) for clinical fact grounding		
DD/MM/YY	Conversational AI & Medical Chatbots Theory Chatbot architecture for patient triage · Symptom checking AI (Ada Health, Babylon) · Mental health support chatbots		
DD/MM/YY	Indian context: ASHA worker support tools, multilingual medical chatbots · Limitations and safety risks of medical chatbots ·		
DD/MM/YY	Case study: ASD diagnosis support chatbot		
DD/MM/YY	Biosignal Types & Medical Wearables Theory ECG, EEG, EMG, EDA, PPG, accelerometry · Wearable devices: smartwatches, patches, implantables ·	UNIT-4	8
DD/MM/YY	Signal acquisition challenges: noise, motion artefacts, electrode drift · Indian wearable health market · Low-cost biosignal acquisition hardware (ESP32, AD8232) .		
DD/MM/YY	Generative AI for Biosignal Synthesis Theory GAN-based ECG synthesis (CardioGAN) · EEG data augmentation for BCI and neurological disorder detection ·		
DD/MM/YY	Synthetic patient data generation for rare conditions ·		
DD/MM/YY	Time-series diffusion models for biosignals ·		
DD/MM/YY	Evaluation metrics: DTW, MMD · ASD application: synthetic EEG for autism detection		

DD/MM/YY	GenAI for Disease Detection from Biosignals Theory Arrhythmia detection from ECG using transformer + GAN augmentation ·		
DD/MM/YY	Epilepsy seizure prediction from EEG · Sleep disorder analysis from PSG data · Stress and anxiety detection using EDA + HRV ·		
DD/MM/YY	Parkinson's disease gait analysis from accelerometry · ASD detection from multimodal wearable data		
DD/MM/YY	Personalised Health Monitoring & Digital Twins Theory Digital twin concept in medicine · Patient-specific physiological model generation · Personalised drug dosage prediction ·		
DD/MM/YY	Ethical Principles in Medical AI Beneficence, non-maleficence, autonomy, justice in AI · Bias in medical datasets: gender, race, socioeconomic · Algorithmic fairness metrics · Bias in ASD detection: Indian gender bias case ·	UNIT-5	5
DD/MM/YY	GDPR, India DPDP Act 2023 and health data WHO Ethics guidelines for AI in health. India: CDSCO AI medical device guidelines 2024 · Clinical validation requirements		
DD/MM/YY	Regulatory Frameworks for Medical AI FDA AI/ML-based SaMD (Software as a Medical Device) guidelines · EU AI Act: high-risk AI in healthcare ·		
DD/MM/YY	Safety, Hallucination & Explainability Theory AI hallucination in clinical settings — risks and mitigation · Explainability methods: SHAP, LIME, Grad-CAM for medical imaging		
DD/MM/YY	· Human-AI collaboration model· Adversarial attacks on medical AI · Robustness testing · Black-box vs interpretable model trade-off in clinical deployment. Future of GenAI in Medicine Theory		
DD/MM/YY	Multimodal medical AI: image + text + biosignal + genomic ·		

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	Python environment setup + VAE implementation	**CO7**	3.0
W2	S-2	Train DCGAN on skin lesion dataset (ISIC 2020) · Evaluate using FID score · Visualise generated vs real lesions · Discuss mode collapse observations	**CO7**	3.0
W3	S-3	CycleGAN for MRI-CT synthesis Dataset: Gold Atlas · Train CycleGAN · Evaluate SSIM and PSNR · Visualise domain transfer · Discuss clinical utility	**CO7**	3.0
	S-4	Use CheXagent or BioViL API · Input NIH chest X-ray images · Generate	**CO7**	

W4		radiology reports · Compare with ground truth reports · Evaluate using BLEU/ROUGE scores		3.0
W5	S-5	Dataset: BraTS 2023 · Fine-tune segmentation diffusion model · Visualise tumour boundaries · Evaluate Dice coeffic	**CO7**	3.0
W6	S-6	Fine-tune BioBERT on i2b2/n2c2 NER dataset · Extract: diseases, drugs, dosages, procedures · Evaluate F1 score · Apply to sample Indian hospital discharge note	**CO7**	3.0
W7	S-7	Build symptom-checker chatbot using GPT-4 API · Add RAG layer with PubMed article retrieval · Test: 10 clinical scenarios · Evaluate accuracy + hallucination rate · Deploy on Gradio interface	**CO7**	3.0
W8	S-8	Dataset: PhysioNet MIT-BIH Arrhythmia · Train GAN for arrhythmia class augmentation · Evaluate FID and clinical validity · Train classifier with and without augmentation · Measure accuracy improvement	**CO8/CO9**	3.0
W9	S-9	Dataset: EEG Motor Movement/Imagery or ASD EEG dataset · Extract frequency features (delta, theta, alpha, beta) · Augment with TimeGAN · Train SVM + LSTM · Compare F1 scores	**CO8/CO10**	3.0
W10	S-10	Deploy trained arrhythmia classifier on Raspberry Pi · Connect with AD8232 ECG sensor (or simulate) · Real-time inference demo · Measure latency and power consumption	**CO9/CO10**	3.0
W11-W15	S-11	Creation of Chatbots- Mini Project	**CO7**	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	**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	**CO5, CO6**	Long/design questions: design modular solutions,

		Evaluation TS6 — Synthesis & Design		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 CA2 — Experimental design and tool configuration 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 CA4 — Efficiency: time/space complexity, optimization	1.0: Correct & efficient | 0.5: Correct, not optimized | 0: Fails	CO7
Output Analysis,	**0.75**	CA5 — Output analysis and result	0.75: Thorough | 0.5:	CO8, CO9

Outcome & Lab Documentation		interpretation CA6 — Documented outcome with verification CA8 — Lab record completeness; viva-voce comprehension	Adequate | 0.25: Partial | 0: Absent	
Professional Attitude & Ethical Conduct	**0.25**	CO9 — Documentation ethics, responsible practice 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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																					
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	2	-	-	2	-	-	-	-	1	2			
CO2	2	3	3	2	3	1			1	1	2			

CO3	2	2	3	2	3	1	-	1	1	2	2			
CO4	3	3	3	3	3	2	1	1	1	1	2			
CO5	1	2	1	2	1	3	2	3	1	2	2			
CO6	2	3	3	3	3	2	1	2	3	2	2			
CO7	3	3	3	2	3	1	-	1	1	1	2			
CO8	2	2	3	2	3	2	-	2	2	2	2			
CO9	2	3	3	3	3	2	1	2	2	1	2			
CO10	2	3	3	3	3	2	1	2	3	2	2			
Avg	2.2	2.6	2.77	2.44	2.7	1.77	1.2	1.75	1.66	1.5	2			

★ *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:.	M	H	H	M	H					M	M
CO3:	M	M	H	M	H			M		H	M
CO4:	H	H	H	H	H	M		M	M	M	M
CO5:		M		M		H	M	H		M	M
CO6:	M	H	H	H	H	M		M	H	M	H
CO7	H	H	H	M	H						M
CO8:	M	M	H	M	H	M		M	M	H	M
CO9:	M	H	H	H	H	M		M	M	M	M
CO10:	M	H	H	H	H	M		M	H	M	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 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

★ *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

CSMA2300 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

Federated Learning (CSMA2301)

School of Computing Science & Engineering (SSCSE) | B.Tech CS &ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–27

Branch:	CS & ME	**Semester:**	IV
Couse Code	CSMA2301	**Course type**	Core – Integrated

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**	CSMA2301
2	**Course Title**	Federated Learning
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-3
5	**Course Status**	Core
6	**Course Objective**	To introduce the fundamentals of Federated Learning, distributed machine learning, and privacy-preserving model training; and to develop practical skills in implementing federated learning algorithms, addressing communication, security, and data privacy challenges, using modern Federated Learning frameworks, and designing collaborative, secure, and scalable AI solutions for real-world application.
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Remember – L1): Recall and list fundamental concepts of healthcare informatics, medical data standards (HL7, FHIR, DICOM), electronic health records (EHR), and clinical terminology systems (SNOMED-CT, ICD-10) CO2 (Understand – L2): Explain the unique characteristics of clinical data, the working of medical image processing algorithms, physiological signal feature extraction, and specialized neural network architectures for health diagnostics. CO3 (Apply – L3): Develop predictive models and diagnostics systems using supervised and unsupervised machine learning algorithms on tabular clinical data, biometric features, and structured EHRs. CO4 (Analyze – L4): Analyze and debug AI models for healthcare, investigating issues like algorithmic bias, clinical dataset imbalance, interpretability deficits, and processing errors in medical imaging or clinical NLP. CO5 (Evaluate – L5):): Evaluate clinical AI model performance using healthcare-centric metrics (Sensitivity, Specificity, ROC-AUC, F1-score) and optimize models considering fairness, clinical validation constraints, and resource efficiency. CO6 (Create – L6): Design, implement, and demonstrate complete, end-to-end medical AI pipelines integrating data ingestion, preprocessing, explainable ML modeling, and deployment architectures to solve real-world healthcare challenges. **LAB COs — Assessed via Laboratory Assessment only:** **CO1 (Remember – L1):** Recall and list the fundamental concepts of Federated Learning, distributed machine learning, federated architectures, client-server communication, privacy-preserving techniques, and commonly used Federated Learning algorithms.**CO2 (Understand – L2):** Explain the characteristics of distributed data, the working of Federated Learning algorithms, communication protocols, aggregation strategies, and privacy-enhancing techniques such as secure aggregation and differential privacy.**CO3 (Apply – L3):** Develop Federated Learning models using supervised and deep learning algorithms on distributed datasets, implementing client-side training, model aggregation, and collaborative learning using standard Federated Learning frameworks.**CO4 (Analyze – L4):** Analyze and debug Federated Learning systems by investigating communication bottlenecks, client heterogeneity, non-IID data distributions, convergence issues, privacy attacks, and security vulnerabilities in distributed model training.**CO5 (Evaluate – L5):** Evaluate Federated Learning model performance using accuracy, precision, recall, F1-score, communication efficiency, and privacy metrics, while optimizing models considering scalability, robustness, resource constraints, and data privacy requirements
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** — Implement **10 Federated Learning programming exercises** using **TensorFlow Federated (TFF)** and **Flower (FLWR)**. **Virtual Labs** — Perform **Federated Learning experiments** on distributed model training, secure aggregation, and non-IID datasets. **MOOC Course** — Complete one online course on **Federated Learning/Distributed Machine Learning** (SWAYAM/NPTEL/Coursera/edX).
11	**References**	1 Federated Learning, Qiang Yang, Yang Liu, Tianjian Chen, and Yongxin Tong (Eds.), Morgan & Claypool Publishers, 2019. 2 Advances and Open Problems in Federated Learning, Lixin Fan and Han Yu (Eds.), Foundations and Trends® in Machine Learning, 2024. 3 Federated Learning, covering Federated Learning principles, optimization, privacy, security, and distributed AI concepts.

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 Federated Learning **(4-0-10-6 = 20 hrs)**	
A	Fundamentals of Federated Learning: Introduction, Definition, History, Evolution of Machine Learning, Centralized vs. Distributed Learning, Federated Learning Architecture, Client–Server Communication Model, Federated Learning Workflow	CO1, CO2, CO3
B	Types of Federated Learning : Horizontal Federated Learning (HFL), Vertical Federated Learning (VFL), Federated Transfer Learning (FTL), Cross-device FL, Cross-silo FL, Hybrid Federated Learning.	
C	Federated Learning Applications: Applications in Healthcare, Finance, Smart Cities, IoT, Mobile Devices, Autonomous Vehicles, Edge AI, Industrial Automation.	
Tools Used	Python, Jupyter Notebook, TensorFlow Federated (TFF), Flower (FLWR), Google Colab	
Activities	**Objective:** Understand Federated Learning architecture and implement a basic distributed learning workflow Build a simple Federated Learning system using simulated clients.Configure client-server communication.Implement Federated Averaging (FedAvg). Compare centralized and federated learning.	
Unit 2	Federated Learning Algorithms and Optimization **(6-0-12-6 = 24 hrs)**	
A	Federated Learning Algorithms Federated Averaging (FedAvg), FedProx, FedNova, SCAFFOLD, Local and Global Model Updates.	CO2, CO3, CO4
B	Challenges in Federated Learning:Non-IID Data Distributions, Data Heterogeneity, Client Heterogeneity, Communication Bottlenecks, Client Selection, Synchronization Strategies, Stratification Techniques, Local Update Rules.	
C	Advanced Optimization Techniques: Adaptive Learning Rate, Momentum, Weight Decay, Gradient Compression, Sparsification, Adaptive Aggregation, Asynchronous Federated Learning, Communication-Efficient Federated Learning	

Tools Used	TensorFlow Federated, Flower, PyTorch, NumPy, Scikit-Learn	
Activities	**Objective:** Implement and compare Federated Learning algorithms under heterogeneous environments. • Develop FL classification models.Compare FedAvg, FedProx, FedNova. Evaluate convergence and communication efficiency.	
Unit 3	Privacy, Security and Federated Transfer Learning **(8-0-16-6 = 30 hrs)**	
A	Privacy-Preserving Federated Learning : Secure Aggregation, Differential Privacy, Homomorphic Encryption, Secure Multi-Party Computation (SMPC).	CO2, CO3, CO4, CO5, CO6
B	Federated Transfer Learning : Framework, Architecture, Training Process, Prediction Process, Secret Sharing-based FTL, Personalized Federated Learning, Meta-learning, Multi-task Learning.	
C	Security in Federated Learning: Model Poisoning, Data Poisoning, Backdoor Attacks, Byzantine Attacks, Adversarial Clients, Defense Mechanisms, Security Analysis.	
Tools Used	PySyft, TensorFlow Privacy, Flower, PyTorch, OpenMined	
Activities	**Objective:** Implement privacy-preserving and secure Federated Learning systems. • Secure aggregation. ,Differential Privacy implementation. ,Simulate poisoning attacks. , Evaluate defense mechanisms.	
Unit 4	Federated Learning for Edge AI and Deployment **(6-0-12-6 = 24 hrs)**	
A	Federated Learning for Edge Computing : IoT, Mobile Devices, Smart Healthcare, Smart Manufacturing, Autonomous Vehicles. .	CO3, CO4, CO5
B	Resource-Constrained Federated Learning : Edge Intelligence, Communication-Efficient Training, Energy-aware Optimization, Device Heterogeneity, Fault Tolerance.	
C	Deployment and Production Systems :Docker, Kubernetes, TensorFlow Lite, FedML, Monitoring, Scalability, Network Latency, Production Deployment.	
Tools Used	FedML, Flower, Docker, Kubernetes, TensorFlow Lite	
Activities	**Objective:** Deploy Federated Learning applications in edge computing environments.. • Deploy collaborative learning models. , Evaluate scalability. ,Measure latency and communication cost	
Unit 5	Advanced Federated Learning and Future Trends **(6-0-10-6 = 22 hrs)**	
A	Advanced Federated Learning : Hierarchical Federated Learning, Blockchain-enabled Federated Learning, Federated Reinforcement Learning, Explainable Federated AI.	CO2, CO3, CO4, CO5, CO6
B	Performance Evaluation : Accuracy, Precision, Recall, F1-score, Communication Cost, Privacy, Robustness, Scalability, Energy Efficiency.	

C	Emerging Trends and Case Studies:Federated Foundation Models, Green Federated Learning, Trustworthy AI, Large Language Models in FL, Real-world Case Studies, Open Research Challenges.	
Tools Used	Flower, FedML, TensorFlow Federated, MLflow, Weights & Biases (W&B)	
Activities	**Objective:** Evaluate advanced Federated Learning systems and implement a real-world mini project. Benchmark FL frameworks. Compare scalability. Develop a real-world Federated Learning application.	

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/Title	UNIT	Total Lectures
DD/MM/YY	Introduction to Federated Learning; Definition, History, Evolution of Machine Learning; Centralized vs. Distributed Learning; Need and Motivation of Federated Learning	UNIT-1	9
DD/MM/YY	Federated Learning Architecture; Client–Server Communication Model; Federated Learning Workflow		
DD/MM/YY	Types of Federated Learning: Horizontal (HFL), Vertical (VFL), Federated Transfer Learning (FTL), Cross-device, Cross-silo, and Hybrid Federated Learning		
DD/MM/YY	Applications of Federated Learning in Healthcare, Finance, IoT, Smart Cities, Mobile Devices, Autonomous Vehicles, and Industrial Automation		
DD/MM/YY	Federated Averaging (FedAvg): Architecture, Working Principle, Local and Global Model Updates		
DD/MM/YY	Privacy and Security Fundamentals: Data Privacy Challenges, Secure Aggregation, Differential Privacy, Communication Protocols		
DD/MM/YY	Federated Learning Frameworks: TensorFlow Federated (TFF), Flower (FLWR), Google Colab, Python Environment		
DD/MM/YY	Hands-on: Setting up Federated Learning Environment and Implementing Basic Federated Learning Workflow		
DD/MM/YY	Hands-on: Simulated Clients, FedAvg Implementation, Model Aggregation, Performance Evaluation under Non-IID Data		
DD/MM/YY	Introduction to Federated Learning Algorithms and Optimization Techniques	UNIT-2	9
DD/MM/YY	Federated Optimization Algorithms: FedAvg, FedProx, FedNova, and SCAFFOLD		
DD/MM/YY	Challenges in Federated Learning: Non-IID Data Distribution, Data Heterogeneity, Client Heterogeneity		
DD/MM/YY	Communication Bottlenecks, Client Selection, Synchronization Strategies, Local Update Rules		
DD/MM/YY	Communication-Efficient Federated Learning: Gradient Compression, Quantization, Sparsification		
DD/MM/YY	Advanced Optimization: Adaptive Learning Rate, Momentum, Weight Decay, Adaptive Aggregation		
DD/MM/YY	Asynchronous Federated Learning, Model Convergence, Communication Cost Analysis		
DD/MM/YY	Hands-on: Developing Federated Classification Models using FedAvg, FedProx, and FedNova		

DD/MM/YY	Hands-on: Performance Evaluation and Communication Cost Analysis under Heterogeneous Clients		
DD/MM/YY	Introduction to Privacy-Preserving Federated Learning and Federated Transfer Learning (FTL)	UNIT-3	9
DD/MM/YY	Secure Aggregation, Differential Privacy, Homomorphic Encryption, Secure Multi-Party Computation		
DD/MM/YY	Federated Transfer Learning (FTL): Framework, Architecture, Training Process, Prediction Process		
DD/MM/YY	Security Threats: Model Poisoning, Data Poisoning, Backdoor Attacks, Byzantine Attacks		
DD/MM/YY	Defense Mechanisms, Adversarial Clients, Security Analysis in Federated Learning		
DD/MM/YY	Personalized Federated Learning, Meta-Learning, Transfer Learning, Multi-task Federated Learning		
DD/MM/YY	Fairness, Trust-aware Collaborative Learning, Secure AI Systems		
DD/MM/YY	Hands-on: Implementing Privacy-Preserving Federated Learning using PySyft and TensorFlow Privacy		
DD/MM/YY	Hands-on: Simulating Security Attacks and Evaluating Defense Mechanisms		
DD/MM/YY	Federated Learning for Edge Computing and Edge AI	UNIT-4	9
DD/MM/YY	Federated Learning Applications in Mobile Devices, IoT Systems, Smart Healthcare, Smart Manufacturing		
DD/MM/YY	Federated Learning for Autonomous Vehicles and Industrial Automation		
DD/MM/YY	Resource-Constrained Federated Learning, Edge Intelligence, Energy-aware Optimization		
DD/MM/YY	Communication-Efficient Training, Device Heterogeneity, Fault Tolerance		
DD/MM/YY	Scalable Federated Learning Systems, Network Latency, Distributed Deployment		
DD/MM/YY	Docker, Kubernetes, TensorFlow Lite, FedML for Production Deployment		
DD/MM/YY	Hands-on: Developing Federated Learning Applications using FedML and Edge Simulation		
DD/MM/YY	Hands-on: Scalability, Latency, Communication Efficiency, and Deployment Analysis		
DD/MM/YY	Advanced Federated Learning Concepts and Future Research	UNIT-5	9
DD/MM/YY	Hierarchical Federated Learning, Blockchain-enabled Federated Learning		
DD/MM/YY	Federated Reinforcement Learning and Federated Transfer Learning		
DD/MM/YY	Performance Evaluation Metrics: Accuracy, Precision, Recall, F1-score, Robustness, Scalability		
DD/MM/YY	Communication Efficiency, Privacy Guarantees, Energy Efficiency, and Green Federated Learning		
DD/MM/YY	Federated Foundation Models, Explainable Federated AI (XAI), Trustworthy AI		

DD/MM/YY	Open Research Challenges and Emerging Trends in Federated Learning		
DD/MM/YY	Hands-on: Benchmarking Federated Learning Frameworks using MLflow and Weights & Biases (W&B)		
DD/MM/YY	Mini Project Demonstration, Case Studies, Course Review, and Outcome Assessment		

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	Installation and Configuration of Python, Jupyter Notebook, Google Colab, TensorFlow Federated (TFF), and Flower (FLWR) Environment	CO7	3.0
		Implementation of Basic Federated Learning Client–Server Architecture using TensorFlow Federated (TFF)		
W2	S-2	Implementation of Federated Averaging (FedAvg) Algorithm for Distributed Model Training	CO7	3.0
		Comparative Study of Centralized Machine Learning and Federated Learning using Simulated Clients		
W3	S-3	Implementation of Horizontal Federated Learning (HFL) and Performance Analysis	CO7	3.0
		Implementation of Federated Optimization Algorithms (FedProx/FedNova) for Client Heterogeneity		
W4	S-4	Analysis of Non-IID Data Distribution and Communication Efficiency in Federated Learning	CO7	3.0
		Model Compression, Gradient Sparsification, and Communication-Efficient Federated Learning		
W5	S-5	Implementation of Secure Aggregation and Differential Privacy using TensorFlow Privacy/PySyft	CO7	3.0
		Simulation of Model Poisoning, Data Poisoning, and Byzantine Attacks with Defense Mechanisms		
W6	S-6	Personalized Federated Learning using Transfer Learning and Client-Specific Models	CO7	3.0
		Federated Learning Implementation using Flower (FLWR) Framework and Multi-Client Simulation		
W7	S-7	Development of Federated Learning Applications for IoT and Edge Computing using FedML	CO7	3.0
		Deployment of Federated Learning Models using Docker, Kubernetes, and Simulated Edge Devices		
W8	S-8	Mini Project: Performance Evaluation of Federated Learning Models using Accuracy, Precision, Recall, F1-Score, Communication Cost, Privacy, and Scalability Metrics with Presentation	CO8/CO9	3.0
		Installation and Configuration of Python, Jupyter Notebook, Google Colab, TensorFlow Federated (TFF), and Flower (FLWR) Environment		
W9	S-9	Implementation of Basic Federated Learning Client–Server Architecture using TensorFlow Federated (TFF)	CO8/CO10	3.0

		Implementation of Federated Averaging (FedAvg) Algorithm for Distributed Model Training		
W10	S-10	Comparative Study of Centralized Machine Learning and Federated Learning using Simulated Clients	CO9/CO10	3.0
		Implementation of Horizontal Federated Learning (HFL) and Performance Analysis		
W11	S-11	Implementation of Federated Optimization Algorithms (FedProx/FedNova) for Client Heterogeneity	CO7	3.0
		Analysis of Non-IID Data Distribution and Communication Efficiency in Federated Learning		
W12	S-12	Model Compression, Gradient Sparsification, and Communication-Efficient Federated Learning	CO7	3.0
		Implementation of Secure Aggregation and Differential Privacy using TensorFlow Privacy/PySyft		
W13	S-13	Simulation of Model Poisoning, Data Poisoning, and Byzantine Attacks with Defense Mechanisms	CO8	3.0
		Personalized Federated Learning using Transfer Learning and Client-Specific Models		
W14	S-14	Federated Learning Implementation using Flower (FLWR) Framework and Multi-Client Simulation	CO8/CO9	3.0
		Development of Federated Learning Applications for IoT and Edge Computing using FedML		
W15	S-15	Deployment of Federated Learning Models using Docker, Kubernetes, and Simulated Edge Devices	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	**Factual Recall & Conceptual Understanding**	Recall fundamental concepts, terminology, architecture, workflow, types (HFL, VFL, FTL), applications, and basic principles of Federated Learning.	CO1 | L1–L2	MTE Sec A | ETE Sec A

TS2	**Conceptual Explanation & Interpretation**	Explain Federated Learning architecture, client–server communication, model aggregation, Federated Averaging (FedAvg), optimization techniques, and privacy-preserving mechanisms.	CO2 | L2	MTE Sec A | ETE Sec A
TS3	**Procedural Application & Implementation**	Apply Federated Learning algorithms and frameworks (TFF, Flower, FedML) to develop distributed machine learning models and implement privacy-preserving collaborative training.	CO3 | L3	MTE Sec B | ETE Sec B
TS4	**Analytical Reasoning & Performance Analysis**	Analyze Federated Learning systems with respect to Non-IID data, client heterogeneity, communication overhead, convergence, scalability, and security threats.	CO4 | L4	MTE Sec B | ETE Sec B
TS5	**Evaluation & Optimization**	Evaluate Federated Learning algorithms, optimization strategies, privacy techniques, communication-efficient methods, and compare their trade-offs in terms of accuracy, privacy, robustness, and scalability.	CO5 | L5	ETE Sec B/C
TS6	**Design & Innovation**	Design secure, scalable, communication-efficient Federated Learning solutions for healthcare, finance, IoT, edge computing, and other real-world AI applications using appropriate frameworks and deployment strategies.	CO5 | 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, Federated Learning concepts, architecture identification, algorithm and privacy mechanism explanation
Sec B	**6**	TS3 — Procedural Application TS4 — Analytical Reasoning	CO3, CO4	Algorithm implementation, Federated Learning workflow analysis, model performance evaluation, error identification, and system behavior analysis
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 identification, objectives, dataset/client selection, evaluation metrics, and success criteria.**CA2:** Experimental design, Federated Learning architecture, framework selection (TFF/Flower/FedML), and client-server configuration.**CA7:** Algorithm selection, workflow design, and implementation strategy.	1.0: Well-defined with design | 0.5: Partial | 0: Missing	CO7, CO8
Code Execution & Computational Efficiency	**1.0**	**CA3:** Correct implementation of Federated Learning algorithms (FedAvg, FedProx, etc.), successful execution, debugging, and output validation.**CA4:** Analysis of communication efficiency, convergence, resource utilization, scalability, and optimization techniques.	1.0: Correct & efficient | 0.5: Correct, not optimized | 0: Fails	CO7

Output Analysis, Outcome & Lab Documentation	**0.75**	**CA5:** Analysis and interpretation of experimental results using accuracy, precision, recall, F1-score, communication cost, privacy, and scalability metrics.**CA6:** Validation of outcomes, comparison with expected results, and conclusions.**CA8:** Laboratory record, code documentation, report quality, and viva-voce performance.	0.75: Thorough | 0.5: Adequate | 0.25: Partial | 0: Absent	CO8, CO9
Professional Attitude & Ethical Conduct	**0.25**	Responsible AI practices, privacy preservation, secure handling of distributed data, teamwork, laboratory discipline, ethical computing practices, and professional documentation standards.	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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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 & Experimental Planning**	Define Federated Learning problem, objectives, client-server configuration, datasets, evaluation metrics, privacy requirements, and success criteria.	CO7, CO8
CA2	**Experimental Design & Development Environment**	Design Federated Learning workflow; configure Python, Jupyter Notebook, TensorFlow Federated (TFF), Flower (FLWR), FedML, and PyTorch environments.	CO7
CA3	**Model Implementation & Execution**	Implement Federated Learning algorithms (FedAvg, FedProx, FedNova, SCAFFOLD); perform client training, model aggregation, debugging, and validate outputs.	CO7
CA4	**Computational Efficiency & Optimization**	Analyze communication overhead, convergence rate, client heterogeneity, resource utilization, scalability, and apply optimization techniques.	CO7
CA5	**Result Analysis & Performance Evaluation**	Evaluate model performance using Accuracy, Precision, Recall, F1-score, Communication Cost, Privacy, Robustness, Scalability, and Energy Efficiency metrics.	CO8
CA6	**Documentation & Experimental Verification**	Maintain laboratory records; document implementation, observations, results, comparisons, and verify outcomes against objectives.	CO7, CO8
CA7	**Algorithm Design & Solution Development**	Design Federated Learning workflow, architecture diagrams, algorithms, pseudocode, deployment strategy, and justify model selection.	CO7, CO8
CA8	**Professional Practice, Viva-Voce & Ethics**	Demonstrate conceptual understanding, responsible AI practices, privacy awareness, teamwork, professional documentation, and effective technical presentation.	CO7, CO9

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

ID	Dimension	What is Measured	Lab CO / PO Anchor
P1	**SDG Alignment & Social Impact**	Align the Federated Learning project with Sustainable Development Goals (SDGs); explain societal impact, privacy preservation, and responsible AI benefits.	CO8 | PO6
P2	**Problem Identification & Requirements Analysis**	Define project objectives, distributed learning requirements, client architecture, datasets, privacy constraints, and measurable success criteria.	CO8 | PO2
P3	**Project Planning & Communication Strategy**	Prepare project schedule, communication workflow, client coordination strategy, testing plan, and risk management approach.	CO10 | PO9
P4	**Innovative Solution Design**	Design an innovative Federated Learning solution; justify algorithm selection, aggregation strategy, optimization method, and privacy mechanism.	CO8 | PO3
P5	**Professional Development Toolchain**	Select and configure appropriate development tools including TensorFlow Federated, Flower, FedML, PySyft, Docker, Kubernetes, MLflow, and Git.	CO7 | PO5
P6	**End-to-End System Implementation**	Develop a complete Federated Learning application integrating client training, model aggregation, privacy preservation, deployment, and monitoring.	CO7, CO8 | PO3
P7	**System Deployment & Testing**	Deploy Federated Learning models; perform functional testing, scalability analysis, communication efficiency evaluation, and security testing.	CO7, CO8 | PO5

P8	**Performance Evaluation & Outcome Measurement**	Evaluate project using Accuracy, Precision, Recall, F1-score, Communication Cost, Scalability, Privacy Guarantees, and Robustness metrics.	CO8 | PO6
P9	**Security, Privacy & Ethical AI**	Implement privacy-preserving mechanisms, secure aggregation, differential privacy, and ensure ethical use of distributed data.	CO8, CO10 | PO2, PO4
P10	**Project Documentation & Technical Reporting**	Prepare professional project report including architecture, methodology, implementation, results, references, and future scope.	CO10 | PO8, PO9
P11	**Teamwork & Leadership**	Demonstrate effective collaboration, task allocation, leadership, communication, and conflict resolution during project execution.	CO10 | PO10
P12	**Innovation & Research Orientation**	Explore emerging Federated Learning technologies, compare research papers, propose novel improvements, and identify future research opportunities.	CO9 | PO11
P13	**Project Demonstration & Technical Presentation**	Present the complete Federated Learning solution through demonstration, viva-voce, technical presentation, and defense of design decisions.	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	–	–	–	–	–	1	2	1	–
CO2	3	2	–	1	2	–	1	–	–	–	2	2	2	–
CO3	3	3	2	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**	**1.8**	**2.33**	**1.8**	**3**	**2.5**	**2**	**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 advanced knowledge of distributed artificial intelligence, privacy-preserving machine learning, and practical Federated Learning skills; promotes continuous learning and research-oriented capabilities (CO1–CO6, CO9).
SDG 8	Decent Work & Economic Growth	**3 (High)**	Develops industry-relevant skills in Federated Learning frameworks, AI model development, edge computing, and professional implementation practices applicable to emerging AI careers (CO7, CO8).
SDG 9	Industry, Innovation & Infrastructure	**3 (High)**	Enables design and development of scalable, secure, and innovative Federated Learning solutions for healthcare, IoT, finance, and intelligent infrastructure systems (CO6, CO8, CO10).
SDG 12	Responsible Consumption & Production	**2 (Moderate)**	Promotes efficient utilization of computational resources through communication-efficient learning, model optimization, privacy-aware AI practices, and sustainable distributed computing approaches (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, and fundamental principles of Federated Learning	**A1 — Receiving:** Awareness and willingness to learn concepts of privacy-preserving distributed learning	**P1 — Perception:** Sensory cues guide identification of Federated Learning tools, frameworks, and system components
L2 — Understand: Explain ideas, concepts, principles, architectures, algorithms, and workflows of Federated Learning	**A2 — Responding:** Active participation and reaction during Federated Learning discussions, experiments, and collaborative activities	**P2 — Set:** Mental and physical readiness to configure environments and perform Federated Learning tasks
L3 — Apply: Use knowledge to implement Federated Learning models, algorithms, and practical AI solutions	**A3 — Valuing:** Showing commitment toward data privacy, security, ethical AI, and responsible model development	**P3 — Guided Response:** Basic practice through guided implementation of Federated Learning models and frameworks
L4 — Analyze: Break down information, examine patterns, and analyze performance, security, and communication challenges	**A4 — Organizing:** Integrating privacy, security, and ethical values into Federated Learning system design	**P4 — Mechanism:** Habitual correct performance in training, evaluating, and optimizing Federated Learning systems
L5 — Evaluate: Judge, justify, assess, and make decisions about algorithms, optimization methods, privacy techniques, and deployment strategies	**A5 — Characterizing:** Internalized value system promoting trustworthy AI, ethical data usage, and professional practices	**P5 — Complex Overt Response:** Skilled performance in developing complete Federated Learning applications and deployment solutions

L6 — Create: Design, develop, and produce new Federated Learning architectures, algorithms, and innovative AI solutions		**P6 — Adaptation:** Modify Federated Learning approaches for different datasets, devices, domains, and application requirements

★ *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

CSMA2301 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

AI Driven Devops (CSMA3300)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–27
Branch:	CS & ME	**Semester:**	V
Couse Code	CSMA3300	**Course type**	Core – Integrated

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**	CSMA3300
2	**Course Title**	**AI Driven Devops**

3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-3
5	**Course Status**	Core
6	**Course Objective**	To introduce the fundamentals of AI-driven DevOps practices for developing, deploying, and managing intelligent healthcare applications by integrating Artificial Intelligence, Continuous Integration/Continuous Deployment (CI/CD), cloud computing, containerization, and MLOps; and to develop practical skills in automating healthcare software delivery, ensuring security, scalability, regulatory compliance, ethical AI practices, and collaborative DevOps workflows for modern medical systems.
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Remember – L1): Recall and describe the fundamental concepts of DevOps, Artificial Intelligence, Software Development Life Cycle (SDLC), Continuous Integration/Continuous Deployment (CI/CD), cloud computing, containerization, healthcare information systems, Electronic Health Records (EHR), and healthcare interoperability standards (HL7, FHIR). CO2 (Understand – L2): Explain AI-driven DevOps workflows, DevSecOps principles, Infrastructure as Code (IaC), container orchestration, MLOps pipelines, cloud-native healthcare architectures, and security requirements for medical software deployment. CO3 (Apply – L3): Apply DevOps tools and AI technologies to automate the development, testing, deployment, and monitoring of healthcare applications using Git, Jenkins, Docker, Kubernetes, cloud platforms, and MLOps frameworks. CO4 (Analyze – L4): Analyze and troubleshoot AI-driven DevOps pipelines by identifying deployment failures, infrastructure issues, model performance degradation, security vulnerabilities, scalability bottlenecks, and operational challenges in healthcare environments. CO5 (Evaluate – L5):): Evaluate the performance, reliability, scalability, security, and compliance of AI-enabled healthcare systems using DevOps metrics, monitoring tools, healthcare regulations (HIPAA, GDPR), and DevOps best practices to ensure continuous service quality. CO6 (Create – L6): Design, implement, and demonstrate end-to-end AI-driven DevOps solutions by integrating CI/CD pipelines, cloud infrastructure, containerized microservices, automated testing, MLOps workflows, monitoring systems, and secure deployment architectures for real-world healthcare applications. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Implement AI-driven DevOps workflows using professional tools and platforms such as Git, GitHub, Jenkins, Docker, Kubernetes, Terraform, Ansible, MLflow, Prometheus, Grafana, and cloud services; configure automated deployment pipelines and maintain reproducible DevOps environments for healthcare applications. CO8 (Create – L5/L6): Design, develop, and deploy scalable AI-enabled healthcare applications using cloud-native architectures, containerized microservices, CI/CD automation, and MLOps pipelines to address real-world clinical and healthcare operational challenges. CO9 (Apply – L2/L3): Demonstrate professional, ethical, and secure DevOps practices by implementing DevSecOps principles, healthcare data privacy, regulatory compliance (HIPAA, GDPR), infrastructure security, continuous monitoring, and responsible AI deployment throughout the software lifecycle. CO10 (Apply – L3): Collaborate effectively in interdisciplinary teams to plan, develop, deploy, monitor, and present AI-driven healthcare solutions using Agile and DevOps methodologies while applying software project management, documentation, communication, and continuous improvement 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. 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**	4. *Textbook:* Textbook: Topol, E. — *Deep Medicine: How Artificial*

Intelligence Can Make Healthcare Human Again, Basic Books.

5. *Reference:* Zhou, S.K., Greenspan, H., Shen, D. — *Deep Learning for Medical Image Analysis*, Academic Press.
6. *Reference:* Shortliffe, E.H., Cimino, J.J. — *Biomedical Informatics: Computer Applications in Health Care and Biomedicine* (5th Ed.), Springer.

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 DevOps, AI in Healthcare, Software Development Life Cycle (SDLC), DevOps Lifecycle, Healthcare Information Systems (HIS), Electronic Health Records (EHR), and Clinical Information Systems.	CO1, CO2, CO3
B	Continuous Integration (CI), Continuous Deployment (CD), Version Control using Git, Healthcare Interoperability Standards (HL7, FHIR), and Cloud Computing Fundamentals.	
C	Healthcare Data Security, DevSecOps Principles, HIPAA, GDPR, Medical Data Privacy, Ethical AI, and Regulatory Compliance in Healthcare Software.	
Tools Used	Git, GitHub, Linux, VS Code, Docker Desktop, FHIR Sandbox APIs	
Activities	**Objective:** TTo familiarize students with DevOps fundamentals, Linux environment, Git-based version control, and AI-enabled healthcare software development workflows. • Configure Git repositories for healthcare projects. • Build a simple CI workflow using GitHub Actions. • Implement secure version control for Electronic Health Record (EHR) applications.	
Unit 2	**Control Statements (6-0-12-6 = 24 hrs)**	
A	Continuous Integration and Continuous Deployment (CI/CD), Jenkins Pipelines, Automated Software Testing, Build Automation, and Healthcare Application Delivery.	CO3, CO4
B	Infrastructure as Code (IaC), Terraform, Ansible, Configuration Management, Infrastructure Automation, and Cloud Resource Provisioning.	
C	Continuous Monitoring, Logging, Automated Rollback Strategies, and High Availability in Healthcare Systems.	
Tools Used	Jenkins, GitHub Actions, Terraform, Ansible, Maven, SonarQube	
Activities	Objective: To automate software development, testing, and deployment processes using DevOps tools. • Develop CI/CD pipelines for Hospital Management Systems. • Automate cloud infrastructure provisioning using Terraform. • Configure automated testing and deployment workflows for telemedicine applications.	

Unit 3	**Functions & Arrays (8-0-16-6 = 30 hrs)**	
A	Cloud Computing Fundamentals, Healthcare Cloud Platforms, AWS, Azure, Google Cloud, Cloud-native Healthcare Applications.	CO2, CO3, CO4, CO5, CO6
B	Docker Containers, Kubernetes, Container Orchestration, Microservices Architecture, Healthcare API Management.	
C	IDeployment of Electronic Health Record (EHR) Systems, Telemedicine Platforms, Medical IoT Applications, and Cloud-based Patient Monitoring Systems.	
Tools Used	**Tools Used:** Docker, Kubernetes, AWS, Azure, Google Cloud Platform, Helm.	
Activities	**Objective:** To understand cloud deployment and container orchestration for healthcare applications. • Dockerize Hospital Management Systems. • Deploy EHR applications on Kubernetes. • Configure scalable cloud infrastructure for remote patient monitoring.	
Unit 4	**Pointers & Strings (6-0-12-6 = 24 hrs)**	
A	Machine Learning Operations (MLOps), AI Operations (AIOps), Model Lifecycle Management, Model Deployment, Continuous Training, and Continuous Monitoring.	CO3, CO4, CO5
B	Explainable AI (XAI), Clinical Decision Support Systems (CDSS), Medical Image AI Deployment, Predictive Healthcare Analytics, and AI Model Governance.	
C	Model Drift Detection, Performance Monitoring, Alerting Systems, Automated Retraining, and Healthcare AI Validation.	
Tools Used	**Tools Used:** PMLflow, Kubeflow, Prometheus, Grafana, TensorFlow Serving, Python.	
Activities	• **Objective:** To deploy, monitor, and maintain AI models in production healthcare environments. • Deploy disease prediction models using MLflow. • Monitor AI models using Prometheus and Grafana. • Configure automated retraining pipelines for healthcare AI applications.	
Unit 5	**User-Defined Data Types & File Handling (6-0-10-6 = 22 hrs)**	
A	DevSecOps, Secure Software Development Lifecycle (SSDLC), Vulnerability Assessment, Penetration Testing, Healthcare Cybersecurity, and Identity & Access Management (IAM).	CO2, CO3, CO4, CO5, CO6
B	Healthcare Compliance Standards, HIPAA, GDPR, FHIR Security, Medical Device Security, Ethical AI, Responsible AI, and Risk Management.	
C	Smart Hospitals, Internet of Medical Things (IoMT), Edge AI, Digital Twins, Generative AI, Continuous Deployment Monitoring, Incident Management, and Disaster Recovery Planning.	
Tools Used	**Tools Used:** OWASP ZAP, Trivy, SonarQube, Prometheus, Grafana, ELK Stack, Kubernetes Security Tools.	
Activities	**Objective:** To implement secure AI-driven DevOps practices and continuous monitoring for healthcare systems.	

	• Perform vulnerability assessment on healthcare applications. • Configure DevSecOps pipelines for secure deployment. • Monitor cloud-based healthcare services and evaluate system performance, compliance, and security.	

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/Title	UNIT	Total Lectures
DD/MM/YY	IIntroduction to AI-Driven DevOps and Digital Transformation in Healthcare	UNIT-1	9
DD/MM/YY	Healthcare Information Systems (HIS), Electronic Health Records (EHR), and Clinical Information Systems		
DD/MM/YY	Software Development Life Cycle (SDLC) and DevOps Lifecycle		
DD/MM/YY	Artificial Intelligence in Healthcare Applications		
DD/MM/YY	Continuous Integration (CI) and Continuous Deployment (CD) Concepts		
DD/MM/YY	Healthcare Interoperability Standards: HL7 and FHIR		
DD/MM/YY	Healthcare Data Security, HIPAA, GDPR, and Ethical AI		
DD/MM/YY	Git, GitHub, Version Control, and Branch Management		
DD/MM/YY	Hands-on: Creating Git Repositories and CI Workflow for Healthcare Applications		
DD/MM/YY	Introduction to CI/CD Pipelines and DevOps Automation	UNIT-2	9
DD/MM/YY	Jenkins Architecture and Pipeline Development		
DD/MM/YY	Automated Build, Testing, and Deployment Strategies		
DD/MM/YY	Infrastructure as Code (IaC) using Terraform		
DD/MM/YY	Configuration Management using Ansible		
DD/MM/YY	Automated Deployment for Hospital Management Systems		
DD/MM/YY	Continuous Monitoring, Logging, and Alert Management		
DD/MM/YY	High Availability, Backup, and Disaster Recovery in Healthcare Systems		
DD/MM/YY	Hands-on: Building a CI/CD Pipeline for a Healthcare Web Application		
DD/MM/YY	Introduction to Cloud Computing and Cloud-native Healthcare	UNIT-3	9
DD/MM/YY	Cloud Platforms: AWS, Azure, and Google Cloud for Healthcare		
DD/MM/YY	Docker Fundamentals and Containerization		
DD/MM/YY	Docker Compose and Multi-container Applications		

DD/MM/YY	Kubernetes Architecture and Container Orchestration		
DD/MM/YY	Microservices Architecture for Healthcare Applications		
DD/MM/YY	Deploying Electronic Health Record (EHR) Systems on Kubernetes		
DD/MM/YY	Medical IoT and Remote Patient Monitoring using Cloud Platforms		
DD/MM/YY	Hands-on: Deploying a Healthcare Application using Docker and Kubernetes		
DD/MM/YY	IIntroduction to MLOps and AIOps in Healthcare	UNIT-4	9
DD/MM/YY	Machine Learning Lifecycle and Model Versioning		
DD/MM/YY	MLflow and Kubeflow for AI Model Deployment		
DD/MM/YY	Continuous Training, Continuous Deployment, and Continuous Monitoring		
DD/MM/YY	Explainable AI (XAI) for Healthcare Applications		
DD/MM/YY	Clinical Decision Support Systems (CDSS) and Predictive Healthcare		
DD/MM/YY	AI Model Drift Detection and Performance Monitoring		
DD/MM/YY	Monitoring AI Applications using Prometheus and Grafana		
DD/MM/YY	Hands-on: Deploying and Monitoring a Disease Prediction Model using MLflow		
DD/MM/YY	Introduction to DevSecOps and Secure Healthcare Software Development	UNIT-5	9
DD/MM/YY	Secure Software Development Lifecycle (SSDLC) and DevSecOps Principles		
DD/MM/YY	Healthcare Cybersecurity, Identity and Access Management (IAM)		
DD/MM/YY	Vulnerability Assessment, Container Security, and Penetration Testing		
DD/MM/YY	Compliance Standards: HIPAA, GDPR, and Healthcare Risk Management		
DD/MM/YY	Smart Hospitals, Internet of Medical Things (IoMT), and Edge AI		
DD/MM/YY	Digital Twins, Generative AI, and Future Trends in Healthcare DevOps		
DD/MM/YY	Incident Management, Disaster Recovery, and Business Continuity Planning		
DD/MM/YY	Hands-on: Implementing a Secure AI-Driven DevOps Pipeline for a Healthcare Application		

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	Installation and Configuration of Linux, Git, GitHub, and DevOps Development Environment	CO7	3.0
W2	S-2	Version Control using Git and GitHub for Healthcare Application Source Code Management	CO7	3.0
W3	S-3	Building Continuous Integration (CI) Pipelines using Jenkins for Healthcare Applications	CO7	3.0
W4	S-4	Continuous Deployment (CD) using GitHub Actions and Jenkins Pipelines	CO7	3.0
W5	S-5	Containerization of a Hospital Management System using Docker	CO7	3.0
W6	S-6	Infrastructure as Code (IaC) using Terraform and Configuration Management using Ansible	CO7	3.0
W7	S-7	Deploying Healthcare Applications on Kubernetes Cluster	CO7	3.0
W8	S-8	Cloud Deployment of Electronic Health Record (EHR) Application on AWS/Azure/GCP	CO8/CO9	3.0
W9	S-9	AI Model Deployment using MLflow/Kubeflow for Disease Prediction Applications	CO8/CO10	3.0
W10	S-10	Continuous Monitoring and Logging using Prometheus and Grafana for Healthcare Services.	CO9/CO10	3.0
W11	S-11	DevSecOps Implementation: Vulnerability Assessment using SonarQube and Trivy	CO7	3.0
W12	S-12	Secure CI/CD Pipeline Implementation with Automated Testing and Container Security	CO7	3.0
W13	S-13	Design and Deployment of a Cloud-native Telemedicine Application using Docker and Kubernetes	CO8	3.0
W14	S-14	Implementation of Secure AI-Driven DevOps Pipeline for a Smart Hospital Application (HIPAA/GDPR Compliance)	CO8/CO9	3.0
W15	S-15	Capstone Mini Project: End-to-End AI-Driven DevOps Pipeline for Healthcare Application (CI/CD, MLOps, DevSecOps, Monitoring & Team Presentation)	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	**Factual Recall & Conceptual Recognition**	Recall and identify the fundamental concepts of AI-Driven DevOps, DevOps lifecycle, Software Development Life Cycle (SDLC), healthcare information systems, Electronic Health Records (EHR), cloud computing, CI/CD, and healthcare interoperability standards (HL7, FHIR).	CO1 | L1–L2	MTE Sec A | ETE Sec A
TS2	**Conceptual Explanation & Logical Interpretation**	Explain DevOps workflows, CI/CD pipelines, DevSecOps principles, Infrastructure as Code (IaC), containerization, cloud-native healthcare architectures, MLOps concepts, and healthcare security and compliance requirements.	CO2 | L2	MTE Sec A | ETE Sec A
TS3	**Procedural Application & Problem Solving**	Apply AI-driven DevOps tools and technologies to automate software development, testing, deployment, cloud provisioning, container orchestration, and AI model deployment for healthcare applications.	CO3 | L3	MTE Sec B | ETE Sec B
TS4	**Analytical Reasoning & Program Tracing**	Analyze DevOps pipelines, identify deployment failures, infrastructure issues, security vulnerabilities, performance bottlenecks, AI model drift, monitoring logs, and operational challenges in healthcare environments.	CO4 | L4	MTE Sec B | ETE Sec B
TS5	**Comparative Evaluation & Algorithmic Justification**	Evaluate the reliability, scalability, security, monitoring strategies, DevSecOps practices, cloud resource utilization, healthcare compliance (HIPAA/GDPR), and AI model performance using appropriate DevOps and operational metrics.	CO5 | L5	ETE Sec B/C
TS6	**Synthesis & Holistic Design**	Design and develop end-to-end AI-Driven DevOps solutions by integrating CI/CD pipelines, cloud infrastructure, Docker, Kubernetes, Infrastructure as Code, MLOps, monitoring systems, and secure deployment architectures for real-world healthcare 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	**CO1, CO2**	Short-answer: definitions, output prediction, syntax

		TS2 — Conceptual Explanation		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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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																					
CO7							H	H	H	M	M	M	H	H	M	M	M	H	H	H	M	M	H	M		H	H
CO8							M	M	H	H	H	M	H	H	H	H	M	H	H	H	H	H	M	H	M	H	M
CO9							M		M		H	H		H	H		H		M	M	H	H	H			H	H
CO10							M	M	H		M	H		H		H	H	H	M	H	H	M	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)

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	–	–	–	–	–	1	–	2	2	2	–
CO3	3	3	2	–	3	2	–	–	1	–	2	3	2	2
CO4	2	3	2	2	2	2	–	–	–	–	2	2	3	2
CO5	2	3	3	2	3	2	1	–	–	–	2	2	3	3
CO6	2	2	3	3	3	2	1	2	1	1	3	3	3	3
CO7	–	–	2	–	3	2	–	–	–	–	–	2	3	3
CO8	–	1	3	2	3	3	–	1	–	–	–	2	3	3
CO9	–	–	–	–	2	2	3	–	1	–	3	–	2	2
CO10	–	–	1	–	2	2	–	3	3	3	2	2	2	3
Avg	**2.50**	**2.14**	**2.13**	**2.25**	**2.63**	**2.13**	**1.67**	**2.00**	**1.33**	**2.00**	**2.13**	**2.22**	**2.50**	**2.57**

★ *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
CO3	H	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	H

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 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

★ *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

CSMA3300 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

RAG and Agentic AI (CSMA3301)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | Semester VI | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–27
Branch:	CS & ME	**Semester:**	VI
Course Code:	CSMA3301	**Course Type:**	Core – Integrated

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**	CSMA3301
2	**Course Title**	RAG and Agentic AI
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-3
5	**Course Status**	Core
6	**Course Objective**	This course introduces Retrieval-Augmented Generation (RAG) and Agentic AI technologies for developing intelligent healthcare applications. Students will learn to build AI systems that retrieve medical knowledge from trusted sources, reason using Large Language Models (LLMs), interact with external clinical tools, and develop autonomous AI agents for healthcare decision support while ensuring ethics, privacy, security, and responsible AI practices
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Remember – L1): Recall and explain the concepts of Large Language Models (LLMs), Retrieval-Augmented Generation (RAG), and Agentic AI. CO2 (Understand – L2): To understand the fundamentals of Generative AI, Large Language Models (LLMs), Retrieval-Augmented Generation (RAG), and Agentic AI CO3

		(Apply – To explain the architecture, components, and workflow of RAG systems, including embeddings, vector databases, and retrieval techniques. CO4 (Analyze – L4): Integrate APIs, external tools, and memory into AI agents.. CO5 (Evaluate – L5):): Develop real-world AI applications while considering ethical, security, and deployment challenges. CO6 (Create – L6): To apply RAG and Agentic AI techniques to solve real-world problems while considering ethical, security, and deployment aspects.. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Develop intelligent healthcare applications for clinical question answering, EHR analysis, and biomedical information retrieval. CO8 (Create – L5/L6): Design autonomous AI agents capable of reasoning, planning, memory management, and tool integration for healthcare workflows.. CO9 (Apply – L2/L3): Develop and deploy production-ready RAG and Agentic AI solutions for real-world medical engineering and digital healthcare environments.. CO10 (Apply – L3): To design and implement autonomous AI agents capable of reasoning, planning, memory management, and tool usage.
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. 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:* Textbook: Topol, E. — *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, Basic Books. *Reference*: *Introduction to Information Retrieval* – Christopher D. Manning, Prabhakar Raghavan & Hinrich Schütze. *Reference: Fundamentals of Data Engineering: Plan and Build Robust Data Systems by Joe Reis, Matt Housley 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	Foundations of Generative AI **(4-0-10-6 = 20 hrs)**	
A	Introduction to Artificial Intelligence, Machine Learning, and Deep Learning ,Generative AI Fundamentals ,Large Language Models (LLMs)	CO1, CO2
B	Transformer Architecture ,Medical AI Applications ,Clinical Decision Support Systems (CDSS) ,Medical Data Sources .	
C	Electronic Health Records (EHR) ,Medical Terminologies (ICD-10, SNOMED CT, FHIR, HL7) ,Prompt Engineering for Healthcare, Challenges of Hallucinations in Medical AI	
Tools	Python ,Google Colab ,Hugging Face ,OpenAI API ,Jupyter Notebook	

Used		
Activities	• **Objective:** To familiarize students with fundamental concepts of Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Generative AI, and Large Language Models (LLMs). **Medical chatbot using prompts ,Clinical text exploration, Healthcare dataset analysis**.	
Unit 2	Retrieval-Augmented Generation (RAG) for Healthcare **(6-0-12-6 = 24 hrs)**	
A	Introduction to RAG, RAG Architecture ,Medical Knowledge Bases , Medical Literature Retrieval , Clinical Document Processin	CO3, CO4
B	Text Chunking ,Embedding Models , Semantic Search , Vector Databases , Similarity Search	
C	Metadata Filtering ,Hybrid Search , Context Injection , RAG Evaluation , Hallucination Reductio	
Tools Used	**Tools Used:** LlamaIndex, FAISS , ChromaDB	
Activities	**Objective: Understand** the architecture, workflow, and components of **Retrieval-Augmented Generation (RAG)**, including document processing, text chunking, embeddings, semantic search, and vector databases. **Design** practical RAG-based healthcare solutions such as **Medical Research Assistants, Clinical Question Answering Systems, and Hospital Knowledge Chatbots** that support clinical decision-making while ensuring accuracy, transparency, and responsible use of medical information.	
Unit 3	Agentic AI for Healthcare **(8-0-16-6 = 30 hrs)**	
A	Introduction to Agentic AI ,AI Agents ,Autonomous Clinical Agents , Planning, Reasoning	CO3, CO4, CO5, CO6
B	Tool Calling, Function Calling , Multi-Agent Systems , Clinical Workflow Automation	
C	Human-in-the-Loop AI , Medical Recommendation Systems, AI-assisted Diagnosis ,Agent Evaluation	
Tools Used	**Tools Used:** AutoGen, OpenAI Agents SDK	
Activities	**Objective: Understand** the fundamentals of **Agentic AI**, including AI agents, autonomous clinical agents, planning, reasoning, tool calling, function calling, and multi-agent systems for healthcare applications. • **Design** intelligent multi-agent healthcare systems capable of clinical reasoning, medical recommendation, diagnosis support, and coordinated decision-making to improve healthcare delivery and patient outcomes...	
Unit 4	Intelligent Healthcare Applications using RAG and Agents **(6-0-12-6 = 24 hrs)**	
A	Clinical Decision Support, Radiology Report Summarization, Medical Report Generation , EHR Analysis	CO3, CO4, CO5
B	AI for Disease Prediction, Drug Recommendation Systems, Healthcare Workflow Automation ,Telemedicine AI	
C	Medical Image Report Assistance,Integration with APIs, Healthcare Information Systems	
Tools Used	**Tools Used:** FastAPI , Streamlit , Python	

Activities	**Objective: Understand** the applications of **Retrieval-Augmented Generation (RAG)** and **Agentic AI** in intelligent healthcare systems, including clinical decision support, radiology report summarization, medical report generation, and Electronic Health Record (EHR) analysis • **Evaluate** the accuracy, reliability, explainability, and efficiency of AI-assisted healthcare applications while ensuring patient safety, data privacy, and ethical use of AI technologies.	
Unit 5	Deployment, Ethics, Security and Future Trends **(6-0-10-6 = 22 hrs)**	
A	Deploying RAG Applications ,Cloud Deployment ,Docker ,Streamlit Deployment, Guardrails for Medical AI	CO2, CO3, CO4, CO5, CO6
B	Explainable AI (XAI) , AI Safety, Medical Data Privacy, HIPAA and GDPR Overview	
C	Responsible AI, Prompt Injection Attacks , AI Governance, Model Monitoring, Future of Agentic AI in Healthcare.	
Tools Used	**Tools Used:** Python, LangChain, and Hugging Face libraries	
Activities	Objective: To understand **and mitigate** security risks such as **prompt injection attacks**, data leakage, model vulnerabilities, and unauthorized access while ensuring regulatory compliance and patient data protection. **Evaluate** deployed RAG and Agentic AI systems through model monitoring, performance assessment, and continuous improvement, and examine emerging trends and future directions of **Agentic AI in Healthcare**.	

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/Title	UNIT	Total Lectures
DD/MM/YY	Introduction to Artificial Intelligence	UNIT-1	9
DD/MM/YY	Overview of Machine Learning and Deep Learning		
DD/MM/YY	Generative AI Fundamentals, Large Language Models (LLMs)		
DD/MM/YY	Transformer Architecture		
DD/MM/YY	Medical AI Applications, Clinical Decision Support Systems (CDSS)		
DD/MM/YY	Medical Data Sources.		
DD/MM/YY	Electronic Health Records (EHR) , Medical Terminologies (ICD-10, SNOMED CT, FHIR, HL7),		
DD/MM/YY	Prompt Engineering for Healthcare		
DD/MM/YY	Challenges of Hallucinations in Medical AI		
DD/MM/YY	Introduction to RAG, RAG Architecture	UNIT-2	9
DD/MM/YY	Medical Knowledge Bases , Medical Literature Retrieval		

DD/MM/YY	Clinical Document Processin		
DD/MM/YY	Text Chunking ,Embedding Models		
DD/MM/YY	Semantic Search , Vector Databases		
DD/MM/YY	Vector Databases , Similarity Search		
DD/MM/YY	Metadata Filtering, Hybrid Search		
DD/MM/YY	Context Injection, RAG Evaluation		
DD/MM/YY	Hallucination Reduction		
DD/MM/YY	Introduction to Agentic AI		
DD/MM/YY	AI Agents,Autonomous		
DD/MM/YY	Clinical A gents , Planning, Reasoning		
DD/MM/YY	Tool Calling, Function Calling		
DD/MM/YY	Multi-Agent Systems	UNIT-3	9
DD/MM/YY	Clinical Workflow Automation		
DD/MM/YY	Human-in-the-Loop AI		
DD/MM/YY	Medical Recommendation Systems		
DD/MM/YY	AI-assisted Diagnosis ,Agent Evaluation		
DD/MM/YY	Introduction of AI application in health care,Clinical Decision Support		
DD/MM/YY	Radiology Report Summarization,Medical		
DD/MM/YY	Medical Report Generation , EHR Analysis		
DD/MM/YY	Overview of prediction techniques ,AI for Disease Prediction		
DD/MM/YY	Drug Recommendation Systems,	UNIT-4	9
DD/MM/YY	Healthcare Workflow Automation ,Telemedicine AI		
DD/MM/YY	Introduction to Medical Image Reporting		
DD/MM/YY	Medical Imaging Modalities (X-ray, CT, MRI, Ultrasound, PET) Medical Image Report		
DD/MM/YY	Assistance,Integration with APIs, Healthcare Information Systems		
DD/MM/YY	Deploying RAG Applications	UNIT-5	9
DD/MM/YY	Cloud Deployment ,Docker ,Streamlit deployment		

DD/MM/YY	Guardrails for Medical AI		
DD/MM/YY	Explainable AI (XAI), AI Safety		
DD/MM/YY	Medical Data Privacy		
DD/MM/YY	HIPAA (Health Insurance Portability and Accountability Act)		
DD/MM/YY	GDPR (General Data Protection Regulation Overview		
DD/MM/YY	Responsible AI, Prompt Injection Attacks		
DD/MM/YY	AI Governance, Model Monitoring, Future of Agentic AI in Healthcare.		

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	Study and Installation of Generative AI development tools.	**CO7**	3.0
W2	S-2	Create medical prompts for diagnosis support.	**CO7**	3.0
W3	S-3	Generate embeddings from clinical documents	**CO7**	3.0
W4	S-4	Build a vector database using FAISS	**CO7**	3.0
W5	S-5	Build a RAG-based clinical knowledge assistant.	**CO7**	3.0
W6	S-6	Develop a patient triage agent.	**CO7**	3.0
W7	S-7	Build a drug information retrieval agent.	**CO7**	3.0
W8	S-8	Create a multi-agent healthcare workflow.	**CO8/CO9**	3.0
W9	S-9	Develop a clinical report summarization system	**CO8/CO10**	3.0
W10	S-10	Deploy a healthcare AI assistant using Streamlit.	**CO9/CO10**	3.0

W11	S-11	Integrate PubMed literature into a RAG pipeline.	**CO7**	3.0
W12	S-12	).Develop a Multi-Agent System (Planner, Researcher, Writer, Reviewer)	**CO7**	3.0
W13	S-13	Text Chunking and Splitting Strategies for RAG Applications	**CO8**	3.0
W14	S-14	Implement Agent Memory using Buffer Memory and Conversation Summary Memory	**CO8/CO9**	3.0
W15	S-15	End-to-end RAG and Agentic AI solution for healthcare (e.g., clinical decision support, medical research assistant, EHR intelligence, or hospital automation	**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	**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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification 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 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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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

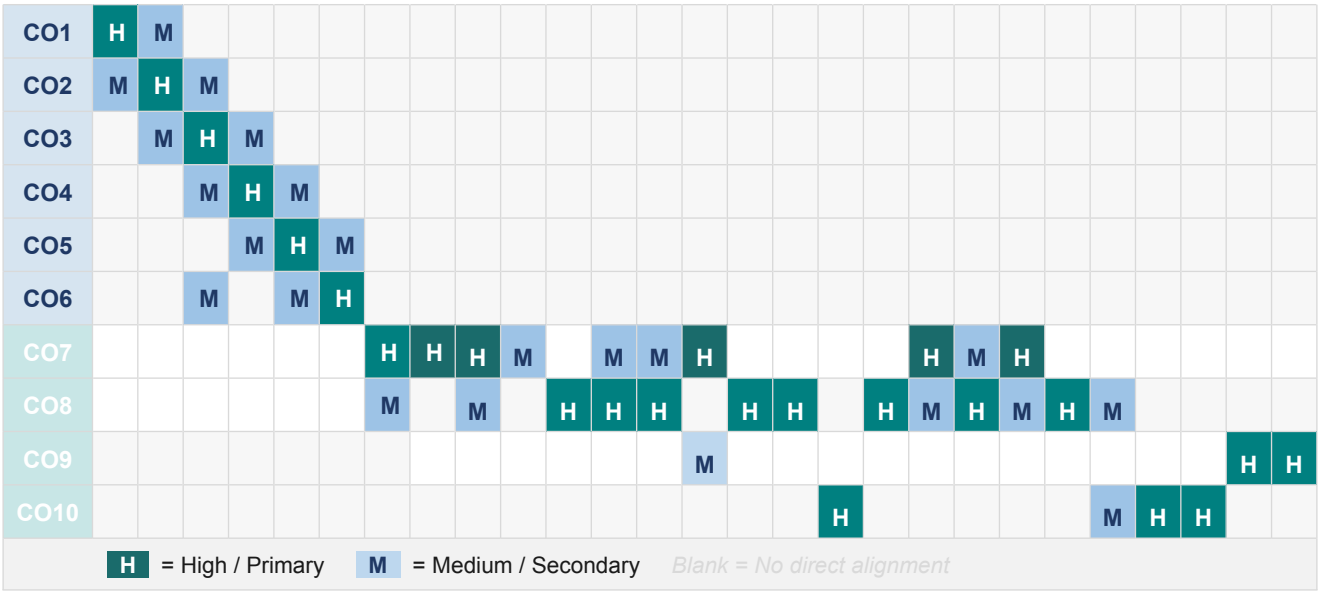
14. CO × Skill Dimensions Mapping (10 COs × [6 Theory+ 8 CA + 13 Project Dimensions])

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	PO7 Ethics	PO8 Teamwork	PO9 Comm.	PO10 Proj.Mgmt	PO11 Lifelong

						& World					
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 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

★ *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

CSMA3301 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 Twins (CSMA4300)

School of Computing Science & Engineering (SSCSE) | B.Tech CS & ME | 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	**Batch:**	2026–2030
Program:	B.Tech	**Current Academic Year:**	2026–27
Branch:	CSE	**Semester:**	VII
Course Code:	CSMA4300	**Course Type:**	Core – Integrated

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**	CSMA4300
2	**Course Title**	**Digital Twins**
3	**Credits**	4
4	**Contact Hours (L-T-P-SL)**	3-0-2-3
5	**Course Status**	Integrated
6	**Course Objective**	Digital Twins is designed to provide students with an understanding of the principles, architecture, and applications of Digital Twin technology. The course enables learners to integrate physical and virtual systems using IoT and real-time data, analyze system performance, support predictive decision-making, and explore Industry 4.0 applications in manufacturing, healthcare, smart cities, and other domains.
7	**Course Outcomes (COs)**	**After successful completion of this course, the student will be able to:** **THEORY COs — Assessed via MTE + ETE:** CO1 (Remember – L1): Explain the fundamental concepts, architecture, lifecycle, enabling technologies, and applications of Digital Twins in Industry 4.0. CO2 (Understand – L2):. Demonstrate the process of data acquisition, communication, connectivity, and digital twin modeling using IoT devices and appropriate communication technologies. CO3 (Apply – L3): Apply simulation techniques and data analytics to monitor, analyze, and optimize the performance of physical systems using Digital Twin models. CO4 (Analyze – L4): Analyze Digital Twin platforms, deployment strategies, interoperability standards, and cybersecurity challenges for secure implementation. CO5 (Evaluate – L5):): Evaluate the applications of Digital Twins across manufacturing, healthcare, smart cities, energy, transportation, and other industrial domains. CO6 (Create – L6): Design and develop basic Digital Twin solutions by integrating sensing, communication, simulation, analytics, and security concepts to address real-world engineering problems. **LAB COs — Assessed via Laboratory Assessment only:** CO7 (Apply – L3): Demonstrate the use of IoT sensors, data acquisition techniques, and communication technologies to collect real-time data for Digital Twin applications. CO8 (Create – L5/L6): Develop basic Digital Twin models using simulation and visualization tools to represent physical systems. CO9 (Apply – L2/L3): Implement data integration, monitoring, and analytics techniques to evaluate the performance of Digital Twin systems CO10 (Apply – L3): Apply Digital Twin platforms and cloud-based tools to design, deploy, and manage Digital Twin applications while considering security and interoperability.
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. NPTEL (IITs)— Fundamentals of IoT, Industry 4.0, AI, Cloud Computing, Data Analytics 2. Coursera: Digital Twins, IoT, AI, Industry 4.0 specialization courses. 3. Arduino Project Hub-IoT sensor interfacing and hardware projects.

11	**References**	1. *Bruno Sergi, Elena G. Popkova, Aleksei V. Bogoviz and Tatiana N. Litvinova, "Understanding Industry 4.0: AI, The internet of things, and the future of work", Emerald publishing limited, 2019.* 2. *Alp Ustundag and Emre Cevikcan, "Industry 0: Managing the Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017.* 3. *Shyam Varan Nath, Pieter van Schalkwyk, Dan Isaacs, "Building Industrial Digital Twins Design, Develop, and Deploy Digital Twin Solutions for Real-world Industries Using Azure Digital Twins", Packt Publishing, , 2021.*

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 Digital Twins (4-0-10-6 = 20 hrs)**	
A	**Introduction to Digital Twins** Evolution of Industrial Revolutions (Industry 1.0 to Industry 5.0), Digital Transformation, Industry 4.0, Definition, Characteristics, Components, Types and Levels of Digital Twins.	CO1
B	**Architecture and Lifecycle** Physical and Virtual Systems, Digital Twin Architecture, Digital Twin Lifecycle, Data Flow and Synchronization, Cyber-Physical Systems (CPS).	
C	**Enabling Technologies and Applications** Internet of Things (IoT), Artificial Intelligence (AI), Cloud Computing, Big Data Analytics, Edge Computing, Applications of Digital Twins in Manufacturing, Healthcare, Smart Cities, Energy, Transportation, Benefits and Challenges.	
Tools Used	(Introduction and Basic Concepts)-Python, Jupyter Notebook, MATLAB/Simulink, Tinkercad, Draw.io/Lucidchart	
Activities	**Objective:** To introduce the fundamental concepts, architecture, lifecycle, enabling technologies, and real-world applications of Digital Twins, enabling students to understand their role in Industry 4.0 and digital transformation.	
Unit 2	**Data Acquisition and Digital Twin Modeling (6-0-12-6 = 24 hrs)**	
A	**A: Data Acquisition** Sensors and Actuators, IoT Devices, Data Collection Methods, Real-Time Data Acquisition, Data Integration	CO2
B	**B: Communication and Connectivity** Communication Protocols, MQTT, OPC UA, REST APIs, Wireless Communication, Cloud Connectivity, Edge Devices.	
C	**C Digital Twin Modeling** 3D Modeling, Simulation Models, Physics-Based Models, Data-Driven Models,	

	Model Validation and Visualization.	
Tools Used	**(IoT Data Collection and Modeling) Arduino IDE, ESP32/NodeMCU, DHT11/DHT22 Sensors, ThingSpeak, MQTT Explorer, Mosquitto MQTT Broker**	
Activities	**Objective:** To develop an understanding of data acquisition methods, IoT communication technologies, and Digital Twin modeling techniques for creating virtual representations of physical systems.	
Unit 3	**Simulation and Analytics (8-0-16-6 = 30 hrs)**	
A	**Simulation Techniques** Introduction to Simulation, Event-Based Simulation, Continuous Simulation, System Dynamics, Scenario Analysis.	CO3
B	**Data Analytics** Data Processing, Machine Learning Basics, Predictive Analytics, Descriptive and Prescriptive Analytics, Data Visualization.	
C	**Monitoring and Optimization** Real-Time Monitoring, Performance Analysis, Predictive Maintenance, Fault Detection, Process Optimization.	
Tools Used	**(Simulation and Data Analysis)- MATLAB/Simulink, Python (NumPy, Pandas, Matplotlib), Node-RED, Grafana**	
Activities	**Objective:** To enable students to perform simulation, visualization, monitoring, and data analytics for evaluating system behavior, predicting failures, and optimizing the performance of Digital Twins.	
Unit 4	**Digital Twin Platforms and Security (6-0-12-6 = 24 hrs)**	
A	**Digital Twin Platforms** Microsoft Azure Digital Twins, AWS IoT TwinMaker, Siemens Digital Twin, PTC ThingWorx, Open-Source Digital Twin Platforms.	CO4
B	**Security and Privacy** Cybersecurity Challenges, Data Privacy, Authentication, Authorization, Secure Data Communication, Risk Management.	
C	**Integration and Deployment** Cloud-Based Deployment, Edge Deployment, System Integration, Scalability, Interoperability, Standards for Digital Twins.	
Tools Used	**Tools Used** (Cloud Platforms and Security) Microsoft Azure Digital Twins, AWS IoT TwinMaker (Demo), Eclipse Ditto, Node-RED, Wireshark	
Activities	**Objective:** To familiarize students with Digital Twin development platforms, cloud deployment, interoperability standards, and cybersecurity practices for secure and scalable Digital Twin implementation.	
Unit 5	**Applications and Future Trends (6-0-10-6 = 22 hrs)**	
A	**Industrial Applications** Digital Twins in Smart Manufacturing, Aerospace, Automotive, Supply Chain, Oil and Gas, Energy Management.	CO5, CO6

B	**Emerging Applications** Healthcare and Personalized Medicine, Smart Cities, Agriculture, Construction, Education, Environmental Monitoring.	
C	**Future Scope and Case Studies** Digital Twins and Industry 5.0, AI-Driven Digital Twins, Sustainable Digital Twins, Challenges and Future Research, Industrial Case Studies and Best Practices.	
Tools Used	**Tools Used:** (Digital Twin Development) Python, Node-RED, ThingSpeak, Azure Digital Twins/Eclipse Ditto, Arduino/ESP32, Grafana	
Activities	**Objective:** To provide practical knowledge of Digital Twin applications across various industrial sectors and enable students to design and implement basic Digital Twin solutions for real-world engineering problems while understanding future research trends.	

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/Title	UNIT	Total Lectures
DD/MM/YY	Introduction to Digital Twins	UNIT-1	9
DD/MM/YY	Fundamentals of Digital Twins		
DD/MM/YY	Components and Types of Digital Twins		
DD/MM/YY	Digital Twin Architecture		
DD/MM/YY	Digital Twin Lifecycle		
DD/MM/YY	Cyber-Physical Systems and Enabling Technologies		
DD/MM/YY	Cloud, Edge Computing and Data Synchronization		
DD/MM/YY	Applications of Digital Twins		
DD/MM/YY	Benefits, Challenges and Future Trends		
DD/MM/YY	Introduction to Data Acquisition and IoT Devices	UNIT-2	9
DD/MM/YY	Sensors and Actuators, Data Collection Techniques		
DD/MM/YY	Real-Time Data Acquisition and Data Integration		
DD/MM/YY	Communication Technologies for Digital Twins		

DD/MM/YY	MQTT, OPC UA, REST APIs, Wireless Communication		
DD/MM/YY	Cloud Connectivity and Edge Devices		
DD/MM/YY	Introduction to Digital Twin Modeling		
DD/MM/YY	3D Modeling, Physics-Based and Data-Driven Models		
DD/MM/YY	Model Validation, Visualization and Unit Revision		
DD/MM/YY	Introduction to Simulation and Simulation Models	UNIT-3	9
DD/MM/YY	Event-Based Simulation and Continuous Simulation		
DD/MM/YY	System Dynamics and Scenario Analysis		
DD/MM/YY	Introduction to Data Analytics		
DD/MM/YY	Data Processing and Data Visualization		
DD/MM/YY	Machine Learning Basics for Digital Twins		
DD/MM/YY	Predictive, Descriptive and Prescriptive Analytics		
DD/MM/YY	Real-Time Monitoring, Fault Detection and Predictive Maintenance		
DD/MM/YY			

	Process Optimization, Industrial Examples and Unit Revision		
DD/MM/YY	Introduction to Digital Twin Platforms	UNIT-4	9
DD/MM/YY	Microsoft Azure Digital Twins		
DD/MM/YY	AWS IoT TwinMaker, Siemens Digital Twin, Eclipse Ditto		
DD/MM/YY	Cybersecurity Fundamentals for Digital Twins		
DD/MM/YY	Authentication, Authorization and Data Privacy		
DD/MM/YY	Secure Communication and Risk Management		
DD/MM/YY	Cloud-Based and Edge Deployment		
DD/MM/YY	System Integration, Scalability and Interoperability		
DD/MM/YY	Standards, Best Practices and Unit Revision		
DD/MM/YY	Digital Twins in Smart Manufacturing	UNIT-5	9
DD/MM/YY	Applications in Aerospace, Automotive and Supply Chain		
DD/MM/YY	Applications in Energy and Oil & Gas Industries		
DD/MM/YY	Digital Twins in Healthcare and Personalized Medicine		
DD/MM/YY			

	Smart Cities, Agriculture and Environmental Monitoring		
DD/MM/YY	Digital Twins in Construction and Education		
DD/MM/YY	Industry 5.0 and AI-Driven Digital Twins		
DD/MM/YY	Sustainable Digital Twins, Research Trends and Industrial Case Studies		
DD/MM/YY	Mini Case Study, Course Review, Revision and End-Semester Preparation		

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	Study of Digital Twin architecture, IoT ecosystem, sensors, and communication protocols used in Digital Twin applications.	**CO7**	3.0
W2	S-2	Interface a temperature and humidity sensor (DHT11/DHT22) with an ESP32/NodeMCU and acquire real-time sensor data.	**CO7**	3.0
W3	S-3	Collect and visualize real-time sensor data using the ThingSpeak cloud platform.	**CO7**	3.0
W4	S-4	Configure MQTT communication between an IoT device and an MQTT broker for real-time data transmission.	**CO7**	3.0
W5	S-5	Develop a basic Digital Twin data acquisition system by integrating multiple IoT sensors (temperature, humidity, and light).	**CO7**	3.0
W6	S-6	Design a simple Digital Twin dashboard for monitoring real-time sensor data using Node-RED and Grafana.	**CO7**	3.0
W7	S-7	Develop a Basic Digital Twin Model of a Physical System Using Simulation and	**CO8**	3.0

		Visualization Tools		
W8	S-8	Implementation of Real-Time Data Monitoring and Visualization for a Digital Twin System	**CO8/CO9**	3.0
W9	S-9	Performance Analysis and Predictive Maintenance of a Digital Twin Using Data Analytics	**CO8/CO10**	3.0
W10	S-10	Deployment of a Cloud-Based Digital Twin Application with Secure Data Communication	**CO9/CO10**	3.0
W11	S-11	Interfacing an Ultrasonic Sensor with ESP32 for Real-Time Distance Monitoring	**CO7**	3.0
W12	S-12	Acquisition and Logging of Multi-Sensor Data for a Digital Twin Environment	**CO7**	3.0
W13	S-13	Development of a Basic Digital Twin Model for a Physical System	**CO8**	3.0
W14	S-14	Real-Time Monitoring and Dashboard Development for a Digital Twin	**CO8/CO9**	3.0
W15	S-15	Predictive Analysis of Digital Twin Data for Fault Detection	**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	**Factual Recall &**	Define the fundamental concepts of Digital Twins, Identify	CO1 | L1–L2	MTE Sec A |

	Conceptual Recognition	the methods of data acquisition and communication, Recognize the applications, platforms, benefits, and challenges of Digital Twins		ETE Sec A
TS2	**Conceptual Explanation & Logical Interpretation**	Explain the architecture, lifecycle, and working principles of Digital Twins, Interpret the role of enabling technologies, Explain the significance of simulation, data analytics, monitoring, and Digital Twin platforms	CO2 | L2	MTE Sec A | ETE Sec A
TS3	**Procedural Application & Problem Solving**	Apply data acquisition techniques, IoT communication protocols, and Digital Twin modeling methods, Implement simulation, monitoring, and data analytics techniques, Utilize Digital Twin platforms and cloud-based technologies	CO3 | L3	MTE Sec B | ETE Sec B
TS4	**Analytical Reasoning & Program Tracing**	Analyze Digital Twin architectures, simulation models, and real-time data flow, Interpret sensor data, communication processes, and analytics results, Analyze and trace the workflow of Digital Twin applications	CO4 | L4	MTE Sec B | ETE Sec B
TS5	**Comparative Evaluation & Algorithmic Justification**	Compare different Digital Twin architectures, modeling techniques, and communication technologies, Evaluate the performance of simulation models, data analytics methods, and Digital Twin platforms, Justify the selection of Digital Twin technologies, cloud platforms, and predictive analytics approaches	CO5 | L5	ETE Sec B/C
TS6	**Synthesis & Holistic Design**	Design and develop a complete Digital Twin solution, Develop innovative Digital Twin applications, Create an end-to-end Digital Twin framework	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 CA2 — Experimental design and tool configuration 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 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 CA6 — Documented outcome with verification CA8 — Lab record completeness; viva-voce comprehension	0.75: Thorough | 0.5: Adequate | 0.25: Partial | 0: Absent	CO8, CO9
Professional Attitude &	**0.25**	CO9 — Documentation ethics,	0.25: Consistent | 0.10:	CO9

Ethical Conduct		responsible practice PO7 — Professional responsibility and ethical conduct	Occasional | 0: Absent	
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 P2 — Problem scope and stakeholder requirements 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 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 P6 — Complete project build and integration 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 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 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) 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																					
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	2	-	-	2	-	-	-	-	-	-	2	1	–
CO2	2	3	2	2	3	-	-	-	-	-	-	2	2	–
CO3	2	3	2	3	3	-	-	-	-	-	-	3	2	2
CO4	2	3	2	3	3	1	-	1	-	-	-	2	3	2
CO5	2	3	2	2	2	2	2	2	1	-	-	2	3	2
CO6	2	2	3	3	3	1	2	1	2	2	3	3	3	3

CO7	2	2	3	2	3	-	-	-	2	1	1	2	3	3
CO8	2	3	3	3	3	-	-	-	2	2	2	2	3	3
CO9	2	3	2	3	3	-	1	-	2	2	2	–	1	2
CO10	2	3	3	3	3	1	1	2	3	3	3	2	2	2
Avg	2.10	2.70	2.20	2.40	2.80	.50	.60	.50	1.10	1.00	1.10	**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						
CO2	M	H	M		H						
CO3	M	H	M	H	H						
CO4	M	H	M	H	H	M	M				
CO5	M	H	M	M	M	M	M				M
CO6	M	M	H	H	H	M	M	M	M	H	H
CO7		M	M		H			M			
CO8		M	H	M	H			M	M		M
CO9		M	M	H	H		M	M	M		M
CO10		M	H	H	H	M	M	M	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 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

★ *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

CSMA4300 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

Credit structure :

Semester	Course Code	Course name	Credits
III	CSMA2300	Generative AI	4
IV	CSMA2301	Federated Learning	4
V	CSMA3300	AI driven Devops	4
VI	CSMA3301	RAG and Agentic AI	4
VII	CSMA4300	Digital Twins	4