Programme Structure

Sharda School of Engineering & Science
Department of Chemistry & Biochemistry
Bachelor of Science
(Chemistry)

Programme Code: SBR0102

Batch: 2026-2030

1.1 Vision, Mission and Core Values of the University

Vision of the University

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

Mission of the University

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

Core Values

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

Vision of the School

Achieving academic excellence in the realm of basic and engineering sciences to address the global challenges and to become global leaders.

Mission of the School

M1. To impart basic, advanced, and transformative knowledge and skills in science and technology.
M2. To strengthen capacity and capabilities in cutting-edge technology and research.
M3. To nurture a multidisciplinary research and entrepreneurship temperament for developing innovative solutions to global, societal, and environmental challenges.
M4. To foster multi-dimensional partnerships and collaborations for skill development and global employability.

1.3. Mission of Sharda School of Chemistry & Biochemistry

Vision of the Department

Achieving academic excellence in the realm of basic and engineering sciences to address the global challenges and to become global leaders.

Mission of the Department

M1. Providing distinctive and relevant education in Chemistry and Biochemistry to students.
M2. Motivating young minds through innovative teaching methods, to acquire theoretical knowledge and practical skills in different disciplines of chemistry, and empowering them with problem-solving skills
M3. Nurturing innovation by carrying out world-class research and scholarly work
M4. Promoting interdisciplinary research in collaboration with national/ international laboratories/Institutions.

1.3.1 Programme Educational Objectives (PEO)

PEO1: To produce graduates having a strong background of basic science, interdisciplinary Sciences and ability to use the knowledge and tools.
PEO2: To produce graduates who can demonstrate technical competence in the field of chemical sciences and develop solutions of the complex problems.
PEO3: To produce graduates having professional competence and skills in the field of science to serve the society globally.
PEO4: To produce researcher who function effectively in a multi-disciplinary environment within a societal and environmental context.
PEO-5: To produce graduates who would be able to take individual responsibility and work as a part of a team towards the fulfillment of both individual and organizational goals.

1.3.2 Map PEOs with Mission Statements:

PEO Statements	School Mission 1	School Mission 2	School Mission 3	School Mission 4
PEO1:	**3**	**1**	**2**	**3**
PEO2:	**3**	**2**	**1**	**3**
PEO3:	**2**	**1**	**2**	**2**
PEO4:	**2**	**1**	**2**	**1**
PEO5:	**2**	**1**	**2**	**1**

1. **Slight (Low)** **2. Moderate (Medium)** **3. Substantial**

1.3.3 Programme Outcomes

PO1: **Knowledge**: Describe the fundamental scientific principles and apply the relevant knowledge of basic sciences, especially chemical sciences to the problems of related to chemistry and emerge from the broader interdisciplinary subfields.
PO2: **Problem analysis**: Identify, formulate, review research literature, and analyze complex problems reaching substantiated conclusions using principles of physical sciences, and chemical sciences.
PO3 : **Design/development of solutions**: Design experiments that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4 : **Conduct investigations**: Conduct laboratory experiments safely, use research-based knowledge, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5 : Modern tools usage: Select, and apply appropriate techniques, resources, and modern software and ICT tools including prediction and modeling to complex scientific activities with an understanding of the limitations.
PO6 : **Environment and sustainability**: Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need of sustainable development.
PO7 : Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the scientific practices.
PO8 : **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams.
PO9 :**Communication**: Communicate effectively on complex scientific activities with community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations.
PO10 : **Project management**: Demonstrate knowledge and understanding of the chemical and biochemical principles and apply these to one's own work, as a member and leader in a team, to manage projects.
PO11 : **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological changes.

Programme Specific Outcomes

PSO1: Utilize theoretical and practical expertise in chemical sciences to successfully prepare for various national and international competitive examinations.
PSO2: Apply theoretical and practical knowledge of chemical sciences to address real-world challenges in industries such as healthcare, environmental science, materials science, and consumer products, promoting sustainability and societal well-being.

1.3.4 Mapping of Programme Outcome Vs Programme Educational Objectives

	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	3	2	2
PO2	2	3	3	1	1
PO3	2	3	3	3	1
PO4	1	1	3	3	2
PO5	2	2	2	3	3
PO6	1	1	1	3	2
PO7	1	2	2	3	1
PO8	3	1	3	2	1
PO9	3	1	3	2	1
PO10	3	2	1	3	2
PO11	3	1	2	2	1
PSO1	3	3	3	1	1
PSO2	2	2	3	1	1

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

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

Semester-I													
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Course Code	Course Name													
CHT1101	Fundamentals of Chemistry	1.6	1.5	0	0	1	0	1	1	1.6	0	1	1	0
CHT1102	Basics of Analytical Chemistry	2.5	2.5	2	2.4	1.2	1	0	1	1.1	1	1.1	2.1	1.8
CHT1202	Plant Biochemistry /University minor/MOOC#	1.8	2.5	2	2.8	1.8	2.5	1.6	1.1	1.3	1.3	-	1.3	1.5
CHT1203	Human Health & Nutritional Disorders	2.5	1.4	2.3	1.2	1.5	1.4	1.0	1.0	1.0	1.8	1.25	2.5	1.8
CHP1101	Basic Analytical Chemistry Lab	2.3	2.3	1.6	2.4	1.0	1.3	1.2	2.1	1.3	1.1	1.1	1.8	1.6
VOB1101	Modern trends in chemical analysis: Step forward from laboratory to industry	2.5	2.5	1.8	2.6	1.2	1	1.5	1	1.1	1	1.1	2.1	1.6
Semester-II														
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Course Code	Course Name													

CHT1103	Inorganic Chemistry-I	2.5	2.5	2	2.4	1.2	1	0	1	1.1	1	1.1	2.6	1.8
CHT1104	Physical Chemistry-I	2.5	2.5	2	2.4	1.2	1	0	1	1.1	1	1.1	2.6	1.8
CHT1105	Quantum Mechanics and Molecular Spectroscopy/ Minor/MOOC	2.3	2.3	1.6	2.4	1.0	1.3	1.2	2.1	1.3	1.1	1.1	1.8	1.6
CHT1106	Indian Metallurgy (IKS)	1.8	2.5	2	2.8	1.8	2.5	1.6	1.1	1.3	1.3	-	1.3	1.5
	Mulya Prawah													
CHP1102	Physical Chemistry Lab-1	2.5	2.5	2	2.4	1.2	1	0	1	1.1	1	1.1	2.6	1.8
Semester-III														
Programme Outcome →		PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Course Code	Course Name													
CHT2101	Inorganic Chemistry-II	3	2.6	1.8	2.5	2.3	2	1.0	1.1	1 .0	1.8	3	3	2.6
CHT2102	Organic Chemistry-I	3	2.1	2.8	2.8	2.8	1.1	2	1.0	1.0	1.0	1.0	1.0	1.3
CHT2106	Introduction to Developmental Biology/Minor/Mooc	1.8	2.5	2	2.8	1.8	2.5	1.6	1.6	1.3	1.3	-	1.3	1.5
CHT2103	Introduction to Engineering Materials	3	2	1.8	1.6	1.6	2.3	1	1.5	1.6	0	2	2	2.5

CHP2101	Inorganic Chemistry Lab-I	2.8	2.6	2.6	3	2	1.8	1.0	1.3	1.6	1.6	2.3	3	2.5
CHP2102	Organic Chemistry Lab-I	3	1.6	1	1.6	3	1.0	1.0	1.8	3.0	1.0	1.0	1.6	1.6
CHR2101	RBL-1	1.6	2	2.5	2.5	2.1	2.0	2.0	2.0	2.0	1.0	2.0	2.0	2.5
Semester-IV														
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Course Code	Course Name													
CHT2104	Organic Chemistry-II	3.0	2.5	2.1	2.1	2.1	2.0	2.0	1.1	1.1	1.1	3.0	3.0	2.3
CHT2105	Physical Chemistry-II	2.6	2.5	1.0	2.0	1.0	1.1	1.0	2	2	1.8	1.3	2.8	3.0
CHT2106	Basics of Pharmaceuticals	3.0	2.0	3.0	2.0	3.0	1.6	1.0	1.0	1.0	1.8	2.0	1.0	1.1
CHT2207	Enzyme and Catalysis/ Minor/ MOOC #	2.5	2.1	2	2.3	1.3	-	-	2.0	3.0	2.5	-	3	2.3
CCP4001	Community Connect	2	2	3	3	1	3	1	3	3	3	2	1	2
CHP2103	Pharmaceutical Chemistry lab	3	2.5	3	3	3	1.6	2	1	1	1.83	2	1.3	2.3
CHR2102	Research-Based Learning-2	2.2	2.0	2.2	1.3	1.3	1.3	1.0	1.3	2.0	2.0	2.3	2.5	2.3
Semester-V														
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Course Code	Course Name													

CHT3101	Organic Chemistry III	2.3	2.3	1.3	1.33	1	1.3	1.0	1.0	1.1	1.1	2.1	2.0	2.0
CHT3102	Inorganic Chemistry III	2.3	2.0	1.1	1.5	1.3	1.5	1.0	2.0	1.1	1.16	1.1	1.8	1.1
CHT3103	Basics of Spectral Techniques	2.3	2.3	1.1	1.1	2.0	1.1	1.0	2.0	1.1	1.1	1.1	2.1	1.8
CHT3104	Physical Chemistry-III	2.3	2.2	1.2	1.5	1.2	1.0	1.0	2.0	1.2	1.2	1.2	2.0	1.8
CHP3101	Organic Chemistry Lab-II	2.0	2.2	1.5	2.7	1.7	1.2	1.0	2.0	1.2	1.2	1.5	2.2	2.0
CHP3102	Inorganic Chemistry Lab-II	2.0	2.2	1.4	2.6	1.6	1.4	1.0	2.0	1.0	1.0	1.2	2.0	2.0
CHR3101	Research-Based Learning-3	2.2	2.0	2.2	1.3	1.3	1.3	1.0	1.3	2.0	2.0	2.3	2.5	2.3
Semester-VI														
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Course Code	Course Name													
CHT3105	Chemistry in Action/ Minor	2.5	2.3	1.6	1.0	1.0	2.0	1.5	1.1	1.1	1.1	1.6	2.1	2.3
CHT3106	Chemical Energetics and Radiochemistry/Minor	2.5	2.3	1.6	1.0	1.0	1.8	1.1	1.1	1.1	1.1	1.6	2.1	2.0
CHT3209	Biological Chemistry/ Minor	3	2.1	2.3	2.3	1.8	2.1	1.6	1.0	1.3	1.3	1.3	1.3	1.0
CHT3109	Nanomaterials: Synthesis and Applications /MOOC*	2.5	2.1	1.6	1.0	1.5	1.3	1.0	1.1	1.1	1.1	1.1	2.1	2.1

CHR3102	Research-Based Learning-4	2	2	2.3	2.3	2	1.8	1.	1.1	2	1	2	2	2.5
Semester-VII (Honours)														
Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Course Code	Course Name													
CHT4101	Advanced Inorganic Chemistry-I	3	2.8	2.1	2.3	-	-	-	1.5	1.4	2.0	-	2.0	2.3
CHT4102	Organic Chemistry-I	3	2.6	-	2.0	2.0	-	1.2	1.3	1.7	-	-	2.0	2.1
CHT4103	Advanced Physical Chemistry-I	3	2.6	2.1	-	2.3	2.1	-	1.3	1.5	2.0	3.0	2.0	-
CHT4104	Advanced Analytical Chemistry-I	3	2.8	2.1	2.3	2.3	2.1	1.4	1.5	1.4	2	3	2	2.3
CHT4301	Advanced Quantum Mechanics*	3	2.8	2.1	2.3	-	2.1	1.4	1.5	1.4	-	-	2.0	2.3
CHP4101	Advanced Inorganic Chemistry Lab-I	3	2.6	-	2	2	-	1.2	-	1.7	2	3	2	-
CHP4102	Advanced Organic Chemistry Lab-I	3	2.6	2.1	2	2	2.1	-	1.3	-	2	3	2	-
CHP4103	Advanced Physical Chemistry Lab-I	3	2.6	-	-	2.3	2.1	-	-	1.5	2	3	2	-
CHP4104	Basic Chemistry Software's	3	-	2.1	2	2	2.1	1.25	-	-	2	3	2	2.1
Semester-VIII (Honours)														

Programme Outcome →		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Course Code	Course Name													
CHT4105	Advanced Inorganic Chemistry-II	3	2.7	2.2	-	-	2.2	1.4	-	1.5	2	3	2	2.3
CHT4106	Advanced Organic Chemistry-II	3.0	2.7	2.2	2.3	2.3	-	1.5	1.3	-	1.2	-	-	-
CHT4107	Advanced Physical Chemistry-II	3	2.7	2.2	-	-	2.2	1.4		1.5	2	3	2	2.3
CHT4109	Science and Technology of Nanomaterials	3	2.7	2.2	-	-	2.2	1.4	-	1.5	2	3	2	2.3
CHP4105	Advanced Inorganic Chemistry Lab-II	3	2.6	-	2.3	2.3	-	1.4	1.3	1.5	2	3	2.0	2.0
CHP4106	Advanced Organic Chemistry Lab-II	3	2.7	2.2	-	-	2.2	1.4	-	1.5	2	3	2	2.3
CHP4107	Advanced Physical Chemistry Lab-II	3	2.7	2.2	-	-	2.2	1.4	-	1.5	2	3	2	2.3
CHR4101	Project	3	-	2.1	2.3	2.3	-	1.4	1.5	1.4	2	3	2	2.3

Programme Structure

Sharda School of Engineering and Science

B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)

S. No.	Certificate/Diploma/Degree awarded	Year	Cumulative minimum credit
1	Certificate in Chemistry	01st Year	40
2	Diploma in Chemistry	02nd Year	80
3	Degree in Bachelor of Science in Chemistry	03rd Year	120
4	Degree in Bachelor of Science in Chemistry with minor	03rd Year	120
5	Degree in Bachelor of Science (Hons) in Chemistry	04th Year	160
6	Degree in Bachelor of Science (Hons) in Chemistry with minor	04th Year	160
7	Degree in Bachelor of Science (Hons with Research) in Chemistry	04th Year	160
8	Degree in Bachelor of Science (Hons with Research) in Chemistry with minor	04th Year	160

4-year UG Degree (Honours with Research): As per UGC guidelines curriculum and credit framework for undergraduate programmes, students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 160 credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

Structure of FY UG Programme

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

Semester	Discipline Core Major (60/80 Credits)	Minor (24/32 Credits)	Inter/Multi - disciplinary courses (09 Credits)	Ability Enhancement courses (AEC) (08 Credits)	Skill Enhancement Courses (SEC) (09 Credits)	Common Value Added Courses (06-08 Credits)	Summer Internship (02-04 Credits)	Research Project (12 Credits)	Total Credits (120/160)	Total Credits (120/160)	(Cummulative Minimum Credits) Required for Award of Diploma / Degree
I	Fundamentals of Chemistry (4)+Basics of Analytical Chemistry (3)+Basic Analytical Chemistry Lab (1) **8**	Plant Biochemistry /University minor/ MOOC # (3) **3**	Human Health & Nutritional Disorders(2) **2**	Communicative English-1 (2) **2**	Modern trends in chemical analysis: Step forward from laboratory to industry (3) **3**	Environment Education (2) **2**			20	40	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	Inorganic Chemistry-1(4)+Physical Chemistry-I (3)+Physical Chemistry Lab-I (1) **8**	Quantum Mechanics and molecular spectroscopy/ Minor/MOOC (3) **3**		Communicative English-II (2) **2**	Introduction to AI (3) **3**	Indian Metallurgy (IKS) (2)+ Mulya Prawah (2) **4**			20		

	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	Inorganic Chemistry-II (4)+Organic Chemistry-I (4)+Inorganic Chemistry Lab-I (1)+Organic Chemistry Lab-I (1) **10**	Introduction to Developmental biology/ Minor/MOOC#/(3) **3**	Introduction to Engineering Materials(2) **2**	Indian Language (2) **2**	AI Principles (3) **3**			RBL1 (0) **0**	20	80	****Consent to be taken from Students for Apprenticeship by floating name of Industries** Mandatory visit to Abhivyakti Wellness Clinic as Audit Course to be taken in any semester (Except 1st & final sem.)
IV	Organic Chemistry-II (4)+Physical Chemistry-II (4)+Basics of Pharmaceuticals (4)+Pharmaceutical Chemistry Lab (2) **14**	Enzyme and Catalysis/Minor/ MOOC #(3) **3**		Community Connect-1 (2) **2**		AI application on Basic Sciences (0)		RBL2 (1) **1**	20		

	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	Organic Chemistry III (4)+Inorganic Chemistry III (4)+Basics of Spectral Techniques (4)+Physical Chemistry-III (4)+Organic Chemistry Lab-II (2)+Inorganic Chemistry Lab-II (2) **20**							RBL3 (0) (Audit) **0**	20	120	3- Year UG Degree inclusive of optional Apprenticeship
VI		Chemistry in Action/Minor (4)+Chemical Energetics and Radiochemistry/Minor (4)+Biological	Nanomaterials: Synthesis and Applications /MOOC*(3)	Campus to Corporate/(2)/Foeign Language (2)		AI Driven Solution in Basic Sciences (0)	Industry Connect-1 (2)/ Summer Internship-1 (2)	RBL4-1 (1)	20		

		Chemistry/Minor (4) **12**	**3**	**2**			**2**	**1**			
OR VI	****APPRENTICESHIP [20]**								20	20	
	Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline / Subject upon securing 120 credits										
VII	Advanced Inorganic Chemistry-I (4)+Advanced Inorganic Chemistry Lab-I (1) Advanced Organic Chemistry-I(4)+ Advanced Inorganic Chemistry Lab-I (1) Advanced Physical Chemistry-I(4)+Advanced Physical	Advanced Quantum Mechanics (4)*							20	160	***ONLY for students going for Apprenticeship & requires Minor with Major Degree** 4- Year UG Degree (Honours) inclusive of optional Apprenticeship

	Chemistry Lab-I(1) Advanced Analytical Chemistry-I(4)+ Basic Chemistry Software's(1) **20**	**4**									
VIII		Advanced Organic Chemistry-II (3)+Advanced Physical Chemistry-II (3)+ (1)+Advanced Organic Chemistry Lab-II (1)+Advanced Physical Chemistry Lab-II (1) **8**	Science and Technology of Nanomaterials(4)+ Advanced Inorganic Chemistry-II (3)+Advanced Inorganic Chemistry Lab-II **8**					Project (4) **4**	20		
OR VIII	****APPRENTICESHIP [20]**								20		
	OR										

VII	Advanced Inorganic Chemistry-I (4)+Advanced Organic Chemistry-I (4)+Advanced Physical Chemistry-I (4)+Advanced Analytical Chemistry-I (4) **16**	Advanced Quantum Mechanics/Minor (4) **4**						Project (Minor Project) in SEM-VII (3)+ Project (Major) in SEM-VII (9) **12**	20	160	4- Year UG Degree (Honours with Research)
VIII	Advanced Inorganic Chemistry-II/ Advanced Organic Chemistry-II (3)+Advanced Inorganic Chemistry Lab-II/ Advanced Organic Chemistry Lab-II (1) **4**	Advanced Physical Chemistry-II/Minor (3)+ Advanced Physical Chemistry Lab-II (1) **4**							20		

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 Science (Chemistry)	Credits	Practical/ Theory	Type	Total Credits
Semester- I				**20**
CHT1101 Fundamentals of Chemistry	4	Theory	Core	4
CHT1102 Basics of Analytical Chemistry	3	Theory	Core	3
CHT1202 Plant Biochemistry /University minor/MOOC[#]	3	Theory	Elective	3
CHT1203 Human Health & Nutritional Disorders	2	Theory	Interdisciplinary	2
ARP101 Communicative English-1	2	Theory+ Practical	AEC	2
EVT1129 Environment Education	2	Theory	VAC	2
CHP1101 Basic Analytical Chemistry	1	Pratical	Core	1
VOB1101 Modern trends in chemical analysis: Step forward from laboratory to industry	3	Pratical	SEC	3
Semester-II				**20**
CHT1103 Inorganic Chemistry-I	4	Theory	Core	4
CHT1104 Physical Chemistry-I	3	Theory	Core	3
CHT1105 Quantum Mechanics and Molecular Spectroscopy/ Minor/MOOC	3	Theory	Elective	3
ARP102 Communicative English-II	2	Theory+ Practical	AEC	2
CHT1106 Indian Metallurgy (IKS)	2	Theory	VAC	2
Mulya Prawah	2	Theory	VAC	2
CHP1102 Physical Chemistry Lab-1	1	Pratical	Core	1
AI3601 Introduction to AI	3	Theory+ Practical	SEC	3
Semester-III				**20**
CHT2101 Inorganic Chemistry-II	4	Theory	Core	4
CHT2102 Organic Chemistry-I	4	Theory	Core	4
CHT1206 Introduction to Developmental Biology/Minor/Mooc	3	Theory	Elective	3
CHT2103 Introduction to Engineering Materials	2	Theory	Multidisciplinary	2
Indian Language	2	Theory	AEC	2

NV3008 AI Principles	3	Theory+ Practical	SEC	3
CHP2101 Inorganic Chemistry Lab-I	1	Practical	Core	1
CHP2102 Organic Chemistry Lab-I	1	Practical	Core	1
CHP2101 RBL-1	0	Practical	Audit	0
Semester-IV				**20**
CHT2104 Organic Chemistry-II	4	Theory	Core	4
CHT2105 Physical Chemistry-II	4	Theory	Core	4
CHT2106 Basics of Pharmaceuticals	4	Theory	Core	4
CHT2207 Enzyme and Catalysis/ Minor/ MOOC #	3	Theory	AEC	3
CCP4001 Community Connect	2	Theory	VAC	2
CHP2103 Pharmaceutical Chemistry lab	2	Practical	Core	2
CHR2102 Research-Based Learning-2	1	Practical	RBL	1
NV3009 AI application on Basic Sciences	0	Theory+ Practical	SEC	0
Semester-V				**20**
CHT3101 Organic Chemistry III	4	Theory	Core	4
CHT3102 Inorganic Chemistry III	4	Theory	Core	4
CHT3103 Basics of Spectral Techniques	4	Theory	Core	4
CHT304 Physical Chemistry-III	4	Theory	Core	4
CHP3101 Organic Chemistry Lab-II	2	Theory	Core	2
CHP3102 Inorganic Chemistry Lab-II	2	Practical	Core	2
CHP3101 Research-Based Learning-3	0	Practical	Audit/RBL	0
Semester-VI Without Apprenticeship				**20**
CHT3105 Chemistry in Action/ Minor	4	Theory	Elective/ Minor/DSE	4
CHT3106 Chemical Energetics and Radiochemistry/Minor	4	Theory	Elective/Minor/DSE	4
CHT3209 Biological Chemistry/ Minor	4	Theory	Elective/ Minor/DSE	4

CHT3109 Nanomaterials: Synthesis and Applications /MOOC*	3	Theory	Interdisciplinary	3
ARP306 Campus to Corporate/ Foreign Language	2	Theory+ Practical	AEC	2
AI3602 AI-Driven Solution in Basic Sciences	0	Theory+ Practical	VAC	0
INC001 Industry Connect	2	Pratical	INC	2
CHR3102 Research-Based Learning-4	1	Pratical	Research Project	1
Semester-VI With Apprenticeship				
CHA3101 Apprenticeship	20	Pratical		
Semester-VII BSc Chemistry (Honours): Inclusive of Optional Apprenticeship (Without Apprenticeship)				**20**
CHT4101 Advanced Inorganic Chemistry-I	4	Theory	Core	4
CHT4102 Organic Chemistry-I	4	Theory	Core	4
CHT4103 Advanced Physical Chemistry-I	4	Theory	Core	4
CHT4104 Advanced Analytical Chemistry-I	4	Theory	Core	4
CHT4301 Advanced Quantum Mechanics*	4	Theory	Minor*	4
CHP4101 Advanced Inorganic Chemistry Lab-I	1	Pratical	Core	1
CHP4102 Advanced Inorganic Chemistry Lab-I	1	Pratical	Core	1
CHP4103 Advanced Physical Chemistry Lab-I	1	Pratical	Core	1
CHP4104Basic Chemistry Software's	1	Theory + Pratical	Core	1
Note: *ONLY for students going for Apprenticeship & requires Minor with Major Degree				
Semester-VIII BSc Chemistry (Honours): Inclusive of Optional Apprenticeship (Without Apprenticeship)				**20**
CHT4105 Advanced Inorganic Chemistry-II	3	Theory	Core	3
CHT4106 Advanced Organic Chemistry-II	3	Theory	Core	3
CHT4107 Advanced Physical Chemistry-II	3	Theory	Core	3
CHT4109 Science and Technology of Nanomaterials	4	Theory	Minor/DSE	4
CHP4105 Advanced Inorganic Chemistry Lab-II	1	Pratical	Core	1

CHP4106 Advanced Organic Chemistry Lab-II	1	Pratical	Core	1
CHP4107 Advanced Physical Chemistry Lab-II	1	Pratical	Core	1
Project	4	Pratical	Project	4
Semester-VIII BSc Chemistry (Honours): With Apprenticeship				
CHA4101 Apprenticeship	20	Pratical		
Semester-VII BSc Chemistry (Honours with Research): Inclusive of Optional Apprenticeship				
CHT4101 Advanced Inorganic Chemistry-I	4	Theory	Core	4
CHT4102 Organic Chemistry-I	4	Theory	Core	4
CHT4103 Advanced Physical Chemistry-I	4	Theory	Core	4
CHT4104 Advanced Analytical Chemistry-I	4	Theory	Core	4
CHT4301 Advanced Quantum Mechanics	4	Theory	Minor	4
Project (Minor Project)*	3	Pratical	Project (Minor)	3
Note: Project (Minor Project)*: Research Project -(12): 03 Credits evaluation will be done in VII Semester				
Semester-VIII BSc Chemistry (Honours with Research): Inclusive of Optional Apprenticeship				
CHT4105 Advanced Inorganic Chemistry-II/CHT4106 Advanced Organic Chemistry-II	3	Theory	Core	3
CHT4107 Advanced Physical Chemistry-II/Minor	3	Theory	Minor	3
CHP4105 Advanced Inorganic Chemistry Lab-II/ CHP4106 Advanced Organic Chemistry Lab-II	1	Pratical	Core	1
CHP4107 Advanced Physical Chemistry Lab-II	1	Pratical	Minor	1
Project (Major Project)*	9	Pratical	Project (Major)	9

Programme-wise Credit Distribution

Course Category	Programme-wise Credit Distribution					
	Bachelor of Science (Chemistry)		Bachelor of Science (Honours) (Chemistry)		Bachelor of Science (Honours with Research) (Chemistry)	
	3 Year		4 Year		4 Year	
	No. of Courses	Total credits	No. of Courses	Total credits	No. of Courses	Total credits
Core Courses (CC)	13	56	21	88	18	76
Multidisciplinary Courses	3	9	3	9	3	9
Minor Electives	7	24	9	32	9	32
Dissertation/Capstone Project	0	0	0	0	2	12
Ability Enhancement Courses (AEC)	4	8	4	8	4	8
Skill Enhancement Courses (SEC)/ Vocational Courses	3	9	3	9	3	9
Practical/Tutorials/Studios	4	4	4	4	4	4
Internship	1	2	1	2	1	2
Field Projects/RBL	4	2	4	2	4	2
VAC	2	6	2	6	2	6
Total	**41**	**120**	**51**	**160**	**50**	**160**

Type	Courses x Credits	Credits	Total Credits
Core	25x79	79	160
Dse-Discipline Specific Elective	4x6	30	
Ge-General Elective	-	-	
Aecc-Ability Enhancement Compulsory Courses	4x2	8	
Sec-Skill Enhancement Courses	3x9	9	

Course Modules

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: I**
1	Course Code	CHT1101
2	Course Name	**Fundamentals of Chemistry**
3	Credits	4
4	Contact Hours (L-T-P)	3-1-0
	Course Type	Core
5	Course Objective	1. Students will gain an understanding of the periodic properties of elements. 2. Current bonding models for simple inorganic and organic molecules to predict structures and important bonding parameters. 3. Molecular polarity and weak chemical forces. 4. The basics of organic chemistry give the most primary and utmost important knowledge and concepts of organic Chemistry, a theoretical picture in multiple stages in an overall chemical reaction. 5. Reactive intermediates, transition states, and states of all the bonds broken and formed, reaction mechanism.
6	Course Outcomes	CO1: Describe the contributions of Indian chemists, ancient chemistry practices, and basic chemistry concepts (atomic structure, periodic properties, bonding. CO2: understand the simple bonding theories of molecules, molecular polarity, periodic trends, reagents, reactive intermediates, and isomerism. CO3: apply knowledge to solve periodic trends, molecular geometry, bond order, magnetic behavior of molecules, electron displacement effects, weak chemical forces, reactive intermediates, and isomerism.

		CO4: analyze shapes of molecules/ions, effects on properties due to electron displacement, mechanism of organic reactions, feasibility of reaction based on energy consideration, and absolute configuration. CO6: Assess molecular orbital diagrams, Born–Haber cycles, reaction mechanisms, and conformational isomers to interpret stability, energy changes, and reaction pathways.	
7	Course Description	This course includes an introduction to ancient Indian Chemistry and the contribution of Indian Chemists, describes molecular polarity, weak chemical forces, chemical bonding, periodic properties of elements, organic reaction intermediates, reaction mechanisms, and stereochemistry.	
8	Outline syllabus		CO Mapping
	Unit 1	**Ancient Indian Chemistry & Periodic Properties of Elements**	
	A	Introduction to Indian Ancient Chemistry and the Contribution of Indian Chemists. Brief discussion, factors affecting, and variation trends of the following properties in groups and periods.	CO1, CO2
	B	Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.	CO2, CO3, CO5
	C	Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach)	CO1, CO3
	Unit 2	**Bonding Theories of Molecules**	
	A	Valence bond theory (VBT), Concept of hybridization, hybrid orbitals, and molecular geometry.	CO1, CO2, CO3
	B	Bent's rule, Valence shell electron pair repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, SF_6, SF_4, ClF_3, I_3^-, ClF_2^{--}.	CO2, CO4

	C	Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions (N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions).	CO2, CO3, CO6
	Unit 3	**Molecular Polarity and Weak Chemical Forces**	
	A	Formal charge, Van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction, dipole moment and molecular Structure (Diatomic and polyatomic molecules), Percentage ionic character from dipole moment.	CO1, CO2, CO5
	B	Polarizing power and polarizability. Fajan's rules and consequences of polarization. Hydrogen bonding.	CO2, CO3
	C	Effects of weak chemical forces, melting and boiling points, solubility, and energetics of dissolution process. Lattice energy and Born-Haber cycle, solvation energy, and solubility of ionic solids.	CO3, CO6
	Unit 4	**Mechanism of Organic Reactions**	
	A	Electronic Displacements: Inductive, electromeric, resonance, mesomeric effects and their applications, Hyperconjugation. Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles.	CO2, CO3, CO4
	B	Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes, and nitrenes (with examples).	CO2, CO3
	C	General mechanism of different organic reactions, Energy considerations.	CO2, CO4, CO6
	Unit 5	**Stereochemistry**	
	A	Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, Newman	CO2, CO3, CO5, CO6

		projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.			
	B	Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.			CO4, CO5
	C	Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds			CO5, CO6
	Mode of Examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s *	1. Lee, J. D. (2008). Concise inorganic chemistry. John Wiley & Sons. 2. Solomons, T. G., & Fryhle, C. B. (2017). *Organic chemistry*. John Wiley & Sons. 3. Bahl, A. (2010). *Advanced organic chemistry*. S. Chand. 1. 4. Mosher, M. (1992). Organic Chemistry. (Morrison, Robert Thornton; Boyd, Robert Neilson). Wiley.			
	Other References	1. Mosher, M. (1992). Organic Chemistry. (Morrison, Robert Thornton; Boyd, Robert Neilson). 2. Carey, F. A., (2012). Guiliano, R. M.Organic Chemistry, Eighth edition, McGraw-Hill Education. 3. Clayden, J., Greeves, N. &Warren, S., (2012). Organic Chemistry, 2nd edition, Oxford University Press. 4. Shriver, D.D. & P. Atkins, (1992). Inorganic Chemistry 2nd Ed., Oxford University Press.			

Pos / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT1101.1	1	1	-	-	1	-	1	1	1	-	1	1	-
CHT1101.2	1	1	-	-	1	-	1	1	1	-	1	1	-

CHT1101.3	2	2	-	-	1	-	1	1	2	-	1	1	-
CHT1101.4	2	2	-	-	1	-	1	1	2	-	1	1	-
CHT1101.5	2	2	-	-	1	-	1	1	2	-	1	1	-
CHT1101.6	2	1	-	-	1	-	1	1	2	-	1	1	-

1. Slight (Low) **2. Moderate (Medium)** **3. Substantial (High)**

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: I**
1	Course Code	CHT1102
2	Course Name	**Basics of Analytical Chemistry**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Type	Core
5	Course Objective	1. Provide and enrich the students with analytical techniques, various types of errors knowingly/ unknowingly introduced, accuracy, and confidence limits in the analytical process. 2. Equip the students with the knowledge of making different kinds of standard solutions, how to standardize the secondary standards, and how to determine the strength of an unknown solution volumetrically. 3. Inculcate the theoretical and experimental knowledge of volumetric and gravimetric quantitative analysis in the presence of interfering agents. 4. Provide theoretical and experimental knowledge, qualitative analysis of various cations and anions in a pure sample mixture of an unknown analyte. 5. Provide theoretical and experimental knowledge, qualitative analysis of various cations and anions containing interfering cations and anions in a mixture of unknown analyte. 6. Provide a correlation between the theoretical aspects of qualitative and quantitative analysis of cations, anions, and molecular systems

6	Course Outcomes	CO1: Define the fundamental concepts of analytical chemistry, including analytical processes, calibration, standardization, types of errors, and statistical parameters used in chemical analysis. CO2: Explain the principles of volumetric analysis, types of titrations, indicators, and endpoint evaluation. CO3: Apply the principles of gravimetric and volumetric methods to perform analytical calculations. CO4: Analyze systematic procedures involved in the qualitative analysis of anions and interfering ions using classical analytical methods. CO5: Evaluate and interpret the chemical principles governing cation group separation, solubility product, and common ion effect in qualitative semimicro analysis. CO6: Assess the analytical data using statistical, volumetric, gravimetric, and qualitative methods	
7	Course Description	Analytical chemistry I comprises the following descriptions as below. 1. Qualitative and quantitative aspects of chemical analysis 2. Volumetric Method of Analysis 3. Gravimetric Analysis 4. Qualitative analysis-I 5. Qualitative analysis-II	
8	Outline syllabus		CO Mapping
	Unit 1	**Qualitative and quantitative aspects of chemical analysis**	
	A	Scope and functions of analytical processes, Calibration and standardization of NaOH, $KMnO_4$, and $HClO_4$	CO1,CO2. CO6
	B	Types of Errors- Systematic, random, and Gross; definition of terms: mean and median, precision and accuracy	CO1,CO2. CO6
	C	Absolute and relative error, Random errors. Sources of error in experimental data, standard deviation, relative standard deviation, and statistical analysis of data.	CO1,CO2. CO6
	Unit 2	**Volumetric Method of Analysis**	
	A	Principles of volumetric analysis, Primary and Secondary standards, Indicators, and their types. Titrations and their theories,	CO2, CO3, CO6

	B	Acid- base titration (strong acid and strong base, weak acid and strong base, weak base and strong acid, weak acid and weak base), Complexometric titrations (titration of mixtures, selectivity, masking and demasking agents);	CO2, CO3, CO6
	C	Precipitation titrations; Redox titrations, calculation of equivalent weight. Theoretical aspects of titration curves and endpoint evaluation; Choice of indicators in each case.	CO2, CO3, CO6
	Unit 3	**Gravimetric Analysis**	
	A	Basic principle, Precipitation reactions; precipitation methods; conditions of precipitation; nucleation; particle size	CO3, CO4, CO6
	B	Crystal growth; Colloidal state; aging; impurities in the analytical precipitate; co-precipitation	CO3, CO4, CO6
	C	Precipitation from a homogeneous solution; washing of precipitate; drying and ignition of precipitate; Applications	CO3, CO4, CO6
	Unit 4	**Qualitative analysis-I**	
	A	Qualitative analysis and its type; systematic analysis of anions in terms of dilute and concentrated sulphuric acid group (CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$)	CO4,CO5, CO6
	B	systematic analysis of anions in terms of dilute and concentrated sulphuric acid group (CH_3COO^-, F^-, Cl^-, Br^-, I^-, $C_2O_4^{2-}$, NO_3^-)	CO4,CO5, CO6
	C	Interfering anions and their removal (fluoride, borate, oxalate, and phosphate) (BO_3^{3-}, PO_4^{3-}, SO_4^{2-}), Sodium carbonate extract preparation and its advantages	CO4,CO5, CO6
	Unit 5	**Qualitative analysis-II**	
	A	Basic principles involved in the analysis of cations and anions, and solubility products, the common ion effect.	CO5, CO6
	B	Principle involved in the division of cations into groups and group reagents. Qualitative semimicro analysis of mixtures containing two anions and two cations	CO5, CO6

	C	Qualitative semimicro analysis of mixtures containing two anions and two cations (Emphasis should be given to the understanding of the chemistry of qualitative analysis of cations of group I to VI, including the zero group).			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s *	Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. J. K. (2000). *Vogel's textbook of quantitative chemical analysis* (6th ed.). Pearson Education. Svehla, G. (1996). *Vogel's textbook of qualitative inorganic analysis: Including elementary instrumental analysis* (7th ed.). Longman. 2. Shriver, D. F., Atkins, P. W., Overton, T. L., Rourke, J. P., Weller, M. T., & Armstrong, F. A. (2014). *Inorganic chemistry* (6th ed.). Oxford University Press.			
	Other References	Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's textbook of macro and semimicro qualitative inorganic analysis* (5th ed.). Longman. 1. Harris, D. C. (2020). *Quantitative chemical analysis* (10th ed.). W.H. Freeman.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	–	–	–	–	–	–	1	–	1	2	–
CO2	3	2	–	1	–	–	–	–	1	–	1	2	1
CO3	2	3	2	2	1	–	–	–	1	–	1	2	2
CO4	2	3	2	3	1	–	–	–	1	–	1	2	2
CO5	2	3	2	3	1	–	–	–	1	–	1	2	2
CO6	3	3	2	3	2	1	–	1	2	1	2	3	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: I**
1	Course Code	CHT1102
2	Course Name	**Human Health & Nutritional Disorders**
3	Credits	2
4	Contact Hours (L-T-P)	2-0-0
	Course Type	AEC/ SEC
5	Course Objective	To understand the link between nutrition and health, identify common nutritional problems, and learn about prevention, treatment, and management strategies for these disorders, ultimately promoting optimal health and well-being.
6	Course Outcomes	CO1: Define key terms related to vital parameters and explain basic concepts of human nutrition. CO2: Apply principles of therapeutic nutrition and anti-nutritional factors in daily life. CO3: Analyze the role of electrolytes and blood gases in maintaining physiological balance. CO4: Classify detoxification enzymes and explain their role in free radical scavenging. CO5: Explain major metabolic disorders and outline strategies for their management. CO6: Evaluate nutritional status and apply nutrition knowledge in health and disease management.

7	Course Description	This module covers fundamental nutrition principles, food science, the impact of nutrition on health and disease, and various nutritional disorders, including malnutrition and related conditions.	
8	Outline syllabus		CO Mapping
	Unit 1	**Basic Concept of Nutrition**	
	A	Introduction to food & nutrition, vital parameters, and health check	CO1,CO6
	B	Nutrients & food groups, balanced diet, and deficiency	CO1,CO6
	C	Nutrition requirements for the susceptible population	CO1,CO6
	Unit 2	**Nutrition and Health**	
	A	Therapeutic nutrition, phytochemicals and health benefits, spices and health benefits	CO2, CO6
	B	Malnutrition and obesity, food for diabetic and high BP patients	CO2, CO 6
	C	Anti-nutritional factors in food	CO2, CO 6
	Unit 3	**Nutritional Disorders-I**	
	A	Electrolytes, blood gases, respiration and acid-base balance	CO3,CO 6
	B	Disorders of acid-base balance	CO3,CO 6
	C	Diagnostic enzymes, disturbances in thyroid function	CO3,CO 6
	Unit 4	**Nutritional Disorders-II**	
	A	Free radicals in health and disease, generation and damage caused by free radicals, free radicals in aetiology of diseases and scavenger systems for them	CO4,CO 6
	B	Disorders of erythrocyte metabolism	CO4,CO 6

	C	Mechanism of drug action and channels of its excretion, enzymes of detoxification			CO4, CO 6
	Unit 5	**Nutritional Disorders-III**			
	A	Disorders of carbohydrate metabolism and ketone bodies, glycogen storage diseases			CO5, CO 6
	B	Cholesterol and triglyceride disorders, disorders of amino acid metabolism			CO5,CO 6
	C	Disorders of nucleic acid metabolism, disorders of mineral metabolism			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s *	Textbook of Medical Biochemistry by Dinesh Puri, Elsevier Textbook of Biochemistry (for Medical Students) – DM Vasudevan and S SreeKumari,4th edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi			
	Other References	Nutrition And Dietetics by Shubhangini A. Joshi, McGraw-Hill Education Nutritional Biochemistry – Tom Brody, 2nd edition, Academic Press			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	2	1	2	1	1	1	1	1	1	2	1	2	1
CO2	2	1	2	-	2	2	1	1	1	2	1	2	1
CO3	3	-	3	1	1	-	1	-	-	2	-	3	2
CO4	3	2	3	2	2	1	1	1	1	2	2	3	3
CO5	3	1	2	1	2	2	1	1	1	2	-	3	2
CO6	2	2	2	1	1	1	1	1	1	1	1	2	2

School		Sharda School of Engineering & Science
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		Semester: I
1	Course Code	**CHT1202**
2	Course Name	**Plant Biochemistry**
3	Credits	03
4	Contact Hours (L-T-P)	3-0-0
	Course Type	DSE
5	Course Objective	This course aims to educate students about the mechanisms and physiology of life processes in plants. To understand the mechanism of various physiological processes related to plant life.
6	Course Outcomes	CO1: Define the mechanisms of water transport (symplast/apoplast) and the physiological trade-off between transpiration and photosynthesis in plants CO2: Illustrate the light-dependent and carbon-fixation reactions of photosynthesis, and relate chloroplast membrane organization to the efficiency of ATP synthesis. CO3:Categorise major phytohormones (Auxins, Gibberellins, etc.) and evaluate their biosynthetic pathways and physiological functions in regulating plant growth and development. CO4: Examine the enzymology and molecular signaling of Nitrogen Fixation and Nitrate Assimilation, and inspect their interaction with carbon metabolism CO5: Compare the primary biosynthetic pathways of Secondary Metabolites (Terpenoids, Alkaloids, Phenolics) and explain biotechnological applications for these compounds. CO6: Interpret the mechanisms of various plant physiological processes and their role in regulating plant growth and development.

7	Course Description	The course is designed to equip students with subject domain knowledge and technical skills pertaining to plants in a holistic manner. Students have exposure to cutting-edge technologies that are currently used in the subject. They are made aware of the social and environmental issues, the significance of plants, and their relevance to the national economy.	
8	Outline syllabus		CO Mapping
	Unit 1	**Plant water relationship and Nutrient uptake**	
	A	Pathway of water movement; concepts of symplast and apoplast; ascent of sap; transpiration	CO1, CO6
	B	Energy exchange during transpiration; role of stomata; relationship with photosynthesis; anti-transpirants; guttation; exchange of gases.	CO1, CO6
	C	Essential and non-essential elements; criteria for essentiality; macro and micronutrients; roles of essential elements; mineral deficiency symptoms; ion antagonism and toxicity	CO1, CO6
	Unit 2	**Photosynthesis**	
	A	Overview of photosynthesis, Light absorption and energy conversion	CO2, CO6
	B	Photosystem structure and function, Electron transport pathways in chloroplast membranes	CO2, CO6
	C	ATP synthesis in chloroplasts, Organization and regulation of photosynthetic Complexes, Carbon reactions: the Calvin–Benson cycle	CO2, CO6
	Unit 3	**Plant growth regulators**	
	A	Introduction to phytohormones, Auxins, Gibberellins, Abscisic acid, Cytokinins, Ethylene, Jasmonic acid	CO3, CO6
	B	Structure Auxins, Gibberellins, Abscisic acid, Cytokinins, Ethylene, Jasmonic acid	CO3, CO6
	C	Function and biosynthesis of Auxins, Gibberellins, Abscisic acid, Cytokinins, Ethylene, Jasmonic acid	CO3, CO6
	Unit 4	**Nitrogen metabolism**	

	A	Overview of nitrogen in the biosphere and in Plants, Overview of biological nitrogen fixation (BNF), Enzymology of nitrogen fixation			CO4, CO6
	B	Symbiotic nitrogen fixation, Ammonia uptake and transport, Nitrate uptake and transport			CO4, CO6
	C	Nitrite reduction, Nitrate signaling, Interaction between nitrate assimilation and carbon metabolism			CO4, CO6
	Unit 5	**Secondary metabolites**			
	A	Terpenoids, Biosynthesis of the basic five-carbon unit, Repetitive additions of C5 units			CO5, CO6
	B	Alkaloids, Alkaloid biosynthesis, Biotechnological application of alkaloid biosynthesis research			CO5, CO6
	C	Phenolic compounds, Phenolic biosynthesis, The phenylpropanoid-acetate pathway, The phenylpropanoid pathway, Universal features of phenolic biosynthesis			CO5, CO6
	Mode of Examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text book/s*	Buchann (2015), Biochemistry and Molecular Biology of Plants, 2nd ed. Publisher: I K International. ISBN-10: 8188237116, ISBN- 978047 0714218 Taiz, L. and Zeiger, E. (2010). Plant Physiology (5th ed.). Sinauer Associates Inc. ISBN13: 978-0878938667, ISBN-10: 0878938664			
	Other References	Jain, V. K. (2022). Fundamentals of Plant Physiology. India: S. Chand Publishing. ISBN: 9789355011459 Kochhar, S. L., Gujral, S. K. (2020). Plant Physiology: Theory and Applications. United Kingdom: Cambridge University Press.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	1	3	2	3	1	3	2	2	2	2	1	1
CO2	2	3	2	3	2	3	1	1	1	1	2	1
CO3	2	3	2	3	2	2	2	1	2	2	2	1

CO4	2	2	2	3	2	3	1	1	1	1	1	2
CO5	2	2	2	3	2	2	2	1	1	1	1	2
CO6	2	2	2	2	2	2	2	1	1	1	1	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: I**
1	Course Code	CHT1101
2	Course Name	**Basic Analytical Chemistry Lab**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-1
	Course Type	Core
5	Course Objective	1. To develop an understanding of cation and anion analysis. 2. To develop skills in gravimetric analysis. 3. To create the skills for the estimation of metal ions. 4. To strengthen the basic principles of titration through the estimation of acid and alkali contents. 5. To make the student learn the real application of quantitative analysis through water analysis. 6. To develop the concept of good lab practices and finally the skills to apply the laboratory skills in research and the chemical industry.
6	Course Outcomes	CO1 Recall principles of qualitative analysis, gravimetric analysis, and titration techniques used in chemical analysis. CO2: Explain procedures involved in acid and basic radical analysis, gravimetric estimation, and standardization methods. CO3 Apply volumetric methods to estimate metal ions and acid–base contents in chemical samples. CO4 Analyze experimental results obtained from gravimetric, volumetric, and precipitation titration methods CO5 Evaluate analytical methods used for metal ion estimation, chloride determination, and qualitative identification of radicals.

		CO6 Assess experimental data using qualitative, gravimetric, and volumetric analytical techniques.	
7	Course Description	This course includes laboratory methods and tests related to acid and basic radical analysis, functional group test, estimation of metal ions, estimation of acids and alkali contents in commercial products, and water analysis.	
8	Outline syllabus		CO Mapping
	Unit 1	**Qualitative Analysis**	
	A	Analysis of Acid radicals	CO1, CO2, CO6
	B	Analysis of Basic Radicals (Zero group and Ist group)	CO1, CO2, CO6
	C	Viva	CO1, CO2, CO6
	Unit 2	**Gravimetric Analysis**	
	A, B	Estimation of Barium as barium sulphate in barium chloride solution.	CO2, CO3, CO6
	C	Viva	CO2, CO3, CO6
	Unit 3	**Estimation of Metals Ions**	
	A	Estimation of iron content in a given sample using the external and internal indicator method.	CO3, CO4, CO6
	B	Estimation of iron content in a given sample using the internal indicator method.	CO3, CO4, CO6
	C	Estimation of copper using thiosulphate.	CO3, CO4, CO6
	Unit 4	**Estimation of Acids and Alkali Contents**	

	A	Standardization of NaOH using HCl.	CO4, CO6
	B	Estimation of oxalic acid by titrating it with $KMnO_4$.	CO4, CO6
	C	Viva	CO6, CO6
	Unit 5	**Precipitation Titration**	
	A	Determination of chloride ion content in a given water sample by Mohr's method.	CO5, CO6
	B	Determination of chloride ion content in a given water sample by Mohr's method.	
	C	Viva	CO5, CO6

	Mode of examination	Pratical			
	Weightage Distribution	CA	CE Viva	CA	
		30%	30%	40%	
	Text Book/s *	1. J. Mendham, R. C. Denney, J.D. Barnes and M.Thomas, 2000. Vogel's textbook of quantitative chemical analysis. prentice hall.			
	Other References	Harris, D.C. 2016. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	–	–	–	–	–	–	1	–	1	2	–
CO2	3	2	1	1	–	–	–	–	1	–	1	2	1
CO3	2	3	2	3	1	–	–	–	1	–	1	2	2
CO4	2	3	2	3	1	–	–	–	1	–	1	2	2
CO5	2	3	2	3	1	–	–	–	1	–	1	2	2

CO6	2	2	1	2	1	1	2	2	1	1	1	1	1

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: I**
1	Course Code	VOB1101
2	Course Name	**Modern Trends in Chemical Analysis: Step Forward from Laboratory to Industry**
3	Credits	3
4	Contact Hours (L-T-P)	0-0-6
	Course Type	SEC
5	Course Objective	1. Chemical Safety and Ethical Handling of Chemicals 2. Standard Procedure for Cleaning Glassware in Analytical Laboratories Calibration of Laboratory Apparatus (Pipettes, Burettes, Thermometers, etc.) 3. Preparation of Buffer Solutions (Acidic, Basic, and Phosphate Buffers) 4. Water Quality Analysis (e.g., Hardness by EDTA, Turbidity Measurement) 5. Recrystallization, Filtration, and Drying Techniques
6	Course Outcomes	CO1: Recall principles of chemical safety, laboratory hazards, and safe handling, storage, and disposal of chemicals. CO2: Explain procedures for calibration of laboratory apparatus, distillation setups, and buffer preparation methods. CO3: Apply experimental techniques for buffer preparation and water quality analysis using analytical instruments.

		CO4: Analyze laboratory data obtained from calibration, buffer systems, and water quality measurements. CO5: Evaluate purification techniques such as recrystallization, filtration, and drying of chemical compounds. CO6:Assess laboratory practices integrating chemical safety, analytical measurements, and purification techniques.	
7	Course Description	This course develops essential laboratory skills, focusing on chemical safety, ethical practices, and standard procedures. Students will learn safe handling, storage, and disposal of chemicals, calibration of laboratory apparatus, and setups for distillation. Practical training includes buffer preparation and water quality analysis, enabling precise and confident execution of laboratory techniques. The course emphasizes both theoretical understanding and practical competence in essential laboratory practices.	
8	Outline syllabus		CO Mapping
	Unit 1	**Chemical safety and ethical handling of chemicals, storage, and disposal**	
	A	Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, and laboratory ventilation.	CO1, CO2, CO6
	B	Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, and material safety data sheet.	CO1, CO2, CO6
	C	Safe storage and disposal of waste chemicals; Recovery, recycling, and reuse of laboratory chemicals and Viva	CO1, CO2, CO6
	Unit 2	**Calibration and Setups of Laboratory Apparatus**	
	A	Calibration of various laboratory apparatus (Pipette, Burette)	CO2, CO3, CO6
	B	Calibration of a Thermometer Using Standard Temperature Points	CO2, CO3, CO6
	C	Typical assemblies of apparatus setups for distillation and reflux, along with their laboratory use, including simple, fractional, steam, and vacuum distillation.	CO2, CO3, CO6

	Unit 3	**Preparation of Buffer**			
	A	To prepare an acidic buffer with CH_3COOH and CH_3COONa and observe the change in pH on the addition of acid and base.			CO3, CO4, CO6
	B	To prepare a basic buffer with NH_4OH and NH_4Cl, and observe the change in pH on the addition of acid and base.			CO3, CO4, CO6
	C	To prepare a phosphate buffer with NaH_2PO_4 and Na_2HPO_4, and observe the change in pH on the addition of acid and base.			CO3, CO4, CO6
	Unit 4	**Water Quality analysis**			
	A	Estimation of the hardness of water by the EDTA titration method.			CO4, CO5, CO6
	B	Determination of turbidity in water using a turbidity meter.			CO4, CO5, CO6
	C	Analysis of pH and Conductivity in water samples.			CO4, CO5, CO6
	Unit 5	**Recrystallisation, filtration and drying**			
	A	Purification of solid compounds by crystallization, preparation of fluted filter paper, removal of traces of coloring matter and resinous products, difficulties encountered during recrystallization, drying of the recrystallized material,			CO5, CO6
	B	Recrystallization of acetanilide, naphthalene, and sulphanilic acid, and recrystallization under an inert gas atmosphere.			CO5, CO6
	C	Preparation and purification of double salt of Ni, filtration with suction; drying of solid compounds; drying of organic solvents.			CO5, CO6
	Mode of examination	Pratical			
	Weightage Distribution	CA	CE Viva	ETE	
		30%	30%	40%	
		Mendham, J. (2009). *Vogel's quantitative chemical analysis* (6th ed.). Pearson.			

	Text Book/s *	Pandey, O. P., Bajpai, D. N., & Giri, S. (2010). *Practical chemistry* (Revised ed.). S. Chand Publishing.
	Other References	Harris, D. C. (2007). *Quantitative chemical analysis* (6th ed.). W. H. Freeman. Harris, D. C. (2016). *Exploring chemical analysis* (9th ed.). W. H. Freeman. Suggested online links: 1. https://www.researchgate.net/publication/268049349_ 2. Development_of_a_Standardized_Procedure_for_Cleaning_Glass_Apparatus_in_ Analytical Laboratories. 3. https://www.vlab.co.in/broad-area-chemical-sciences 4. http://chemcollective.org/vlabs

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	–	–	–	1	2	–	1	–	1	2	1
CO2	3	2	1	1	1	–	–	–	1	–	1	2	1
CO3	2	3	2	3	1	–	–	–	1	–	1	2	2
CO4	2	3	2	3	1	–	–	–	1	–	1	2	2
CO5	2	3	2	3	1	–	–	–	1	–	1	2	2
CO6	3	3	2	3	2	1	1	1	2	1	2	3	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: II**
1	Course Code	CHT1103
2	Course Name	**Inorganic Chemistry-I**
3	Credits	4
4	Contact Hours (L-T-P)	3-0-1
	Course Type	Core
5	Course Objective	1. To provide the basic concepts in acid-base theory and apply them to understand and compare the reactive acidity, basicity, and reactivity of the molecules. 2. To provide knowledge about the characteristic properties of the s-block elements 3. To illustrate the knowledge about characteristic properties of p-block elements. 4. To describe the redox chemistry of inorganic compounds. 5. Make it comprehensible various metallurgical processes.
6	Course Outcomes	CO1:Recall fundamental concepts of acids–bases, redox reactions, and general properties of s- and p-block elements. CO2: Explain theories of acid–base behavior, bonding in hydrides, and trends in s- and p-block elements. CO3: Apply principles of redox reactions and electrode potentials to balance reactions and predict inorganic transformations.

		CO4: Analyze structure, bonding, and reactivity patterns of selected compounds of s- and p-block elements. CO5: Evaluate metallurgical processes and purification techniques using thermodynamic and electrochemical principles. CO6: Assess relationships between acid–base behavior, redox chemistry, and metallurgical processes in inorganic systems.	
7	Course Description	This course describes the acid-base properties of compounds and the chemistry of s-block and p-block elements. This course also includes redox properties of elements and metallurgical processes.	
8	Outline syllabus		CO Mapping
	Unit 1	**Acids and Bases**	
	A	Concepts of Acids and Bases: Arrhenius concept; Bronsted – Lowry concept; Acidity and Basicity based on stability of conjugate acid-base pair	CO1,CO2, CO6
	B	Lewis acid – base concept ; Usanovich Concept; Superacids,	CO1,CO2, CO6
	C	HSAB principle and its applications, Amphoterism, Lux-Flood concept	CO1,CO2, CO6
	Unit 2	**Chemistry of s-block Elements**	
	A	General trends of variation of electronic configuration, metallic nature, oxidation states,	CO2,CO3, CO6
	B	Properties and reactions of some selected compounds such as hydrides, halides, oxides, oxyacids	CO2,CO3, CO6
	C	Complex chemistry in respect of s-block elements (Group 1 and Group 2)	CO2,CO3, CO6
	Unit 3	**Chemistry of p-block elements**	
	A	Structure and bonding in hydrides of group 13 (only Diborane), group 14, group 15 (EH_3 where E=N, P, As), and group 16.	CO3, CO4, CO6
	B	Oxides: Oxides of nitrogen, phosphorus, and sulphur. Oxoacids: Oxoacids of nitrogen, phosphorus, and peroxoacids of sulphur.	CO3, CO4, CO6

	C	Halides: Halides of nitrogen and phosphorus			CO3, CO4, CO6
	Unit 4	**Redox chemistry**			
	A	Oxidation-reduction is an electron transfer process, involving oxidizing and reducing agents			CO4, CO5, CO6
	B	Ion-electron method of balancing redox reactions			CO4, CO5, CO6
	C	Standard Electrode Potential and its application to inorganic reactions with an emphasis to MnO_4^-/Mn^{+2} (acidic, basic, and neutral medium), $Cr_2O_7^{2-}/Cr^{+3}$ (acidic and basic medium), Fe^{+3}/Fe^{+2}.			CO4, CO5, CO6
	Unit 5	**Metallurgy**			
	A	The chief mode of occurrence of metal based on the standard electrode potential. Ellingham diagrams for the reduction of metal oxides using carbon and carbon monoxide as reducing agents.			CO4, CO5, CO6
	B	Method of purification of metals: Electrolytic Kroll process, Van Arkel-de Boer process			CO4, CO5, CO6
	C	Mond's process: electrolytic reduction			CO4, CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s *	1. Atkins, P., Overton, T., Rourke, J., Weller, M., & Armstrong, F. (2010). *Shriver & Atkins' inorganic chemistry* (5th ed.). Oxford University Press. 2. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). *Inorganic chemistry: Principles of structure and reactivity* (4th ed.). Addison-Wesley.			
	Other References	https://nptel.ac.in/courses/104101090 Reference books Greenwood, N. N., & Earnshaw, A. (1997). *Chemistry of the elements* (2nd ed.). Butterworth-Heinemann. Miessler, G. L., & Tarr, D. A. (1999). *Inorganic chemistry* (2nd ed.). Prentice Hall			

		International. Garg, R., & Singh, R. (n.d.). *Inorganic chemistry*. Tata McGraw-Hill Publishing.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	–	–	–	–	–	–	1	–	1	2	–
CO2	3	2	–	1	–	–	–	–	1	–	1	2	1
CO3	2	3	2	2	1	–	–	–	1	–	1	2	2
CO4	2	3	2	3	1	–	–	–	1	–	1	2	2
CO5	2	3	2	3	1	1	–	–	1	–	1	2	2
CO6	3	3	2	3	2	1	–	1	2	1	2	3	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: II**
1	Course Code	CHT1104
2	Course Name	**Physical Chemistry I**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Type	Core
5	Course Objective	1. To understand the laws of solid-state chemistry and the arrangement of ions/atoms/molecules in a crystal lattice. 2. To provide an understanding of physical states of matter and how they are related to daily life applications. 3. To define how the initially primitive models of real gases in physical chemistry are elaborated to take into account more detailed observations. 4. To extend the concept of solutions from Raoult's Law to industrial application processes. 5. To the theoretical aspects of chemical kinetics and identify the importance of rate equations for studying the kinetics of reactions 6. To provide the introduction and application of solid, liquid and gaseous states. To list different properties of liquids involving surface tension and viscosity coefficients.

6	Course Outcomes	CO1: Recall fundamental concepts of solid-state structures, liquid properties, and gaseous behaviour in physical chemistry. CO2: Explain principles governing colligative properties, gas laws, and physical properties of liquids. CO3: Apply theoretical principles to solve problems related to gas behaviour, colligative properties, and chemical kinetics. CO4: Analyze crystal structures, deviations in solutions and gases, and distribution laws in chemical systems. CO5: Evaluate reaction kinetics, catalytic processes, and thermodynamic factors influencing reaction rates. CO6 Assess relationships among solid state properties, solution behaviour, gaseous systems, and reaction kinetics in chemical processes.	
7	Course Description	Course emphasizing the various solid state structures and its correlation to atomic coordination, distinguishing properties of liquid state, physical properties of molecules in solutions and gaseous state, thermochemistry aspects of chemical process.	
8	Outline syllabus		CO Mapping
	Unit 1	**Solid State**	
	A	Crystalline and amorphous solids, crystal lattices, and unit cells,	CO1, CO2, CO6
	B	Crystal systems -types, close packing, packing fraction, Crystal density, Ionic Radii, radius ratio.	CO1, CO2, CO6
	C	X–ray diffraction: Bragg's law, Structures of NaCl, KCl, and CsCl (qualitative treatment only), Point Defects.	CO1, CO2, CO6
	Unit 2	**Liquid State**	CO1, CO2, CO6
	A	Qualitative treatment of the structure of the liquid state	CO2, CO3, CO6
	B	Physical properties of liquids: vapor pressure, surface tension, coefficient of viscosity, and their determination.	CO2, CO3, CO6
	C	Effect of addition of various solutes on surface tension and viscosity. Temperature variation of the viscosity of liquids and comparison with that of gases.	CO2, CO3, CO6

	Unit 3	**Gaseous State**			
	A	Kinetic theory of gases, derivation of the ideal gas equation, Maxwell distribution of molecular velocities and molecular energies,			CO3, CO4, CO6
	B	Deviation of gases from ideal behaviour, compressibility factor (Z), van der Waals' equation of state, and its application to explain the deviation of gases.			CO3, CO4, CO6
	C	Critical constant of gas in terms of van der Waals' constant: derivation of P_c, T_c, and V_c.			CO3, CO4, CO6
	Unit 4	**Solution**			
	A	Colligative properties, Raoult's law, Deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions			CO4, CO5, CO6
	B	Azeotropes, Partial miscibility of liquids: critical solution temperature			CO4, CO5, CO6
	C	Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, Solvent extraction.			CO4, CO5, CO6
	Unit 5	**Kinetics and Catalysis**			
	A	Molecularity and order, differential and integrated form of rate expressions for zero-order and first-order reactions			CO4, CO5, CO6
	B	differential and integrated form of rate expressions for second-order reactions, experimental methods of the determination of rate laws			CO4, CO5, CO6
	C	Catalysis, positive and negative catalysis, Characteristics of catalytic reactions, Heterogeneous catalysis, and homogeneous catalysis. Activation energy			CO4, CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	

	Text Book/s *	1. Kapoor K. L., "Textbook of Physical Chemistry", Macmillan Publishers 2. Puri, Sharma and Pathania, "Principles of Physical Chemistry, Vishal Publishing Co.
	Other References	Glasston, Physical Chemistry

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	–	–	–	–	–	–	1	–	1	2	–
CO2	3	2	–	1	–	–	–	–	1	–	1	2	1
CO3	2	3	2	2	1	–	–	–	1	–	1	2	2
CO4	2	3	2	3	1	–	–	–	1	–	1	2	2
CO5	2	3	2	3	1	–	–	–	1	–	1	2	2
CO6	3	3	2	3	2	1	–	1	2	1	2	3	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: III**
1	Course Code	CHT2101
2	Course Name	**Inorganic Chemistry II**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Core
5	Course Objective	1. Have an understanding of bonding of d-block elements, isomerism in inorganic complexes and their applications. 2. Understand the process of lanthanide contraction. 3. Understand the bonding behavior of complexes. 4. Acquire knowledge about factors affecting the stability of complexes. 5. Relate the magnetic properties with elements. 6. Apply the knowledge to interpret the magnetic nature of a given compound.
6	Course Outcomes	CO1: Define and describe the characteristic properties of 3d elements, including ionic radii, oxidation states, and complexation tendencies. CO2: Explain and compare the catalytic and electronic spectral properties of transition metals, and interpret spectrophotometric estimation of metal ions. CO3: Apply principles of coordination chemistry to interpret structure, bonding, isomerism, and applications of transition metal complexes. CO4: Analyze the comparative chemistry of lanthanides and actinides with respect to electronic configuration, contraction phenomena, and separation principles.

		CO5: Evaluate theories of metal-ligand bonding, stability factors of coordination complexes, and justify the relationship between ligand properties and complex stability. CO6: Design and propose explanations for the magnetic and color properties of transition and inner transition metal complexes, integrating theoretical models with experimental data.	
7	Course Description	This course enables the student to understand the chemistry of d and f block elements. The bonding, isomerism, and magnetic properties of coordination compounds are described.	
8	Outline syllabus		CO Mapping
	Unit 1	**Chemistry of d-block elements**	
	A	Characteristic properties of 3d elements: ionic radii, oxidation states, and complexation tendency	CO1, CO2, CO6
	B	Catalytic properties and electronic spectral properties. Spectrophotometric estimation of metal ions.	CO1, CO2, CO6
	C	Stability of various oxidation states and e.m.f. (Latimer, Frost diagrams). Comparison of 3d elements with 4d & 5d elements	CO1, CO2, CO6
	Unit 2	**Chemistry of f-block elements**	
	A	Comparative study of lanthanide and actinide elements with respect to electronic configuration, atomic and ionic radii, oxidation state, and complex formation	CO2,CO3, CO6
	B	Lanthanide and Actinide Contraction.	CO2,CO3, CO6
	C	Occurrence and principles of separation of lanthanides and actinides	CO2,CO3, CO6
	Unit 3	**Coordination Chemistry-I**	
	A	Werner's theory, nomenclature, and stereochemistry of complexes with coordination numbers 4, 5, 6; Isomerism in coordination complexes.	CO3, CO4, CO6

	B	Important applications of coordination compounds and chelates. Theories of metal-ligand bonding in transition metal complexes			CO3, CO4, CO6
	C	valence bond theory of coordination compounds with specific reference to CN^{-}, NH_3, OH^{-}, and limitations.			CO3, CO4, CO6
	Unit 4	**Coordination Chemistry-II**			
	A	A brief outline of the thermodynamic stability of metal complexes (methods of determination excluded).			CO4, CO5, CO6
	B	Effect of central ion on stability (ionic size, ionic charge, electronegativity), effect of ligand on stability (size and charge of ligand, basic character, steric effects, chelation, and size of the chelate ring)			CO4, CO5, CO6
	C	Color of complexes, Theory behind colour, Colour in transition and inner transition elements			CO4, CO5, CO6
	Unit 5	**Magnetic Properties of Complexes**			
	A	Types of magnetic behaviour, methods of determining magnetic susceptibility,			CO5, CO6
	B	spin-only formula. L-S coupling,			CO5, CO6
	C	correlation of μs and μeff values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s *	Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). *Inorganic chemistry: Principles of structure and reactivity* (4th ed.). Addison-Wesley. Greenwood, N. N., & Earnshaw, A. (1997). *Chemistry of the elements* (2nd ed.). Butterworth-Heinemann.			

	Other References	Cotton, F. A., & Wilkinson, G. (1999). *Advanced inorganic chemistry* (6th ed.). John Wiley & Sons. Atkins, P., Overton, T., Rourke, J., Weller, M., & Armstrong, F. (2010). *Shriver & Atkins' inorganic chemistry* (5th ed.). Oxford University Press. Miessler, G. L., & Tarr, D. A. (1999). *Inorganic chemistry* (2nd ed.). Prentice Hall International.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	1	1	1	1	3	3	2
CO2	3	2	1	2	2	2	1	1	1	1	3	3	2
CO3	3	3	2	2	2	2	1	1	1	2	3	3	3
CO4	3	3	2	3	2	2	1	1	1	2	3	3	3
CO5	3	3	2	3	3	2	1	1	1	2	3	3	3
CO6	3	3	3	3	3	2	1	2	1	3	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: III**
1	Course Code	CHT2102
2	Course Name	**Organic Chemistry I**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Core
5	Course Objective	To provide knowledge of synthesis, physical and chemical properties of aliphatic hydrocarbons alkanes alkenes and alkynes. Discuss the structure, reactivity of benzene, its homologues, and polynuclear aromatic hydrocarbons like naphthalene, anthracene and phenanthrene Identify and categorize many functional groups like alcohol, ether, phenol and epoxides and their reactivity Describe the structure, reaction, and properties of alcohols. Ethers, and epoxides and phenol. Apply the knowledge in organic synthesis.

6	Course Outcomes	CO1: Define and describe the structure, nomenclature, methods of preparation, and basic reactions of alkanes, alkenes, alkynes, arenes, alkyl/aryl halides, alcohols, phenols, thiols, ethers, epoxides, and organometallic compounds. CO2: Explain the mechanisms of important organic reactions including free radical halogenation, electrophilic and nucleophilic addition, elimination reactions (Saytzeff and Hofmann), aromatic electrophilic substitution, and nucleophilic substitution (SN1, SN2, SNi, SNAr, benzyne) with stereochemical aspects. CO3: Apply concepts of reactivity, orientation, aromaticity (Hückel rule), and stability to predict products of reactions involving hydrocarbons and their derivatives, including organometallic reagents and functional group transformations. CO4: Analyze the influence of substituents, reaction conditions, intermediates (carbocations, carbanions, free radicals), and solvent effects on the outcome, selectivity, and mechanisms of organic reactions. CO5: Evaluate reactivity and selectivity of organic reactions under different conditions. CO6: Design synthetic pathways for the preparation of organic compounds using appropriate reagents and reactions, including multi-step synthesis and functional group interconversions.	
7	Course Description	This course enables the students to generalize the structural properties relationship of alkanes, alkenes, and alkynes. It also gives an in-depth idea about the synthesis and properties of various compounds, such as alcohol, phenol, alkyl aryl halides, ethers, and epoxide, by different methods.	
8	Outline syllabus		CO Mapping
	Unit 1	**Aliphatic Hydrocarbon**	
	A	**Alkanes:** Methods of synthesis (with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids & their salts) Chemical reactions: Nitration, Halogenation, Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity.	CO1, CO2, CO6
	B	**Alkenes:** Methods of synthesis, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides. The Saytzeff rule, Hofmann elimination, relative stabilities of alkenes. Chemical reactions – hydrogenation, electrophilic and free radical additions, Markownikoff's rule, Anti Markownikoff's rule, hydroboration, oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$.	CO1, CO2, CO6

	C	**Alkynes:** Methods of synthesis, chemical reactions, acidity of terminal alkynes, mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.	CO1,CO3, CO6
	Unit 2	**Arenes and Aromaticity**	
	A	Structure of benzene; molecular formula and Kekule structure, stability and carbon-carbon bond lengths of benzene, resonance, MO picture of benzene.	CO2, CO4, CO6
	B	Aromaticity: The Huckel rule, aromatic ions. Aromatic electrophilic substitution – general pattern of the mechanism, role of σ and π complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction.	CO2, CO3, CO6
	C	Activating and deactivating substituents, Directive influence of groups (orientation and ortho/para ratio), Side chain reactions of benzene derivatives, Birch reduction. Structure, preparation and reactions of naphthalene and anthracene.	CO2, CO4, CO6
	Unit 3	**Alkyl Halide, Aryl Halides and Organometallic compounds**	
	A	**Alkyl halides:** Methods of preparation, nucleophilic substitution reactions – SN^1, SN^2 and SN^i mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs elimination	CO3, CO5, CO6
	B	Aryl halides: Preparation (including preparation from diazonium salts), nucleophilic aromatic substitution; SN^{Ar}, Benzyne mechanism Relative reactivity of Alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.	CO3,CO5, CO6
	C	Organometallic compounds of Mg and Li (Grignard reagents), their applications	CO3, CO6
	Unit 4	**Alcohol, Phenol and Thiol**	
	A	**Alcohols**: Preparation, Bouvaeult-Blanc reduction, properties and relative reactivity of 1^0, 2^0, 3^0 alcohols. Important reactions of alcohols.	CO4, CO5, CO6

		Preparation and properties of polyhydric alcohols: glycols and glycerol.			
	B	**Phenols:** Preparation and properties; acidity and factors affecting acidity, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism.			CO4, CO5, CO6
	C	**Thiols:** Nomenclature, synthesis, and important reactions.			CO4, CO5, CO6
	Unit 5	**Ethers and Epoxides**			
	A	**Ethers:** Preparation (Williamson Synthesis), Physical and Chemical properties, Diethyl ether, Crown ethers.			CO5, CO6
	B	Structure, synthesis, and important reactions of thioethers.			CO5, CO6
	C	**Epoxides:** Synthesis, acid and base catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s*	1. Solomons, T. G., & Fryhle, C. B. (2017). *Organic chemistry*. John Wiley & Sons. 2. Bahl, A. (2010). *Advanced organic chemistry*. S. Chand. 3. Mosher, M. (1992). Organic Chemistry. (Morrison, Robert Thornton; Boyd, Robert Neilson)			
	Other References	Kalsi, P. S. (2005). Organic reactions and their mechanisms. New Age International.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	2	2	2	2	2	1	1	1	1	1	1
CO2	3	3	3	3	3	1	2	1	1	1	1	1	1
CO3	3	2	3	3	3	1	2	1	1	1	1	1	1
CO4	3	2	3	3	3	1	2	1	1	1	1	1	1
CO5	3	2	3	3	3	1	2	1	1	1	1	1	1
CO6	3	2	3	3	3	1	2	1	1	1	1	1	1

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: III**
1	Course Code	CHT2103
2	Course Name	**Introduction to Engineering Materials**
3	Credits	2
4	Contact Hours (L-T-P)	2-0-0
	Course Type	SEC
5	Course Objective	1. Explain the various types of Engineering Materials and their classification. 2. Illustrate the knowledge about the cements and their types. 3. Understand the action of different types of engineering materials, such as composites 4. Acquire knowledge about the formulation of ceramics and refractories. 5. Acquire thorough proficiency in the types and behaviour of nanomaterials, Metal-organic framework, and covalent-organic framework. 6. Describe technologically engineering materials, construction materials, inorganic polymers, metal-organic frameworks, nanomaterials, and their properties.

6	Course Outcomes	**CO1:** Define and describe the fundamental concepts of various engineering materials and study their classification. **CO2:** Explain the relationship between structure, properties, and performance of different engineering materials such as metals, ceramics, polymers, and composites. **CO3:** Apply principles of materials science to determine mechanical, thermal, and electrical properties for engineering applications. **CO4:** Analyze material behavior by interpreting the crystal defects and microstructural characteristics. **CO5:** Evaluate the suitability of different materials for specific engineering applications based on their properties and performance. **CO6:** Design or propose appropriate material selection strategies for engineering components, considering mechanical and environmental requirements.	
7	Course Description	This course describes the chemistry of engineering materials and nanomaterials with emphasis on polymers. This course satisfies the requirement of the B.Sc. Chemistry Honors Program.	
8	Outline syllabus		CO Mapping
	Unit 1	**Engineering materials**	
	A	Introduction to Engineering Materials, Types, and various types of Engineering materials	CO1, CO2, CO6
	B	Glass and related compounds, Composition, mechanical, and fabricating characteristics	CO1, CO2, CO6
	C	Characteristics and applications of composites in advanced technologies	CO1, CO2, CO6
	Unit 2	**Cement**	
	A	Cement: Raw material, composition, manufacturing process and application of Portland cement, Chemistry of setting of cement	CO2, CO3, CO6
	B	Refractories: Introduction, classification	CO2, CO3, CO6
	C	Properties, raw materials, manufacturing and applications	CO2, CO3, CO6

	Unit 3	**Composites**			
	A	Introduction to composite materials: Definition of composites, Classification of composites; General characteristics of reinforcement- classification.			CO3,CO4, CO6
	B	Polymer matrix composites: Thermoplastic and thermosetting resins; Commonly used matrix reinforcement systems; Fibre, Flake, and particulate reinforced composites, Reinforcements used in PMC: glass, carbon, aramids.; Thermoset matrices for aerospace components- polyesters, epoxies, phenolics. Thermoplastic matrices for advanced composites			CO3,CO4, CO6
	C	Nanocomposites: Nanoparticle dispersion in polymer matrix.			CO3,CO4, CO6
	Unit 4	**Ceramics**			
	A	Introduction to ceramic materials; Classification of ceramics,			CO4, CO5, CO6
	B	Mechanical behavior of ceramics, glass, and glass ceramics.			CO4, CO5, CO6
	C	Applications of ceramics in advanced technologies			CO4, CO5, CO6
	Unit 5	**Metal organic Framework/COF**			
	A	Introduction, Metal organic framework (MOF), Covalent organic framework (MOF), Synthesis of MOF/COF			CO5, CO6
	B	Properties of MOF/COF			CO5, CO6
	C	Applications of MOF, COF			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s*	Odian, G. (n.d.). *Principles of polymerization*. John Wiley. Billmeyer, F. W. (n.d.). *Textbook of polymer science*. John Wiley. Felder, R. M., & Rousseau, R. W. (n.d.). *Elementary principles of chemical*			

		processes. Wiley Publishers. Poole, C. P., & Owens, F. J. (2003). *Introduction to nanotechnology*. John Wiley & Sons.
	Other References	Kaskel, S. (2016). *The chemistry of metal–organic frameworks: Synthesis, characterization, and applications*. Wiley-VCH.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	1	1	2	-	-	1	-	2	2	2
CO2	3	2	2	2	2	3	1	-	1	-	2	2	3
CO3	3	2	3	2	2	2	1	2	2	-	2	2	3
CO4	3	2	2	2	2	2	1	1	1	-	2	2	2
CO5	3	2	1	1	1	2	-	-	1	-	2	2	2
CO6	3	2	2	2	2	3	1	-	1	-	2	2	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: III**
1	Course Code	CHP2102
2	Course Name	**Organic Chemistry Lab-I**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
	Course Type	Core
5	Course Objective	1. To learn methods for purification and qualitative analysis of organic compounds 2. To execute independently purification techniques to organic compounds like filtration, recrystallization, sublimation, and distillation. 3. To perform the qualitative test on unknown organic compounds, i.e., preliminary tests, tests for extra elements. 4. To understand the basic concept of quantitative analysis for organic compounds 5. To understand the concept of organic acid and perform the acid-base titration to calculate their solubility in solvents at room temperature.
6	Course Outcomes	CO1: Describe principles of purification techniques such as recrystallization, filtration, and sublimation, along with solubility and melting point determination. CO2: Explain procedures for purification of organic compounds and qualitative analysis of elements (N, S, halogens) and functional groups. CO3: Apply purification techniques, solubility tests, and melting point determination to obtain pure organic compounds and calculate percentage yield.

		CO4: Analyze experimental results to identify extra elements and functional groups, and differentiate types of alcohols. CO5: Evaluate purity and efficiency of purification methods based on melting point, yield, and experimental observations. CO6: Design and perform synthesis of organic compounds such as nitration of benzene, iodoform, and phenolphthalein using appropriate techniques.	
7	Course Description	This course gives an idea about detection of organic elements/functional groups in a sample.	
8	Outline syllabus		CO Mapping
	Unit 1	**Purification of Organic Compounds-1**	
	A	To check the solubility of organic compounds and Filtration/Purification of organic compounds by recrystallization using Water solvent (Phthalic acid, Benzoic acid)	CO1, CO2, CO6
	B	Filtration/Purification of organic compounds by recrystallization using an organic solvent (Naphthalene)	CO1, CO2, CO6
	C	Determination of the melting points of the above compounds and report the yields of pure compounds.	CO1, CO2, CO6
	Unit 2	**Purification of Organic Compounds-2**	
	A	To perform the purification of crude naphthalene by the sublimation method and calculate the percentage yield and M.P.	CO2, CO3, CO6
	B	To determine the solubility of the given organic acid(oxalic acid)	CO2, CO3, CO6
	C	To determine the solubility of the given organic acid(oxalic acid)	
	Unit 3	**Element detection in organic compounds(N, S, halogen)**	CO2, CO3, CO6
	A	To analyze the presence of extra elements (N, S, halogens) other than C, H, &O in the given organic compound	
	B	To analyze the presence of extra elements (N, S, halogens) other than C, H, &O in the given organic compound	CO3, CO4, CO6

	C	To analyze the presence of extra elements (N, S, halogens) other than C, H, &O in the given organic compound			CO3, CO4, CO6
	Unit 4	**Functional Group Analysis**			CO3, CO4, CO6
	A	To analyze the presence of functional group/s in the given organic compounds			
	B	To identify primary, secondary, and tertiary alcohols			CO4, CO5, CO6
	C	To identify primary, secondary, and tertiary alcohols			CO4, CO5, CO6
	Unit 5	**Synthesis of Organic Compounds**			
	A	To execute the nitration of Benzene			CO4, CO5, CO6
	B	To perform the synthesis of Iodoform			CO4, CO5, CO6
	C	To perform the synthesis of Phenolphthalein			CO4, CO5, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE Viva	CA	
		30%	30%	40%	
	Text Book/s *	O.P. Pandey, D.N. Bajpai, S.Giri, (2005). Practical Chemistry, S. Chand & Co. Vogel, I. (1974). *Practical organic chemistry*.			
	Other References	Mendham, J. (2005). *Quantitative chemical analysis of Vogel*. De Boeck Higher.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	3	1	1	2	3	1	1	1	1

CO2	3	1	1	1	3	1	1	2	3	1	1	1	1
CO3	3	2	1	2	3	1	1	2	3	1	1	1	1
CO4	3	2	1	2	3	1	1	2	3	1	1	1	1
CO5	3	2	1	2	3	1	1	2	3	1	1	1	1
CO6	3	1	1	1	3	1	1	1	3	1	1	2	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: III**
1	Course Code	CHP2101
2	Course Name	**Organic Chemistry Lab-I**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
	Course Type	Core
5	Course Objective	The main objectives of this course are to teach the students about the detection of cations and anions qualitatively. This course also aims to teach the student the quantitative estimation of metal ions by various analytical techniques.
6	Course Outcomes	CO1: Describe principles of qualitative and quantitative analysis of cations, anions, complexometric titration, and redox reactions. CO2: Explain procedures for systematic qualitative analysis of cations, anions, and their mixtures using standard methods. CO3: Apply volumetric and gravimetric techniques to quantitatively estimate ions such as halides, nitrates, Ca^{2+}, Fe^{2+}/Fe^{3+}, and Cr. CO4: Analyze experimental observations to identify unknown cations and anions in mixtures using confirmatory tests.

		CO5: Evaluate the accuracy and reliability of analytical results based on calculations, titration data, and experimental conditions. CO6: Design and perform analytical procedures, including complexometric titration and redox analysis for real sample applications (e.g., dolomite, milk powder).	
7	Course Description	Qualitative and quantitative determination of elements from a mixture.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on qualitative analysis of an anion**	
	A	Quantitative analysis of anions: Bromide, Carbonate, Chloride, Fluoride, Iodide, Nitrate	CO1, CO2, CO6
	B	Quantitative analysis of anions: Bromide, Carbonate, Chloride, Fluoride, Iodide, Nitrate	CO1, CO2, CO6
	C	Quantitative analysis of anions: Bromide, Carbonate, Chloride, Fluoride, Iodide, Nitrate	CO1, CO3, CO6
	Unit 2	**Practical based on qualitative analysis of cation**	
	A	Quantitative analysis of cations: Aluminium, Ammonium, Antimony, Arsenic, Barium, Bismuth, Cadmium, Calcium, Lead, Magnesium, Mercury, Strontium, Tin	CO2, CO6
	B	Quantitative analysis of cations: Aluminium, Ammonium, Antimony, Arsenic, Barium, Bismuth, Cadmium, Calcium, Lead, Magnesium, Mercury, Strontium, Tin	CO2, CO3, CO6
	C	Quantitative analysis of cations: Aluminium, Ammonium, Antimony, Arsenic, Barium, Bismuth, Cadmium, Calcium, Lead, Magnesium, Mercury, Strontium, Tin	CO2, CO6
	Unit 3	**Practical based on qualitative analysis of cation and anion in a mixture**	
	A	Qualitative analysis of cations and anions in an unknown mixture	CO3, CO4, CO6
	B	Qualitative analysis of cations and anions in an unknown mixture	CO3, CO6
	C	Qualitative analysis of cations and anions in an unknown mixture	CO3, CO6

	Unit 4	**Practical based on complexometric titration**			
	A	Analysis of Dolomite			CO4, CO5, CO6
	B	Analysis of Ca in milk powder			CO4,CO5, CO6
	C	Analysis of Ca in milk powder			CO4, CO6
	Unit 5	**Practical related to redox reaction**			
	A	Quantitative determination of Cr and Fe in a mixture			CO5, CO6
	B	Quantitative determination of Fe^{2+} and Fe^{3+} in a mixture			CO5, CO6
	V	Quantitative determination of Fe^{2+} and Fe^{3+} in a mixture			CO5, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE	CA	
		30%	30%	40%	
	Text Book/s *	1. Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (2000). *Vogel's textbook of quantitative chemical analysis* (6th ed.). Pearson Education Limited. 2. Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (2000). *Vogel's textbook of quantitative chemical analysis* (6th ed.). Pearson Education Limited			
	Other References	Pandey, O. P., Bajpai, D. N., & Giri, S. (2010). *Practical chemistry* (Rev. ed.). S. Chand Publishing.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	2	3	2	2	1	1	1	1	2	3	2
CO2	3	3	2	3	2	1	1	1	1	1	2	3	2
CO3	2	3	3	3	2	2	1	2	2	2	3	3	3
CO4	3	2	2	3	2	2	1	1	1	1	2	3	2

CO5	3	3	2	3	2	2	1	1	1	1	2	3	3
CO6	3	3	2	3	2	2	1	2	1	1	3	3	3

School		Sharda School of Engineering & Science
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: III**
1	Course Code	**CHT2204**
2	Course Name	**Introduction to Developmental Biology**
3	Credits	03
4	Contact Hours (L-T-P)	3-0-0
	Course Type	DSE
5	Course Objective	To provide basic knowledge of the development processes. To explain various molecular and cellular mechanisms involved in animal development. To differentiate animal models in the study of developmental processes
6	Course Outcomes	CO1: Define the fundamental concepts of evolutionary embryology and the stages of early development, including fertilization, cleavage, gastrulation, and neurulation. CO2: Explain the Spemann-Mangold organizer theory and the role of the Nieuwkoop center in mesodermal induction and body axis determination. CO3: Apply the molecular mechanisms of differential gene expression and identify the role of key signaling pathways (Fgf, Wnt, Hedgehog) in cell-cell communication and intercellular connections. CO4: Compare and contrast the developmental patterns of model organisms, such as C. elegans (cell lineage), Drosophila (axis patterning), and Zebrafish (early embryogenesis). CO5: Interpret various teratogenic agents (chemical, physical, and biological) and appraise their impact on embryonic development with specific reference to alcohol and retinoic acid.

		CO6: Interpret the comprehensive foundation in developmental biology, moving from fundamental biological processes to advanced molecular mechanisms and clinical applications	
7	Course Description	This course aims to equip learners with foundational knowledge about the development processes and the various molecular and cellular mechanisms involved in animal development.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Developmental Biology**	
	A	History, Evolutionary embryology and Basic concepts of developmental biology, Overview of fertilization	CO1, CO6
	B	early development- Patterns of cleavage, germ layer formation, implantation, placentation,	CO1, CO6
	C	Formation of blastula, embryogenesis: Nieuwkoop center, Spemann-Magold organizer theory and mesodermal induction, Gastrulation, Fate maps, and neural tube formation.	CO1, CO6
	Unit 2	**Molecular biology of development**	
	A	Role of differential gene expression in development, Role of cell-cell communication in development.	CO2, CO6
	B	Key signaling pathways in development: Fgf, Hedgehog, Wnt, TGFß, and Notch. Cadherins in establishing intercellular connections	CO2, CO6
	C	Role of extracellular matrix in development: Concepts of induction, competence, and senescence.	CO2, CO6
	Unit 3	**Study on model organisms**	
	A	*Caenorhabditis elegans:* Study of cell lineage, mosaic development and organogenesis (vulva formation).	CO3, CO6
	B	*Drosophila melanogaster:* Role of maternal effect genes, morphogens and zygotic genes (Gap genes to homeotic genes) in axis formation and body patterning.	CO3, CO6
	C	*Danio rerio* (Zebra fish)*:* Study various early embryogenesis stages starting from the zygote - cleavage - blastula - gastrula - segmentation, pharyngula, hatching and early larval development	CO3, CO6

	Unit 4	**Stem cells and their implications in treatment strategies**			
	A	Stem cells and their types, and their			CO4, CO6
	B	Pluripotent cells, Induced pluripotent stem cells			CO4, CO6
	C	stem cells applications in human development and diseases. Ethical issues.			CO4, CO6
	Unit 5	**Developmental defects and the role of teratogens**			
	A	Chemical, physical and biological agents which can cause developmental defects.			CO5, CO6
	B	Brief discussion of alcohol and retinoic acid as teratogenic agents.			CO5, CO6
	C	Brief discussion of alcohol and retinoic acid as teratogenic agents.			CO5, CO6
	Mode of Examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text book/s*	Alberts, B. (2015). Molecular Biology of the Cell. 6th Edition, Garland Science, Taylor and Francis Group, New York. 2. Gilbert, S.F. and Barresi, M.J.F. (2017), Developmental Biology, 11th Edition 2016. Am. J. Med. Genet., 173: 1430-1430. https://doi.org/10.1002/ajmg.a.38166.			
	Other References	Kimmel, C.B., Ballard, W.W., Kimmel, S.R., Ullmann, B. and Schilling, T.F. (1995), Stages of embryonic development of the zebrafish. Dev. Dyn., 203: 253-310. https://doi.org/10.1002/aja.1002030302 2. Basson, M. A. (2012). Signaling in cell differentiation and morphogenesis. Cold Spring Harbor perspectives in biology, 4(6), a008151. https://doi.org/10.1101/ cshperspect.a008151			

Mapping: CO Vs POs and PSOs

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CO1	1	3	2	3	1	3	2	2	2	2	1	1
CO2	2	3	2	3	2	3	1	1	1	1	2	1

CO3	2	3	2	3	2	2	2	1	2	2	2	1
CO4	2	2	2	3	2	3	1	1	1	1	1	2
CO5	2	2	2	3	2	2	2	1	1	1	1	2
CO6	2	2	2	2	2	2	2	1	1	1	1	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: IV**
1	Course Code	CHR2101
2	Course Name	**Research-Based Learning -1 (RBL-1)**
3	Credits	0
4	Contact Hours (L-T-P)	0-0-4
	Course Type	RBL
5	Course Objective	1. the course aims to allow the students to perform a research project within the field of chemistry under supervision according to an individual study plan. 2. To summarize the results in a research report and present the results of the project.
6.	Course Outcomes	

6	Course Outcomes	CO1: Apply experimental approaches to identify and address a research problem through appropriate scientific methodology. CO2: Collect and organize research data through literature survey and experimental observations for further interpretation and evaluation. CO3:Demonstrate professional research practices, including time management, collaboration, and integration of theoretical and practical knowledge. CO4: Analyse and communicate research outcomes effectively through scientific discussions and oral presentations in academic forums. CO5: Evaluate and document research findings by preparing a structured scientific report with appropriate data representation. CO6: Design and conduct an independent research investigation demonstrating critical thinking, creativity, and problem-solving ability.	
7	Course Description	This course will deepen the student's understanding of research in general, and basic science and technological research in particular. The students are expected to apply knowledge of methodology, concepts, philosophical problems, and creative mapping in this course to their own fields of exploration to get optimal results.	
8	Outline syllabus		CO Mapping
	Unit 1	**Identifying the research problem** Selection of a research problem based on the application on a particular field of science and technology	CO1, CO6
	Unit 2	**Literature search and formulation of scientific methods** Rigorous literature searches and collection of data for performance and execution of methods	CO2, CO6
	Unit 3	**Managing time and execution of scientific methodology** Solving the research problem by meticulous time management, planning, and well-standardized methods so as to link theoretical and practical knowledge	CO3, CO6
	Unit 4	**Research Presentation in a scientific forum** Discussion and presentation of research problem on a scientific forum and also in front of peer's students and friends	CO4, CO6
	Unit 5	**Making of a scientific report** Making of a scientific report, include results, graphs, table with future remarks justifying the research problem, checking the similarity index, and submitting it to the competent authority	CO5, CO6

	Mode of examination	Practical			
	Weightage Distribution	CA	MTE	ETE	
		40%	-	60%	
	Text Book/s *	**Suggested Readings:** Research Methodology: Methods and Techniques by CR Kothari Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by J. David Creswell and John W. Creswell **Reference Books** Qualitative Research: A Guide to Design and Implementation by Elizabeth J. Tisdell and Sharan Merriam			
	Other References	Qualitative Inquiry and Research Design: Choosing Among Five Approaches by Cheryl N. Poth and John W. Creswell			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	2	2	2	1	1	1	1	1	1	1	2	3	2
CO2	2	2	2	1	1	1	1	1	1	1	2	3	2
CO3	2	1	2	2	2	2	1	2	3	2	2	2	2
CO4	2	2	2	1	1	1	1	1	3	3	2	2	2
CO5	2	2	2	1	1	1	1	1	1	2	3	2	3
CO6	3	3	3	2	2	2	1	2	3	3	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: IV**
1	Course Code	CHT2104
2	Course Name	**Organic Chemistry-II**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Core
5	Course Objective	1. Develop an appreciation for the role of organic chemistry in everyday life and biological systems, with a focus on the identification and core properties of oxygen-, sulphur-, and nitrogen-containing functional groups. 2. Understand and interpret name reactions and their mechanisms involving oxygen-, sulphur-, and nitrogen-based organic functional groups. 3. Analyse the physical and chemical properties, along with the characteristic reactions, of carbonyl-containing compounds. 4. Identify mono- and dicarboxylic acids and evaluate their physical properties and typical chemical reactions. 5. Examine the structure, reactivity, and synthetic importance of nitrogen- and sulphur-containing heterocycles. 6. Develop critical insights and analytical skills related to the reactivity and transformations of carbonyl compounds, carboxylic acids and their derivatives, and heterocyclic systems containing sulphur and nitrogen.
6	Course Outcomes	CO1:Describe structures, preparation methods, and properties of aldehydes, ketones, carboxylic acids, amines, nitro compounds, and heterocycles.

		CO2:Explain mechanisms of key reactions, including nucleophilic addition, condensation, rearrangements, substitutions, and oxidation–reduction reactions. CO3:Apply reaction principles to predict products of reactions such as Aldol, Cannizzaro, Michael addition, ester hydrolysis, and amine reactions. CO4:Analyze reaction pathways, intermediates, and the effect of substituents on reactivity, basicity, and orientation in aromatic systems. CO5: Evaluate the reactivity and selectivity of carbonyl, carboxylic acid derivatives, and nitrogen-containing compounds under different conditions. CO6: Design synthetic routes for the preparation of organic compounds involving carbonyl, amine, nitro, and heterocyclic systems.	
7	Course Description	This course explores the structure, properties, and reactivity of oxygen, sulfur, and nitrogen-containing organic compounds. Emphasis is placed on name reactions, mechanisms, and functional group transformations. Students will critically analyze carbonyls, carboxylic acids, amines, and heterocycles, gaining insights into their significance in daily life, biological systems, and synthetic chemistry.	
8	Outline syllabus		CO Mapping
	Unit 1	**Chemistry of Aldehydes and ketones**	
	A	Structure, reactivity and preparation of Aldehydes and ketones; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism.	CO1, CO2, CO6
	B	Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions	CO1, CO2, CO6
	C	Oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, $KMnO_4$,$K_2Cr_2O_7$, PDC and PCC); Addition reactions of unsaturated carbonyl compounds: Michael addition (1,2 vs 1,4 addition).	CO1, CO2, CO6
	Unit 2	**Carboxylic Acids and their functional Derivatives**	
	A	Preparation, physical properties and reactions of monocarboxylic acid, Preparation and reactions of acid chlorides, anhydrides, esters and amides, Acetoacetic ester: keto-enol tautomerism, preparation by Claisen condensation, Acid hydrolysis and ketonic hydrolysis	CO2, CO3, CO6

	B	Comparative study of nucleophilic substitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reaction	CO2, CO3, CO6
	C	Preparation of Dicarboxylic acid (succinic acid and adipic acid), Typical reactions of dicarboxylic acids	CO2, CO3, CO6
	Unit 3	**Nitrogen Containing Functional Groups: Amines, Cyano, Urea**	
	A	Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Hoffmann's exhaustive, Carbylamine reaction, Mannich reaction, , Curtius & Schimidt, methylation, Hofmann-elimination reaction, Hoffmann-bromamide degradation reaction.	CO3, CO4, CO6
	B	Distinction between 1°, 2°and 3°amines with Hinsberg reagent and nitrous acid. Arylamines: Synthesis & reactions of aniline, orientation/directive influence of amine on substitution.	CO3, CO4, CO6
	C	Preparation and important reactions of nitriles and isonitriles, Diazonium Salts: Preparation and their synthetic applications.	CO3, CO4, CO6
	Unit 4	**Nitrogen Containing Functional Groups: Nitro, nitrite, nitrate**	
	A	Preparation and important reactions of nitro alkanes & nitroarenes, Mechanism of electrophilic substitution in nitroarenes	CO4, CO5, CO6
	B	Reduction of aliphatic & aromatic nitro compounds, Nucleophilic aromatic substitution reaction. Picric acid	CO4, CO5, CO6
	C	Preparation and important reactions of nitrate and nitrite compounds	CO4, CO5, CO6
	Unit 5	**Nitrogen & Sulphur-containing Heterocycles**	
	A	Classification, Nomenclature, structure, aromaticity of thiophene, pyrrole, furan, and pyridine. Basic nature of N-heterocycles	CO4, CO5, CO6
	B	Synthesis and mechanism of substitution reaction of 5-membered heterocycles.	CO4, CO5, CO6

	C	Synthesis, reactions, and mechanism of substitution reactions in Pyridine & Pyrimidines.			CO4, CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s *	Solomons, T. W. G., Fryhle, C. B., & Snyder, S. A. (2016). *Organic chemistry* (12th ed.). Wiley. Bahl, A., & Bahl, B. S. (2019). *Advanced organic chemistry* (21st ed.). S. Chand Publishing. Morrison, R. T., & Boyd, R. N. (2011). *Organic chemistry* (7th ed.). Pearson Education.			
	Other References	Finar, I. L. (2002). *Organic chemistry: Volume 1 – The fundamental principles* (6th ed.). Pearson Education. Joule, J. A., & Mills, K. (2010). *Heterocyclic chemistry* (5th ed.). Wiley-Blackwell.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	3	2	2	2	2	2	1	1	2	3	3	2
CO2	3	3	2	2	2	2	2	1	1	2	3	3	3
CO3	3	2	2	2	2	2	2	1	1	2	3	3	2
CO4	3	2	2	2	2	2	2	1	1	1	3	3	2
CO5	3	2	2	2	2	2	2	1	1	1	3	3	2
CO6	3	3	3	3	3	2	2	2	2	2	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: IV**
1	Course Code	CHT2105
2	Course Name	**Physical Chemistry-II**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Core
5	Course Objective	1. To provide detailed knowledge of chemical equilibria for its application in industrial processes. 2. To provide the concept of strong and weak electrolytes, buffer solution, solubility, and solubility product, and indicators used in different analyses. 3. To teach the surface phenomenon, including monolayer and multilayer adsorption. 4. To provide the concept of particle size, coagulation, flocculation, and micelle formation. 5. To introduce the concept of photochemistry and its applications in photochemical reactions 6. To provide detailed knowledge of different processes needing the concept of ionic, chemical equilibria, surface chemistry, photochemistry, and colloids.

6	Course Outcomes	**CO1:** Describe concepts of chemical equilibrium, law of mass action, equilibrium constants, and their temperature dependence. **CO2:** Explain ionic equilibrium concepts, including pH, buffers, hydrolysis, solubility product, and acid–base theories. **CO3:** Apply principles of colloidal systems, including stability, coagulation, and electrokinetic properties in practical systems. **CO4:** Analyze adsorption phenomena using isotherms such as the Freundlich and Langmuir, and factors affecting adsorption. **CO5:** Evaluate photochemical processes based on laws of photochemistry, quantum yield, and reaction mechanisms. **CO6:** Design and interpret chemical systems by integrating concepts of equilibrium, surface chemistry, colloids, and photochemistry.	
7	Course Description	This course emphasizes the process in chemical and ionic equilibrium and associated phenomenon. The concept of Acid and basic behavior of liquid solution will be extensively discussed. The chemical processes which occur at surfaces and associated rates, the synthesis and relevance of colloids are also discussed. Moreover, various photo physical and photochemical processes are introduced.	
8	Outline syllabus		CO Mapping
	Unit 1	**Chemical Equilibrium**	
	A	Law of mass action; Thermodynamic treatment of Law of mass action, Relation between Kp, Kc, and Kx;	CO1,CO2, CO6
	B	Variation of equilibrium constant with temperature - The Van't Hoff Equation;	CO1,CO2, CO6
	C	Le Chatelier's principle and its application to the formation of ammonia and phosgene, Le Chatelier's principle and physical equilibria.	CO1,CO2, CO6
	Unit 2	**Ionic Equilibrium**	
	A	Strong, weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant, and ionic product of water. pH scale, common ion effect;	CO2, CO3, CO6
	B	dissociation constants of mono (acetic acid), di (carbonic acid), and triprotic (phosphoric acid) acids. Buffer solutions, their types, and the Henderson-Hasselbalch equation for the calculation of	CO2, CO3, CO6

		pH, buffer capacity, Hydrolysis of salts, degree of hydrolysis, and pH of salt solutions.	
	C	Solubility and solubility product of sparingly soluble salts, applications of the solubility product principle. Theory of acid–base indicators; selection of indicators and their limitations.	CO2, CO3, CO6
	Unit 3	**Colloids**	
	A	Classification, preparation, structure, and stability of Colloids; Tyndall effect, The electrical double layer; Zeta potential;	CO3, CO4, CO6
	B	Coagulation of colloidal solution; Hardy-Shulze rule; Flocculation value; Electro kinetic properties; Electrophoresis; Electro-osmosis;	CO3, CO4, CO6
	C	Protective colloids; Gold number; Emulsion; Oil in water (o/w) emulsion and water in oil (w/o) emulsion; Gels, Micelles: Critical micelle concentration	CO3, CO4, CO6
	Unit 4	**Surface Chemistry**	
	A	Physical adsorption, chemisorption, Applications of Adsorption, Factors influencing adsorption,	CO4, CO5, CO6
	B	Freundlich adsorption isotherm	CO4, CO5, CO6
	C	Langmuir adsorption isotherm	CO4, CO5, CO6
	Unit 5	**Photochemistry**	
	A	Primary and secondary processes in photochemical reactions. Laws of photochemistry: Grotthus-Draper law, Stark-Einstein law of photochemical equivalence.	CO5, CO6
	B	quantum yield and its measurement for a photochemical process, examples of low and high quantum yields, and actinometry.	CO5, CO6
	C	Photosensitized reactions, Luminescence phenomena in photochemistry.	CO5, CO6
	Mode of examination	Theory	

	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s *	1. Silbey, R. J., Alberty, R. A., Papadantonakis, G. A., & Bawendi, M. G. (2022). *Physical chemistry*. John Wiley & Sons. 2. Atkins, P. W., De Paula, J., & Keeler, J. (2023). *Atkins' physical chemistry*. Oxford university press.			
	Other References	Noyes, R. M. (1974). Physical chemistry (Barrow, Gordon M.). Levine, I. N. (2021). Physical chemistry. Atkins, P., & De Paula, J. (2006). *Physical chemistry* (Vol. 1). Macmillan.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	3	1	2	1	1	1	2	2	2	1	3	3
CO2	2	3	1	2	1	2	1	2	2	2	1	2	3
CO3	2	2	1	2	1	1	1	2	2	2	1	3	3
CO4	3	3	1	2	1	1	1	2	2	2	2	3	3
CO5	3	2	1	2	1	1	1	2	2	2	1	3	3
CO6	3	2	1	2	1	1	1	2	2	1	2	3	3

School		Sharda School of Engineering & Science
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: IV**
1	Course Code	**CHT2208**
2	Course Name	**Enzyme and Catalysis**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Type	Core
5	Course Objective	1.To introduce the concept and importance of enzyme in the human body and living cell 2.To have a deep understanding of the classification and identification of enzyme 3. To familiarize with the factors affecting the enzyme velocity, like the temperature, p H, and substrate 4.To introduce the concept of enzyme kinetics and the equation given by Michaelis and Menton 5. To introduce the various enzyme isolation and purification techniques from various sources
6	Course Outcomes	At the end of this course students will be in a position to CO1: Understand the mechanism of action of the enzyme. CO2: Solve various enzyme kinetics and will be able to correlate the V_{max} and K_m in the Michaelis-Menten equation CO3: Correlate the isolation technique of plant cells with that of animal and microbial cells. CO4: Explain the regulation strategies of allosteric enzymes and the mechanism of various inhibition processes.

		CO5: Conclude various applications of enzymes in different fields. CO6: Apply the overall concepts of enzymology in different fields of biochemistry.	
7	Course Description	This course describes various theoretical and practical concepts of enzymes and their application in various fields of industry	
8	Outline syllabus		CO Mapping
	Unit 1	**Enzyme Classification**	
	A	Enzyme: History and perspectives, enzyme classification, nomenclature, and EC number of enzymes, Co-enzyme, and Co-factors	CO1,CO6
	B	NAD/NADH, FAD/$FADH_2$, pyridoxal phosphate, thymine pyrophosphate	CO1,CO6
	C	Isoenzymes-Lactate dehydrogenase and alkaline phosphatase, Allosteric enzymes: positive and negative regulation, different metallo enzymes with examples	CO1,CO6
	Unit 2	**Enzyme Kinetics**	
	A	Enzyme substrate complex and mechanism of enzyme action: Lock and key hypothesis, induced fit theory, and acid catalysis and base catalysis	CO2, CO6
	B	Factors affecting rates of enzymatic reactions (pH, temperature, substrate concentration,	CO2, CO6
	C	Overview of the Michaelis-Menten equation, its derivation, the Lineweaver-Burk equation, and their derivations	CO2, CO6
	Unit 3	**Enzyme Inhibitions**	
	A	Enzyme inhibition and types: Irreversible inhibition with examples, reversible inhibition with examples,	CO3,CO6
	B	Competitive, non-competitive, and uncompetitive inhibition, Methanol poisoning	CO3, CO6
	C	Transpeptidase inhibition in bacteria and nerve gas inhibition	CO3,CO 6
	Unit 4	**Isolation and Purification of Enzymes**	

	A	Isolation of enzymes from plant, animal and microbial, Homogenization and centrifugation technique used in enzyme isolation			CO4,CO 6
	B	Different purification techniques of enzymes: Ammonium sulphate precipitation, dialysis, Gel filtration chromatography,			CO4,CO 6
	C	Ion exchange chromatography, affinity chromatography, enzyme activity and specific activity			CO4, CO 6
	Unit 5	**Industrial Applications of Enzymes**			
	A	Applications of enzyme in beverage industry (soft drinks, fruit drinks and hard drinks			CO5, CO 6
	B	Food processing industry and dairy industry, and pharmaceutical industry			CO5,CO 6
	C	Medicine/drug, health and biosensor industry			CO 5,CO 6
	Mode of Examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text book/s*	1.Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.). New York, WH: Freeman ISBN-13: 9781319114671 2.Voet. D., Voet. J.G. (2013) Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN: 978-1-11809244-6.			
	Other References	3.Nicholas, C.P., Lewis, S. (1999). Fundamentals of Enzymology (3rd ed.). New York, Oxford University Press Inc. ISBN:0 19 850229 X			

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

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: IV**
1	Course Code	CHT2106
2	Course Name	Basics of Pharmaceuticals
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Core
5	Course Objective	1. To learn about drug-receptor interactions, lead discovery, drug design, and molecular mechanisms by which drugs act in the body. 2. To understand various drug targets in the body and drug development strategies with mechanism of action of antibacterial agents and concept of drug resistance. 3. To compare and contrast the specific pharmacology of the major classes of drugs, important distinctions among members of each class, the risks and benefits, in relation to the organ systems they affect, and the diseases for which they are used therapeutically. 4. To apply the pharmacodynamics and pharmacokinetic principles that describe drug actions in humans. 5. To identify the role of molecular genetics and Pharmacoeconomics principles in pharmacotherapeutics and drug development

6	Course Outcomes	CO1: Describe principles of drug action, drug discovery, physicochemical properties, and basic pharmacological terms. CO2: Explain pharmacokinetics, pharmacodynamics, drug metabolism, and mechanisms of action of drugs and antibiotics. CO3: Apply concepts such as partition coefficient, pH, bioavailability, and dose-response relationships in drug action. CO4: Analyze the effect of structural, electronic, and steric factors on drug activity using models like Hammett and Hansch equations. CO5: Evaluate drug efficacy, toxicity, therapeutic index, and factors influencing drug action and dosage. CO6: Design and interpret strategies for drug synthesis, development, and evaluation, including CADD, bioassays, and clinical trials.	
7	Course Description	To highlight the importance of Medicinal Chemistry in our lives and the fascination of working in a field that overlaps the disciplines of Chemistry, Biology, Biochemistry, Pharmacology, etc.	
8	Outline syllabus		CO Mapping
	Unit 1	**Physicochemical principles of drug action**	
	A	Discovery and Development of Drugs- History of drug discovery, Strategies in drug discovery, lead discovery, lead development, pharmacophore identification	CO1, CO2, CO6
	B	Physicochemical properties of drugs: Partition coefficient, lipophilicity effects and parameters (log P, π-substituent constant), Hammett equation and electronic parameters (sigma), drug dissolution,	CO1, CO6
	C	Acid-base properties, surface activity, bioavailability, stereochemical aspects of drug action, steric effects (Taft steric and molar refractivity), Hansch equation	CO1, CO3, CO6
	Unit 2	**Pharmacology - 1**	
	A	Pharmacokinetics: various modes of administration of the drug, distribution, metabolism (biotransformation) and drug excretion, apparent volume of distribution (aVd), half-life (t½), and clearance (CL) that are used to decide the doses and rational dosing during the drug treatment	CO2, CO3, CO6

	B	Pharmacodynamics: site and mechanism of drug action, Basic idea about drug targets	CO2, CO6
	C	Concepts of agonists, antagonists, partial agonist and inverse agonists	CO2, CO6
	Unit 3	**Pharmacology-2**	
	A	Definition of the following medicinal terms: soft drug, drug analogue, prodrug, drug efficacy and potency, LD50, ED50, drug toxicity	CO3, CO5, CO6
	B	drug addiction, spurious drugs, misbranded drugs, adulterated drugs, pharmacopoeia	CO3, CO6
	C	Quantitative aspect of drug action: analysis of dose response curve and therapeutic index (safety index). Factors affecting drug action and doses	CO3, CO5, CO6
	Unit 4	**Medicinal Biochemistry**	
	A	Introduction to the development of antimicrobial agents, historical development of antimicrobials, chemotherapy, use of synthetic compounds, and the antibiotic revolution	CO4, CO6
	B	Mechanism of action at the molecular level of selected antibiotics: inhibitors of cell wall: introduction to bacterial cell wall, peptidoglycan structure synthesis, mechanism of antibiotics inhibiting cell wall synthesis.	CO4, CO5, CO6
	C	cationic antibiotics, mechanism of action of antiseptics, disinfectants, and their comparison	CO4, CO6
	Unit 5	**Synthesis and Drug Development**	
	A	Synthesis of the representative drugs of the following classes: analgesic agents, antipyretic agents, anti- inflammatory agents (Aspirin)	CO5, CO6
	B	Synthesis of the representative drugs of the following classes of antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides); antiviral agents (Acyclovir)	CO5, CO6

	C	Development of new drugs: Introduction to computer-aided drug design (CADD), Bioassays, screening of compounds. pre-clinical and clinical phases of drug evaluation			CO5, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book/s *	Reference books: 1. Pandeya, S.N. and Dimmock, J.R. (1997). *An introduction to drug design*. New Age International. 2. Kar, A. (2005). *Medicinal chemistry*. New Age International. 3. Hardman, J.G. and Limbird, L.E. (2001). Goodman and Gilman's the pharmacological basis of therapeutics, McGraw-Hill. *New York*.			
	Other References	Suggested online links: https://nptel.ac.in/courses/104/106/104106106/ https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cy16/ https://www.edx.org/course/medicinal-chemistry-the-molecular-basis-of-drug-di Subject: Pharmaceutical Science - e-PG Pathshala https://epgp.inflibnet.ac.in › Home › ViewSubject			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	3	2	3	2	1	1	1	2	2	1	1
CO2	3	2	3	2	3	2	1	1	1	2	2	1	1
CO3	3	2	3	2	3	1	1	1	1	2	2	1	1
CO4	3	2	3	2	3	2	1	1	1	2	2	1	1
CO5	3	2	3	2	3	1	1	1	1	2	2	1	1
CO6	3	2	3	2	3	2	1	1	1	1	2	1	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: IV**
1	Course Code	CCP4001
2	Course Name	**Community Connect**
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
	Course Type	AEC
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 a better understanding of the problems of people living in disadvantage position in society, maybe socially, medically, economically, or otherwise. 3. This type of live project work will help our students to connect their classroom learning with practical issues/problems in society.
6	Course Outcomes	CO1: Describe the process of team formation, problem identification, and resource planning for community-based projects. CO2: Explain methods of survey design, questionnaire development, and community interaction strategies. CO3: Apply data collection techniques through surveys or service activities to address community needs. CO4: Analyze collected data to assess community issues and project outcomes. CO5: Evaluate the effectiveness and impact of project activities on the community.

		CO6: Design and present project findings with proper justification based on data and community impact.			
7	Course Description	In Community Connect projects, students will learn how to identify problems in rural and underprivileged communities by conducting surveys, or help the communities by providing services or solutions for the issues they face.			
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 a survey or a 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			
	Weightage Distribution	CA	MTE	ETE	
		60%	-	40%	
	Text Book/s *	*1. Principles of Community Engagement* Principles of Community Engagement Clinical and Translational Science Awards Consortium (2011) *Principles of Community Engagement*. 2nd edn. Bethesda, MD: National Institutes of Health. *2. The Cambridge Handbook of Organizational Community Engagement and Outreach* The Cambridge Handbook of Organizational Community Engagement and Outreach			

		Schober, P.S. (ed.) (2019) *The Cambridge Handbook of Organizational Community Engagement and Outreach*. Cambridge: Cambridge University Press.
	Other References	*3. Learning Through Community Engagement: Vision and Practice in Higher Education* Learning Through Community Engagement: Vision and Practice in Higher Education Xing, J. and Hirsch, P. (2017) *Learning Through Community Engagement: Vision and Practice in Higher Education*. Singapore: Springer.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	2	2	3	3	1	3	1	3	3	3	2	1	2
CO2	2	2	3	3	1	3	1	3	3	3	2	1	2
CO3	2	2	3	3	1	3	1	3	3	3	2	1	2
CO4	2	2	3	3	1	3	1	3	3	3	2	1	2
CO5	2	2	3	3	1	3	1	3	3	3	2	1	2
CO6	2	2	3	3	1	3	1	3	3	3	2	1	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: IV**
1	Course Code	CHP2103
2	Course Name	**Pharmaceutical lab**
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
	Course Type	Core
5	Course Objective	1. To learn about drug-receptor interactions, lead discovery, drug design and molecular mechanism by which drug acts in the body. 2. To understand various drug targets in the body and drug development strategies with mechanism of action of antibacterial agents and concept of drug resistance. 3. To compare and contrast the specific pharmacology of the major classes of drugs, important distinctions among members of each class, the risks and benefits, in relation to the organ systems they affect, and the diseases for which they are used therapeutically. 4.To apply the pharmacodynamic and pharmacokinetic principles that describe drug actions in humans. 5.To identify the role of molecular genetics and Pharmacoeconomics 6. Principles in pharmacotherapeutics and drug development.

6	Course Outcomes	CO1: Describe principles of physicochemical analysis, drug synthesis, purification, and evaluation of bioactive compounds. CO2: Explain experimental methods for partition coefficient, pH–pKa influence, antioxidant activity, and drug analysis. CO3: Apply techniques to determine partition coefficient, drug solubility, antioxidant properties, and perform titrimetric analysis of pharmaceuticals. CO4: Analyze experimental data to evaluate drug purity, bioactive compound activity, and physicochemical properties. CO5: Evaluate the effectiveness of synthesis, purification methods, and analytical results for pharmaceutical compounds. CO6: Design and perform experiments, including drug synthesis, molecular docking, and analytical studies for pharmaceutical applications.	
7	Course Description	To highlight the importance of Medicinal Chemistry in our lives and the fascination of working in a field that overlaps the disciplines of Chemistry, Biology, Biochemistry, Pharmacology etc.	
8	Outline syllabus		CO Mapping
	Unit 1	**Analysis of Physicochemical Properties**	
	A	Determination of Oil-Water Partition Coefficient of Mandelic Acid/ Benzoic Acid	CO1,CO6
	B, C	Influence of pH and p*K*a on Ionization and Solubility of Drugs (i)Paracetamol (ii) Aspirin	CO1, CO6
	Unit 2	**Separation and analysis of bioactive compounds**	
	A	**Analysis of ascorbic acid in a Vitamin C tablet**	CO2, CO6
	B	Free Radical Scavenger Activity: Determination of the Antioxidant Profile of Ascorbic acid and its comparison with bioactive Substances (aloe vera, lemon juice, green tea, pomegranate juice).	CO2, CO6
	C	Free Radical Scavenger Activity: Determination of the Antioxidant Profile of Ascorbic acid and its comparison with bioactive Substances (aloe vera, pomegranate juice).	CO2, CO6
	Unit 3	**Synthesis and analysis**	

	A	To synthesize potassium Salt of Benzilic acid and evaluate its physico-chemical properties			CO3, CO6
	B	To synthesize potassium Salt of Benzoic Acid and evaluate its physico-chemical properties			CO3, CO6
	C	Synthesis of Aspirin and determination of its purity			
	Unit 4	**Synthesis and Purification**			
	A	Synthesis of Bis-β-naphthol & its purification using precipitation or crystallization method			CO4, CO6
	B	Synthesis of oil of wintergreen from salicylic acid			CO4, CO6
	C	Synthesis of Bis-β-naphthol & its purification using precipitation or crystallization method			
	Unit 5	**Chemical analysis of drugs**			
	A	Analysis of commercial antacid tablet by titration method.			CO5, CO6
	B	Determination of the Free Salicylic Acid Concentration in Aspirin by forming Fe^{+3} Complexes			CO5, CO6
	C	To identify the interactive amino acid residue of a receptor molecule with a ligand system using molecular docking software/servers.			CO5, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	MTE	ETE	
		30%	30%	40%	
	Text Book/s *	1. Metri, S.M., Kolageri, M.S., Babar, V.B., Maske, P.P., Mahesh, A.R. and Bhandarakavathe, M.M.H., (2009). *A Textbook of Fundamentals of Medicinal Chemistry*. JEC PUBLICATION. 2. Khopkar, S.M., (1998). *Basic concepts of analytical chemistry*. New Age International.			
	Other References	**Suggested online links:** https://old.iupac.org/publications/cd/medicinal_chemistry/index.htmlhttp:// greenparkschool.co.in/greenpark/index.php/blog/chemistry/ COMPARITIVE%20STUDY%20OF%20COMMERCIAL%20ANTACIDS%20-%201.pdf			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	3	3	3	2	2	1	1	2	2	1	2
CO2	3	2	3	3	3	2	2	1	1	2	2	1	2
CO3	3	2	3	3	3	1	2	1	1	2	2	1	2
CO4	3	3	3	3	3	2	2	1	1	2	2	1	2
CO5	3	3	3	3	3	1	2	1	1	2	2	2	3
CO6	3	3	3	3	3	2	2	1	1	1	2	2	3

Batch: 2026-2030		Semester: V
1	Course Code	CHT3101
2	Course Name	**Organic Chemistry-III**
3	Credits	4
4	Contact Hours (L-T-P)	0-0-4
	Course Type	Core
5	Course Objective	1. Draw the basic structure of carbohydrates, nucleic acids, peptides, and lipids. 2. Identify the functional groups in carbohydrates, amino acids, peptides, and lipids. 3. Predict the products of chemical reactions of monosaccharides, amino acids, and lipids (acetal/hemiacetal formation or oxidation). 4. To know about soaps and detergents and their properties and applications. 5. Introduction to heterocycles. 6. Build a sound foundation about Carbohydrates, amino acids and peptides, oil, fats and lipids, heterocycles.
6	Course Outcomes	CO1: Define and describe the classification, structure, nomenclature, and biological importance of carbohydrates, amino acids, lipids, drugs, and natural products, including their basic structural representations and examples. CO2: Explain the structural features, synthesis, properties, and classification of carbohydrates, amino acids, lipids, and selected drugs and natural products, including reaction mechanisms and physicochemical characteristics. CO3: Apply the concepts of chemical reactions, stereochemistry, and physicochemical properties to interpret transformations and reactions involving carbohydrates, amino acids, lipids (oils and fats), and drug molecules. CO4: Analyze and differentiate the structure, composition, and biological functions of lipids, membranes, drugs, and natural products, including their mechanisms of action and structure–activity relationships. CO5: Evaluate the pharmacological importance, therapeutic applications, and structure–activity relationships of drugs and bioactive natural products (alkaloids and terpenes), along with their metabolic and industrial relevance. CO6: Design and correlate conceptual relationships between biomolecules (carbohydrates, amino acids, and lipids) and drugs/natural products to explain their biological, medicinal, and industrial applications.

7	Course Description	Organic Chemistry-III encompasses carbohydrates, amino acids and peptides, oils, fats and lipids, soap and detergents, and heterocycles. It deals with reducing and nonreducing sugars, confirmations, structural elucidation of sugars, synthesis, and structural elucidation of amino acids and peptides.Further, it provides detailed knowledge of oil, fats, lipids, soap, and detergents. It also discusses the synthesis, reaction, and mechanism of the substitution reaction of Furan, Pyrrole, Thiophene, Pyridine, and Pyrimidine.	
8	Outline syllabus		CO Mapping
	Unit 1	**Carbohydrates**	
	A	Classification, biological importance, reducing and non-reducing saccharides	CO1, CO2, CO3, CO6
	B	Haworth projections and conformational structures; Interconversions of aldoses and ketoses	CO1, CO2, CO3, CO4
	C	Killiani-Fischer synthesis and Ruff degradation, structure elucidation of fructose and glucose.	CO2, CO3, CO4, CO6
	Unit 2	**Amino acids**	
	A	Classification of α-Amino Acids: Essential and Non-Essential Amino Acids	CO1, CO2, CO6
	B	Synthesis of amino acids	CO2, CO3, CO4
	C	Chemical and Physical Properties	CO1, CO2, CO3, CO4, CO6
	Unit 3	**Oil, Fats & Lipids**	
	A	Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids	CO1, CO2, CO3, CO4, CO6
	B	Trans fats, Hydrogenation, Saponification value, Iodine number. Classification, Biological importance of triglycerides and phosphoglycerides and cholesterol	CO2, CO3, CO4, CO5

	C	Lipid membrane, Liposomes and their biological functions and underlying applications.			CO1, CO2, CO3, CO4, CO5, CO6
	Unit 4	**Drugs**			
	A	Introduction, Classification (based on therapeutic action), Nomenclature: Generic name, Brand name, Systematic name			CO1, CO2, CO5
	B	Requirements of an ideal drug, General aspects of drug action, structure-activity relationship, metabolism of drugs, Chemical structures, pharmacological activity,			CO2, CO3, CO4, CO5, CO6
	C	synthesis and uses of some important drugs: Aspirin, Paracetamol, Phenacetin, Chloramphenicol.			CO2, CO3, CO4, CO5
	Unit 5	**Natural Products**			
	A	Alkaloids & Terpenes: Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification			CO1, CO2, CO3, CO4, CO5
	B	Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.			CO1, CO2, CO3, CO4, CO5, CO6
	C	Natural Occurrence and classification of terpenes, the isoprene rule.			CO1, CO2, CO3, CO4, CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ETE	
		25%	15%	60%	
	Text Book/s *	Bahl, A., & Bahl, B. S. (n.d.). *Advanced organic chemistry*. S. Chand & Company Ltd. Finar, I. L. (n.d.). *Organic chemistry: Volume 1*. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).\ Finar, I. L. (n.d.). *Organic chemistry: Volume 2 – Stereochemistry and the chemistry of natural products*. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).			

	Other References	Joule, J. A., & Mills, K. (n.d.). *Heterocyclic chemistry*. Wiley-Blackwell. Finar, I. L. (n.d.). *Stereochemistry and the chemistry of natural products*. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	1	1	2	2	1
CO2	3	2	1	1	1	1	1	1	1	1	2	2	1
CO3	2	3	1	2	1	2	1	1	1	1	2	2	2
CO4	2	3	2	2	1	1	1	1	1	1	2	2	2
CO5	2	2	1	1	1	1	1	1	1	1	2	2	3
CO6	2	2	2	1	1	2	1	1	2	2	3	2	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: V**
1	Course Code	CHT3102
2	Course Name	**Inorganic Chemistry-III**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Core
5	Course Objective	1. To provide knowledge about the symmetry of molecules 2. To illustrate the knowledge about nuclear chemistry 3. To illustrate the basics of organometallic chemistry 4. To administer the knowledge of Bioinorganic Chemistry 5. To provide an introduction to photosynthesis and metalloenzymes.
6	Course Outcomes	CO1: Define and describe molecular symmetry, symmetry operations, symmetry elements, and point groups of molecules. CO2: Explain and classify organometallic compounds based on hapticity and polarity of M–C bonds and interpret concepts such as EAN, isolobal analogy, and the 18-electron rule. CO3: Apply the concepts of structure, bonding, and reactivity of organometallic complexes to explain the properties and applications of compounds such as ferrocene and Zeise's salt.

		CO4: Analyse the role of metal ions in biological systems, including essential metals, toxicity, deficiency, and their functions in hemoglobin and myoglobin. CO5: Evaluate the structure and function of chlorophyll, photosynthesis (Z-scheme), and metalloenzymes in biological processes. CO6: Integrate and relate the concepts of molecular symmetry, organometallic chemistry, and bioinorganic chemistry in understanding chemical and biological systems.	
7	Course Description	This course describes organometallic, nuclear, and bioinorganic chemistry. This course satisfies the requirement of the B.Sc. Chemistry Honors Program.	
8	Outline syllabus		CO Mapping
	Unit 1	**Basics of Molecular Symmetry**	
	A	Introduction of molecular symmetry, symmetry operations, symmetry elements, classification, and examples	CO1, CO2, CO6
	B	Molecular point groups and examples	CO1, CO2, CO6
	C	Group multiplication table, construction of character table (C_{2v} and C_{2h} point groups)	CO1, CO2, CO6
	Unit 2	**Basics of Organometallic Chemistry I**	
	A	Introduction- Definition and classification of organometallic compounds based on hapticity and polarity of M-C bond; General characteristics, examples	CO2, CO3, CO6
	B	Effective atomic number (EAN), Isoelectronic and Isolobal concept in organometallic chemistry, 18e and 16e rule, and their exceptions	CO2, CO3, CO6
	C	Organoberyllium, organomagnesium, and organolithium compounds: synthesis and applications	CO2, CO3, CO6
	Unit 3	**Basics of Organometallic Chemistry II**	
	A	Synthesis, structure, bonding, and reactivity of Ferrocene	CO3,CO4, CO6

	B	Synthesis, structure, and bonding of Zeise's salt, pi-bonded organometallic complexes			CO3,CO4, CO6
	C	Applications of organometallic complexes			CO3,CO4, CO6
	Unit 4	**Bioinorganic Chemistry-I**			
	A	Importance of metal ions in biological systems, essential and trace metals			CO4, CO5, CO6
	B	Metal ion toxicity, deficiency, and related diseases, chelating agents are used in toxicity			CO4, CO5, CO6
	C	Hemoglobin and myoglobin functions and CO poisoning			CO4, CO5, CO6
	Unit 5	**Bioinorganic Chemistry-II**			
	A	Photosynthesis, Chlorophyll: structure, classification, and function, Z-scheme in photosynthesis			CO5,CO6
	B	Metalloenzymes: definition, classifications, properties, and functions			CO5,CO6
	C	Catalase, peroxidase, superoxide dismutase			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ETE	
		25%	15%	60%	
	Text Book/s *	References 1. *Bioinorganic Chemistry*, Ashim.K. Das 2. *General and Inorganic Chemistry*, Vol-I and II; R. Sarkar			
	Other References	1. Douglas, B.E. and McDaniel, D.H. *Concepts & Models of Inorganic Chemistry*, Oxford, 1970 2. Symmetry and spectroscopy of molecules, K. Veera Reddy, New Age International Publisher.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	1	1	1	1	1	2	1	1	1	2	1
CO2	3	2	1	1	1	1	1	2	1	1	1	2	1
CO3	2	2	1	2	2	1	1	2	1	1	1	2	2
CO4	2	3	1	2	1	2	1	2	1	1	2	2	2
CO5	2	2	1	1	1	2	1	2	1	1	2	1	2
CO6	2	2	2	2	2	2	1	2	2	2	3	2	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: V**
1	Course Code	**CHT3103**
2	Course Name	**Basics of Spectral Techniques**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Core
5	Course Objective	1. Provide knowledge of the interaction of the electromagnetic spectrum with matter, and to record the information in the form of signals 2. Provide knowledge of various rules for electronic transition in a molecule upon irradiation with UV-Vis electromagnetic radiation to analyze the structure of an unknown molecule 3. Provide theoretical knowledge of various rules for molecular vibrations in a molecule upon irradiation with infrared electromagnetic radiation to analyze the structure of an unknown molecule 4. Analyze the structure of a molecule with help of various rules of fragmentation pattern in molecules through mass spectrum and NMR signals 5. Elucidate the structure of any unknown simple molecules integrating the results of various spectroscopic techniques such as UV-Vis, IR, NMR and Mass.

		6. Provide detailed knowledge of solving the molecular structural problems by integrating various spectroscopic techniques	
6	Course Outcomes	CO1: Define and describe the properties of electromagnetic radiation and its interaction with matter in spectro-analytical methods. CO2: Explain electronic transitions, Beer–Lambert law, and Woodward–Fieser rules to interpret UV-Visible spectra of organic molecules. CO3: Apply the principles of molecular vibrations and selection rules to interpret IR and Raman spectra for functional group identification. CO4: Analyse fragmentation patterns and isotopic peaks in mass spectra for structural elucidation of organic molecules. CO5: Evaluate NMR spectral parameters such as chemical shift, spin–spin coupling, and peak integration to determine molecular structures. CO6: Integrate and solve molecular structural problems using combined spectroscopic techniques, including UV-Vis, IR, Mass, and NMR spectroscopy.	
7	Course Description	1. Introduction to spectro-analytical methods 2. UV-Visible Spectroscopy 3. Infrared and Raman Spectroscopy 4. Mass spectroscopy 5. Nuclear Magnetic Resonance Spectroscopy	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to spectro-analytical methods**	
	A	Properties of electromagnetic radiation, interaction of radiation with matter	CO1, CO2, CO6
	B	Absorption and emission of electromagnetic radiations	CO1, CO2, CO6
	C	Fourier transform spectroscopy	CO1, CO2, CO6
	Unit 2	**UV-Visible Spectroscopy**	
	A	Lambert's-Beer's law; Different type of electronic transitions; Chromophores; auxochromes	CO2, CO3, CO6
	B	Red shift; blue shift; Effect of conjugation; solvent effect; absorption in dyes	CO2, CO3, CO6

	C	Woodward's rule for conjugated cyclic and acyclic dienes; absorption in aromatic compounds	CO2, CO3, CO6
	Unit 3	**Infrared and Raman spectroscopy**	
	A	Introduction; Theory; electromagnetic range (functional group region and fingerprint region); frequency of vibrations of diatomic molecules	CO3, CO4, CO6
	B	Modes of vibrations of atoms in polyatomic molecules; fundamental frequencies and overtones, selection rules IR spectrum as a tool of structural analyses of alkanes, alkenes, alkynes, alcohol, aldehydes and ketones, carboxylic acids and amines.	CO3, CO4, CO6
	C	Raman Spectroscopy**:** Introduction to Raman Spectroscopy, Theories of Raman spectroscopy, Stokes and anti-Stokes lines, Rotational and Vibrational Raman spectroscopy. Examples and Application Raman Spectroscopy	CO3, CO4, CO6
	Unit 4	**Mass spectroscopy**	
	A	Basic principle and Theory, Components of mass spectrometer, exact masses of nuclides	CO4, CO5, CO6
	B	Molecular ions; isotope ions; fragment ions, metastable ions, Mc-Lafferty rearrangement	CO4, CO5, CO6
	C	Factors affecting cleavage pattern, structural elucidation of alkane, alkene, alcohol and ethers.	CO4, CO5, CO6
	Unit 5	**Nuclear Magnetic Resonance Spectroscopy**	
	A	NMR active nuclei, Proton NMR Spectroscopy (^{1}H): Introduction; Theory; shielding and deshielding of magnetic nuclei	CO5, CO6
	B	Equivalent and non-equivalent protons, chemical shift, and its measurements; factors influencing chemical shift	CO5, CO6
	C	Peak area; spin-spin interactions; coupling constant 'J' and factors influencing 'J' value, Structural elucidation of organic molecules	CO5, CO6

	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ETE	
		25%	15%	60%	
	Text Book/s *	1. Sharma, Y. R. (2015). *Basics of organic spectroscopy*. Krishna Prakashan Media. 2. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2000). *Analytical chemistry: An introduction* (7th ed.). Saunders College Publishing.			
	Other References	Sharma, B. K. (2005). *Instrumental methods of chemical analysis*. (4th ed.). Goel Publishing House. Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2015). *Spectroscopy* (4th ed.). Brooks/Cole, Cengage Learning. Banwell, C. N., & McCash, E. M. (1994). *Fundamentals of molecular spectroscopy* (4th ed.). McGraw-Hill. McHale, J. L. (2017). *Molecular spectroscopy*. CRC Press. Nakamoto, K. (2008). *Infrared and Raman spectra of inorganic and coordination compounds: Part A: Theory and applications* (6th ed.). Wiley-Interscience. Silverstein, R. M., Webster, F. X., & Kiemle, D. J. (2005). *Spectrometric identification of organic compounds* (7th ed.). John Wiley & Sons.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	1	1	1	1	1	2	1	1	1	2	1
CO2	3	2	1	1	2	1	1	2	1	1	1	2	1
CO3	2	2	1	2	2	1	1	2	1	1	1	2	2
CO4	2	3	1	2	2	1	1	2	1	1	2	2	2
CO5	2	3	1	2	2	1	1	2	1	1	2	2	2
CO6	2	3	2	2	3	2	1	2	2	2	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: V**
1	Course Code	**CHT3104**
2	Course Name	**Physical Chemistry III**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Core
5	Course Objective	1. To provide detailed concepts in Electrochemistry, theories for strong and weak electrolytes, and to implant the concept of Ionic and electrolytic conductance. 2. To inculcate the concept of equilibrium, the equilibrium constant, and to calculate free energy change from it. 3. To inculcate the concept of conservation of energy. 4. To inculcate the concepts related to laws of thermodynamics applicable in daily life. 5. To make students understand the concept of chemical equation and thermochemical equation. 6. To inculcate the concept of thermodynamics and to calculate free energy change from it, and to provide detailed concepts in Electrochemistry, theories for strong and weak electrolytes.

6	Course Outcomes	CO1: Define and describe the principles of electrolytic conductance, electrochemical cells, and thermodynamic systems, including conductivity, molar conductance, electrochemical series, and basic thermodynamic terms. CO2: Explain the concepts of electrochemistry and thermodynamics, including ionic conductance, Nernst equation, electrochemical cells, entropy, enthalpy, and free energy relationships. CO3: Apply the laws of thermodynamics and electrochemistry to analyze physical and chemical processes involving entropy, free energy, EMF, and equilibrium conditions. CO4: Analyze the driving forces of chemical and physical changes using thermodynamic functions, electrochemical principles, second law of thermodynamics, and entropy concepts. CO5: Evaluate thermochemical processes and electrochemical systems by calculating enthalpy changes, EMF, and thermodynamic parameters using Hess's law, Kirchhoff's equation, and related principles. CO6: Integrate concepts of electrochemistry, thermodynamics, and thermochemistry to solve problems and interpret chemical equilibrium, spontaneity, and energy transformations.	
7	Course Description	Students will develop a detailed understanding to analyze the basics of electrochemistry, thermodynamics, and thermochemistry.	
8	Outline syllabus		CO Mapping
	Unit 1	**Electrolytic conductance**	
	A	Conduction in electrolyte solutions, Arrhenius theory of electrolytic dissociation	CO1, CO2, CO3, CO6
	B	Conductivity, equivalent and molar conductivity, variation with dilution.	CO1, CO2, CO3, CO6
	C	Kohlrausch law. Debye-Hückel-Onsager equation, Walden's rules.	CO1, CO2, CO3, CO4, CO6
	Unit 2	**Electrochemistry**	
	A	Types of Electrodes, Introduction and Conventional representation of electrochemical cells; Electrolytic and Galvanic cells; Salt Bridge, Reversible and irreversible cells.	CO1, CO2, CO3, CO4, CO6

	B	The Nernst equation and its application for measurement of EMF; Calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and ΔS); concentration cells (with and without transference),	CO1, CO2, CO3, CO4, CO5, CO6
	C	Liquid junction potential, Application of concentration cells. Electrochemical corrosion and its mechanism in acid and neutral media.	CO2, CO3, CO4, CO5, CO6
	Unit 3	**Thermodynamics I**	
	A	Recapitulation of Laws of Thermodynamics, Entropy changes in reversible and irreversible processes, Entropy changes for an ideal gas in isothermal, isobaric, and isochoric processes.	CO3, CO4, CO6
	B	Physical significance of entropy, Helmholtz free energy (A) and Gibbs free Energy (G), variation of Free Energy with pressure and temperature, Maxwell relations, Gibbs-Helmholtz equation.	CO3, CO4, CO6
	C	Relation between Enthalpy of reaction at constant volume and pressure, Enthalpy of formation, Kirchhoff equation, Hess's Law and application, measuring the enthalpy of combustion.	CO3, CO4, CO6
	Unit 4	**Thermodynamics II**	
	A	Discussion of experiential knowledge to account for the spontaneity in changes. Second law of thermodynamics, different statements of the law, Carnot cycle and its efficiency, Carnot theorem, Thermodynamic scale of temperature.	CO1, CO2, CO3, CO4, CO6
	B	Concept of Entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical changes, Gibbs and Helmholtz functions: Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities.	CO2, CO3, CO4, CO5, CO6
	C	Variation of G and A with P, V, and T. Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data.	CO2, CO3, CO4, CO5, CO6
	Unit 5	**Thermochemistry**	
	A	Standard state, standard enthalpy of formation. Hess's Law of heat summation and its applications.	CO2, CO3, CO4, CO5, CO6

	B	Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermochemical data.			CO2, CO3, CO4, CO5, CO6
	C	Temperature dependence of enthalpy, Kirchhoff's equation.			CO2, CO3, CO4, CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ETE	
		25%	15%	60%	
	Text Book/s *	Atkins, P., & de Paula, J. (2022). *Atkins' physical chemistry* (11th ed.). Oxford University Press. Castellan, G. W. (2004). *Physical chemistry* (3rd ed.). Narosa Publishing House. Engel, T., & Reid, P. (2021). *Physical chemistry* (4th ed.). Pearson Education. Kapoor, K. L. (2011). *A textbook of physical chemistry* (Vols. 2 & 5). Macmillan Publishers India. Levine, I. N. (2020). *Physical chemistry* (7th ed.). McGraw-Hill Education. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2023). *Principles of physical chemistry* (50th ed.). Vishal Publishing Co.			
	Other References	Atkins, P. W. (1991). *The elements of physical chemistry*. Oxford University Press.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	1	1	1	1	1	2	1	1	1	2	1
CO2	3	2	1	1	1	1	1	2	1	1	1	2	1
CO3	2	2	1	2	1	1	1	2	1	1	1	2	2
CO4	2	3	1	2	1	1	1	2	1	1	2	2	2
CO5	2	2	1	1	1	1	1	2	1	1	2	1	2
CO6	2	3	2	2	2	1	1	2	2	2	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: V**
1	Course Code	CHP3101
2	Course Name	**Organic Chemistry Lab-II**
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
	Course Type	Core
5	Course Objective	1. An understanding of different biomolecules. 2. Skills to apply the theoretical knowledge of biomolecules in experiments. 3. The distinction between different types of sugars. 4. The concepts of saponification and iodine value. 5. To develop skills to apply the theoretical knowledge of dyes in experiments. 6. The concept of good lab practices and finally, the skills to apply laboratory skills in research.
6	Course Outcomes	CO1: Recognize and categorize different classes of carbohydrates using qualitative tests such as Molisch, Fehling, and Benedict reactions, and distinguish reducing and non-reducing sugars. CO2: Interpret qualitative reactions and chromatographic methods used for the identification and separation of amino acids and proteins. CO3: Determine physicochemical parameters of oils, fats, and lipids, including saponification value, iodine value, and acid value through laboratory experiments.

		CO4: Examine the synthesis and purification processes of organic compounds such as m-dinitrobenzene, dibenzalacetone, and osazones. CO5: Assess the preparation and properties of dyes and pigments, including azo dyes, indigo dye, and p-nitroacetanilide. CO6: Design and execute laboratory experiments for qualitative and quantitative analysis of biomolecules and organic compounds following good laboratory practices.	
7	Course Description	This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, and amino acids.	
8	Outline syllabus		CO Mapping
	Unit 1	**Qualitative & Quantitative tests for Carbohydrates**	
	A	Differentiate between a reducing/non-reducing sugar (Molish, Fehling, Benedict etc. tests), identify.	CO1, CO2, CO6
	B	To distinguish between aldoses (like glucose) and ketoses (like fructose). To distinguish between mono- , di- and poly saccharides.	CO1, CO2, CO6
	C	Estimation of glucose Estimation of sucrose	CO1, CO2, CO6
	Unit 2	**Qualitative & Quantitative tests for Amino acids**	
	A	To detect the presence of protein in the given solution using the ninhydrin test. b. biuret test. c. Xanthoprotein test	CO1, CO2, CO6
	B	Sorenson's formol titration To determine the isoelectric point of glycine	CO1, CO2, CO6
	C	Paper chromatographic separation of a mixture containing 2/3 amino acids	CO1, CO2, CO6
	Unit 3	**Practical on Oils, Fats & Lipids**	
	A	i)To determine the saponification value of castor oil ii)To determine the saponification value of mahua oil	CO3, CO4, CO6

	B	i) To determine the acid value of castor oil ii) To determine the iodine value of mahua oil			CO3, CO4, CO6
	C	i)To prepare the soap using mahua oil and castor oil and compare their properties (Lathering, pH) ii)To determine of alkali content & total fatty matter in cleansing agents.			CO3, CO4, CO6
	Unit 4	**Synthesis of Organic Compounds**			
	A	To prepare m-dinitrobenzene from nitrobenzene			CO3, CO4, CO6
	B	To perform the synthesis of dibenzalacetone (crossed aldol reaction) and report its yield and melting point			CO3, CO4, CO6
	C	Preparation of osazones			CO3, CO4, CO6
	Unit 5	**Practicals on Dyes & Pigments**			
	A	Synthesis of i) an Azo dye ii) p-Nitroacetanilide from Acetanilide			CO4, CO5, CO6
	B	Synthesis of i) Indigo dye ii)Orange-II			CO4, CO5, CO6
	C	Estimation of the primary amino group by diazotization			CO4, CO5, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE	CA	
		30%	30%	40%	
	Text Book/s*	Pandey, O.P., Bajpai, D.N. and Giri, S., (1972). *Practical Chemistry (For B. Sc. I, II- and III-Year Students)*. S. Chand Publishing. Vogel, I., (1974). *Practical organic chemistry*.			

	Other References	Robinson, R.J., 1953. A textbook of quantitative analysis.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	2	2	1	2	1	1	1	2	1	1	1	2	1
CO2	2	2	1	2	1	1	1	2	1	1	1	2	1
CO3	2	2	1	3	2	1	1	2	1	1	1	2	2
CO4	2	2	2	3	2	1	1	2	1	1	1	2	2
CO5	2	2	2	3	2	1	1	2	1	1	2	2	3
CO6	2	3	2	3	2	2	1	2	2	2	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: V**
1	Course Code	**CHP3102**
2	Course Name	**Inorganic Chemistry Lab-II**
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
	Course Type	Core
5	Course Objective	This laboratory course focuses on the estimation and analysis of physicochemical parameters of industrially important materials such as metals, cement, fertilizers, fuels, and water. It provides hands-on experience in analytical techniques, including titrimetry, calorimetry, and instrumental methods. Students perform experiments related to quality assessment, composition analysis, and environmental monitoring. The course also introduces the synthesis of dyes, pigments, and inorganic compounds along with their characterization. Emphasis is placed on accuracy, data interpretation, and safe laboratory
6	Course Outcomes	CO1: Explain the principles and significance of physicochemical parameters and analytical techniques used for industrial materials such as metals, cement, fertilizers, and petrochemicals. CO2: Apply standard laboratory methods to estimate parameters such as nitrogen content, alkalinity, COD, and available chlorine in various samples.

		CO3: Perform experimental procedures for determining properties like calorific value, flash point, and setting time of cement using appropriate instruments. CO4: Analyze experimental observations and data to determine the composition and quality of materials such as water, fuels, and fertilizers. CO5: Evaluate the accuracy, precision, and reliability of experimental results by comparing with standard values and identifying sources of error. CO6: Design and carry out the synthesis of dyes, pigments, and inorganic compounds, and propose suitable methods for their characterization.	
7	Course Description	The course enables students to estimate the parameters of cement, fertilizers and petrochemicals. Physicochemical parameters are also discussed.	
8	Outline syllabus		CO Mapping
	Unit 1	**Estimation of physicochemical parameters**	
	A	Estimation of copper and calcium in a mixture.	CO1, CO2, CO6
	B	Determination of initial and final setting time of cement.	CO1, CO2, CO6
	Unit 2	**Analysis of fertilizers**	CO1, CO2, CO6
	A	Preparation of a sample of phosphate and sulphate fertilizers	
	B	Estimation of nitrogen in fertilizer	CO1, CO2, CO6
	C	Determination of free acidity in ammonium sulphate fertilizer	CO1, CO2, CO6
	Unit 3	**Analysis of petrochemicals**	CO1, CO2, CO6
	A	Determination of calorific value of a fuel by Bomb's Calorimeter	
	B	Determination of flash point by Able's closed cup apparatus.	CO3, CO4, CO6
	Unit 4	**Titrimetric estimation of chemical parameters**	

	A	Analysis of alkalinity of a water sample by acid-base titration.			CO3, CO4, CO6
	B	Estimation of available chlorine in bleaching powder iodometrically.			CO3, CO4, CO6
	Unit 5	Analysis of physico-chemical parameters			CO3, CO4, CO6
	A	Preparation of Potash Alum.			CO3, CO4, CO6
	B	Estimation of chemical oxygen demand in a given water sample.			CO3, CO4, CO6
	Unit 5	**Practicals on Dyes & Pigments**			
	A	Synthesis of i) an Azo dye ii) p-Nitroacetanilide from Acetanilide			CO4, CO5, CO6
	B	Synthesis of i)Indigo dye ii)Orange-II			CO4, CO5, CO6
	C	Estimation of the primary amino group by diazotization			CO4, CO5, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE Viva	CA	
		30%	30%	40%	
	Text Book/s *	Pandey, O. P., Bajpai, D. N., & Giri, S. (2010). *Practical chemistry* (Revised ed.). S. Chand Publishing.			
	Other References	Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. J. K. (Eds.). (2000). *Vogel's textbook of quantitative chemical analysis* (6th ed.). Prentice Hall.			

PO →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9		PO 11	PSO1	PSO2

CO ↓										PO 10			
CO1	2	2	1	2	1	1	1	2	1	1	1	2	1
CO2	2	2	1	2	1	1	1	2	1	1	1	2	2
CO3	2	2	1	3	2	1	1	2	1	1	1	2	2
CO4	2	3	2	3	2	2	1	2	1	1	1	2	2
CO5	2	2	2	3	2	2	1	2	1	1	2	2	3
CO6	2	3	2	3	2	2	1	2	2	2	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: V**
1	Course Code	CHR3101
2	Course Name	**Research-Based Learning -3 (RBL-3)**
3	Credits	0
4	Contact Hours (L-T-P)	0-0-2
	Course Type	RBL
5	Course Objective	1. The course aims to allow the students to perform a research project within the field of chemistry under supervision according to an individual study plan. 2. To summarize the results in a research report and present the results of the project.
6	Course Outcomes	CO1: Apply experimental approaches to identify and address a research problem through appropriate scientific methodology. CO2: Collect and organize research data through literature survey and experimental observations for further interpretation and evaluation. CO3:Demonstrate professional research practices, including time management, collaboration, and integration of theoretical and practical knowledge. CO4: Analyse and communicate research outcomes effectively through scientific discussions and oral presentations in academic forums. CO5: Evaluate and document research findings by preparing a structured scientific report with appropriate data representation.

		CO6: Design and conduct an independent research investigation demonstrating critical thinking, creativity, and problem-solving ability.			
7	Course Description	This course will deepen the student's understanding of research in general, and basic science and technological research in particular. The students are expected to apply knowledge of methodology, concepts, philosophical problems, and creative mapping in this course to their own fields of exploration to get optimal results.			
8	Outline syllabus				CO Mapping
	Unit 1	**Identifying the research problem** Selection of a research problem based on the application on a particular field of science and technology			CO1, CO6
	Unit 2	**Literature search and formulation of scientific methods** Rigorous literature searches and collection of data for performance and execution of methods			CO2, CO6
	Unit 3	**Managing time and execution of scientific methodology** Solving the research problem by meticulous time management, planning, and well-standardized methods so as to link theoretical and practical knowledge			CO3, CO6
	Unit 4	**Research Presentation in a scientific forum** Discussion and presentation of research problem on a scientific forum and also in front of peer's students and friends			CO4, CO6
	Unit 5	**Making of a scientific report** Making of a scientific report, include results, graphs, table with future remarks justifying the research problem, checking the similarity index, and submitting it to the competent authority			CO5, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text Book/s *	**Suggested Readings:** Research Methodology: Methods and Techniques by CR Kothari Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by J. David Creswell and John W. Creswell			

		Reference Books Qualitative Research: A Guide to Design and Implementation by Elizabeth J. Tisdell and Sharan Merriam
	Other References	Qualitative Inquiry and Research Design: Choosing Among Five Approaches by Cheryl N. Poth and John W. Creswell

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	2	2	2	1	1	1	1	1	1	1	2	3	2
CO2	2	2	2	1	1	1	1	1	1	1	2	3	2
CO3	2	1	2	2	2	2	1	2	3	2	2	2	2
CO4	2	2	2	1	1	1	1	1	3	3	2	2	2
CO5	2	2	2	1	1	1	1	1	1	2	3	2	3
CO6	3	3	3	2	2	2	1	2	3	3	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: VI**
1	Course Code	**CHT3105**
2	Course Name	**Chemistry in Action**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Elective
5	Course Objective	1. To know about polymers, their properties, and applications. 2. To have an insight into the composition and applications of dyes and pigments. 3. To have an understanding of soap/detergent properties and the manufacturing process. 4. To increase the understanding of processes involved in the synthesis, effects, uses, and consequences of insecticide use of Organochlorines, Organophosphates, Anilides-based pesticides and insecticides. 5. To discuss the classification, Oxygen balance, Properties, Chemical reactions, manufacture of important explosives like TNT, PETN, RDX, and to be aware of the handling and storage of explosives. 6. To provide the knowledge and critical thinking about polymers, pesticides and insecticides, dyes, pigments, and explosives.

6	Course Outcomes	CO1: Identify and summarize the fundamental concepts of industrial chemistry, including polymers, dyes, surfactants, pesticides, and explosives, with their basic classifications and properties. CO2: Explain and illustrate the principles governing structure–property relationships in polymers, colour and constitution in dyes, and amphiphilic behaviour in surfactants. CO3: Apply chemical principles to understand polymerization mechanisms, dye application methods, cleansing action of soaps and detergents, and functional uses of pesticides and explosives. CO4: Analyze the synthesis, classification, and functional performance of polymers, dyes, detergents, pesticides, and explosives, including their mechanisms and industrial preparation methods. CO5: Evaluate the industrial processes, environmental impact, safety considerations, and efficiency of polymers, dyes, detergents, pesticides, and explosive materials. CO6: Develop and integrate a critical understanding of industrial chemical products and their real-world applications, including sustainability, environmental impact, and technological advancements.	
7	Course Description	Chemistry in Action deals with polymers, dyes, pigments, pesticides, insecticides, and explosives. Polymers deal with introduction, vulcanization, biodegradable, and conducting polymers. Pesticides and insecticides, synthetic approach for DDT, Gammexene, Malathion, Parathion, and anilides. Explosives encompass oxygen balance, the manufacture of high explosives, blasting fuses, and smokeless powders.	
8	Outline syllabus		CO Mapping
	Unit 1	**Polymers**	
	A	Introduction and classification, Number average and weight average molecular weight, Degree of polymerization. Polymerisation reactions -Addition and condensation, Mechanism of cationic polymerization	CO1, CO2, CO3
	B	Anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; thermosetting (phenol-formaldehyde, Polyurethanes), thermoplastics (PVC, polythene)	CO2, CO3, CO4, CO5
	C	Synthetic fibres (acrylic, polyamide, polyester) and Rubbers – natural and synthetic: Buna-S; Vulcanization; Biodegradable and conducting polymers with examples.	CO1, CO3, CO4, CO5, CO6

	Unit 2	**Dyes & Pigments**	
	A	Relation between colour and constitution with reference to Witt's theory, definition of dyes & pigments, difference between dyes & pigments	CO1, CO2
	B	Classification of dyes based on a) chemical constitution with illustrative examples b) methods of application to fibre	CO2, CO3, CO4
	C	Synthesis of Pigment Yellow G, Benzidine orange, Pigments Orange VI	CO3, CO4, CO5
	Unit 3	**Soaps and Detergents**	
	A	Soaps: Raw material, chemical reaction, types, and cleansing action. Surfactants- emulsion and emulsifying agents	CO1, CO2, CO3
	B	Wetting and non-wetting, CMC, hydrophobic and hydrophilic nature, amphipathic structures, and types	CO2, CO3, CO4
	C	Detergents- raw materials, detergent builders, additives, and cleansing action.	CO3, CO4, CO5, CO6
	Unit 4	**Pesticides & Insecticides**	
	A	General introduction to pesticides (natural and synthetic), benefits, and adverse effects	CO1, CO4, CO5
	B	Synthesis, technical manufacture, and uses of representative pesticides	CO3, CO4, CO5
	C	Insecticides in the following classes: Organochlorines (DDT, Gammexene); Organophosphates (Malathion, Parathion); Anilides (Alachlor and Butachlor).	CO2, CO3, CO4, CO5, CO6
	Unit 5	**Explosives**	
	A	Introduction, Classification, Oxygen balance, Properties, Chemical reactions	CO1, CO2, CO4

	B	Manufacture of important explosives: Trinitrotoluene (TNT), Nitroglycerine (NG), Pentaerythritol tetranitrate(PETN)			CO3, CO4, CO5
	C	Cyclomethylene trinitroamine (RDX) blasting fuses, smokeless powder, black powder, precautions during storage of explosives			CO3, CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ETE	
		25%	15%	60%	
	Text Book/s*	1. Billmeyer, F.W., (1984). *Textbook of Polymer Science*. John Wiley & Sons. 2. Lubs, H.A., (1955). The chemistry of synthetic dyes and pigments. *(No Title)*. 3. Atkinson, E.R., (1952). The Chemistry of Synthetic Dyes. Volume 1 (Venkataraman, K.). 4. Rangnekar, D.W. and Singh, P.P., (1980). *An introduction to synthetic dyes*. Himalaya Publishing House.			
	Other References	1. Gürses, A., Açıkyıldız, M., Güneş, K., Gürses, M.S., Gürses, A., Açıkyıldız, M., Güneş, K. and Gürses, M.S., (2016). Dyes and pigments: their structure and properties. *Dyes and pigments*, pp.13-29. 2. Samanta, A.K., Awwad, N., and Algarni, H.M. eds., (2020). *Chemistry and technology of natural and synthetic dyes and pigments*. BoD–Books on Demand. 3. Chiellini, E. and Solaro, R. eds., (2003). *Biodegradable polymers and plastics*. Springer Science & Business Media.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	1	1	1	2	2
CO2	2	2	2	1	1	2	1	1	1	1	1	2	2
CO3	2	3	2	1	1	3	2	1	1	1	2	2	3
CO4	2	2	2	1	1	2	2	1	1	1	2	2	2
CO5	3	3	2	1	1	3	2	2	2	2	3	3	3
CO6	3	2	1	1	1	1	1	1	1	1	1	2	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: VI**
1	Course Code	CHT3106
2	Course Name	**Chemical Energetics and Radiochemistry**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Elective
5	Course Objective	1. Develop understanding about Energy, its types, demand, units and generation 2. Understand the concept of partial molar quantities and their variation wi 3. Understand the concept of ensembles, partition function and their applications. 4.Provide detailed knowledge of phase equilibria 5. inculcate the understanding of different concepts of radiochemistry. 6. To provide an in-depth understanding of various laws of thermodynamics, their applications, statistical thermodynamics, phase equilibrium, and radiochemistry.

6	Course Outcomes	CO1: Define and outline the fundamental concepts of energy, energy sources, thermodynamic laws, and global energy consumption patterns. CO2: Explain and interpret the principles and types of non-conventional energy sources, including fuel cells, solar energy systems, and biofuels. CO3: Apply the principles of solar photovoltaics to evaluate solar cell design, performance parameters, and energy conversion processes. CO4: Analyse radioactive decay processes, nuclear transformations, and fundamental laws governing radiochemistry. CO5: Evaluate nuclear structure models and nuclear interactions to interpret properties such as nuclear forces, magnetic dipole moments, and quadrupole moments. CO6:Integrate and formulate scientific understanding of thermodynamics, energy systems, and radiochemistry to assess modern energy technologies and nuclear applications.	
7	Course Description	This course takes in detail the energy consumption, demand, energy generation strategies, types of energy, and basic principles of energy generation from solar power and fuels. Basics of radiochemistry, terminology, and energy generation are also covered in this course	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Energy**	
	A	Definition and units of energy, power, Forms of energy, Conservation of energy, second law of thermodynamics, Energy flow diagram to the earth. Origin and time scale of fossil fuels,	CO1, CO2, CO6
	B	Conventional energy sources, Role of energy in economic development and social transformation. Global Energy Scenario: Energy consumption in various sectors, projected energy consumption for the next century	CO1, CO2, CO6
	C	Exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear and hydroelectric power, impact of the exponential rise in energy usage on the global economy	CO1, CO2, CO6
	Unit 2	**Non-Conventional Energy**	
	A	Need for Non-conventional energy sources, Types of Non-Conventional energy sources, Fuel cells: Definition, Design, and Principle of operation with special reference to H2O2-Solid oxide electrolyte cells-Advantages and Disadvantages of fuel cells-Applications of Fuel cells.	CO1, CO2, CO6

	B	Solar Energy: Basics of Solar Energy and development, Units and measurements, Solar spectrum – Electromagnetic spectrum, Solar radiation, and its Measurements, Solar energy collectors: Flat Plate and Concentrating Collectors- solar pond -Applications of Solar energy.	CO1, CO2, CO6
	C	Biofuel: Ethanol and Methanol production from Cellulose and wood Biomass, Biodiesel Production from Non-Edible Oil Seeds.	CO1, CO2, CO6
	Unit 3	**Solar Photovoltaics**	
	A	Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell. Fundamentals of solar cell	CO3, CO4, CO6
	B	Types of solar cells, First generation solar cells: design, fabrication, performance, and drawbacks, Second generation solar cells: design, performance, and drawbacks	CO3, CO4, CO6
	C	Third generation solar cells: design, performance and drawbacks, I-V characteristics of a PV module, maximum power point, cell efficiency, fill factor, effect of irradiation and temperature	CO3, CO4, CO6
	Unit 4	**Radiochemistry**	
	A	Natural and induced radioactivity; radioactive decay-α-decay, β-decay, γ-decay;	CO3, CO4, CO6
	B	neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half-life period	CO3, CO4, CO6
	C	Geiger-Muller relationship, Geiger-Nuttal rule, radioactive displacement law, radioactive series	CO3, CO4, CO6
	Unit 5	**Nuclear force and structures**	
	A	Two-body problem - properties of the deuteron and derivation of depth-range relationship, its applications in explaining the nature of the nuclear force	CO4, CO5, CO6
	B	Elementary particles; nuclear models - strong and weak interaction,	CO4, CO5, CO6

	C	Nuclear magnetic dipole moment and electric quadrupole moment in terms of the shell model, collective model, and Fermi gas model.			CO4, CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ETE	
		25%	15%	60%	
	Text Book/s *	**1.** Choppin, G., Liljenzin, J.-O., Rydberg, J., & Ekberg, C. (2013). *Radiochemistry and nuclear chemistry* (4th ed.). Butterworth-Heinemann. [Kindle Edition] **2.** Atkins, P., de Paula, J., & Keeler, J. (2018). *Physical chemistry* (11th ed.). Oxford University Press.			
	Other References	Singh, N. B., Gajbhiye, N. S., & Das, S. S. (n.d.). *Comprehensive physical chemistry*. New Age International Publishers.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	1	1	1	1	1	1	1	1	1	2	1
CO2	3	2	1	1	1	2	1	1	1	1	1	2	2
CO3	2	2	2	1	1	2	1	1	1	1	1	2	2
CO4	2	3	2	1	1	2	1	1	1	1	2	2	2
CO5	2	3	2	1	1	1	1	1	1	1	2	2	2
CO6	3	3	2	1	1	3	2	2	2	2	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: VI**
1	Course Code	CHT3209
2	Course Name	**Biological Chemistry**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Type	Elective
5	Course Objective	1.To introduce the students about the concept of free energy change and the entropy change (randomness and distortedness) taking place inside the various cell organelles of particular cells and tissues of living organism when these cells undergo various biochemical reaction like oxidation reduction, elimination, substitution and re arrangement. 2.To explain the importance of electron carriers, role of various inorganic ions and organic molecules in the various protein and enzyme complex which forms an integral part of cell membranes of all living organisms 3.To elaborate the role of biocatalyst and differentiate it with a chemical catalyst in the mode of action and mechanism. 4.To introduce about the concept of how joining of smaller molecules leads to the requirement of energy and the breakdown of larger molecules in to smaller one leads to release of energy without the loss of those energy in the living cell ie how energy is conserved in the cell. 5.To explain the chemistry of signaling of regulating molecules like hormones and their mechanism of action.

6	Course Outcomes	CO1: Remember the meaning of free energy change, basic concepts of spontaneity, and fundamental statements of the second and third laws of thermodynamics in living systems. CO2: Understand the generation of micro and mini voltage and current during electron transfer through various electron carriers, and explain the role of chemistry and physics in this process. CO3: Apply the concept of activation energy to differentiate between catalysts and biocatalysts, and explain factors responsible for enhanced enzyme efficiency. CO4: Analyze the metabolic pathways of biomolecules, including carbohydrates (glucose, maltose, starch), fats (triacylglycerol), and nucleotides in terms of anabolism and catabolism. CO5: Evaluate the role of insulin in diabetes mellitus and interpret the chemical basis of the regulation of biochemical reactions. CO6: Create integrated models or explanations linking thermodynamics, electron transfer, enzyme catalysis, and metabolic pathways in living systems.	
7	Course Description	This course covers the information about the various chemical and physical phenomenon inside a living system and how the energy is conserved and utilized	
8	Outline syllabus		CO Mapping
	Unit 1	**Thermodynamics in a living world**	
	A	Biological order and disorder; thermodynamic principles inside cells: Mitochondria; Free energy change ($\Delta G^{/0}$) : Hydrolysis reaction (Glucose-6-phosphate, Glutamine, Maltose),	CO1,CO6
	B	Elimination reaction (Malate), rearrangement reaction (Fructose-6-phosphate); ATP as energy currency; ($\Delta G^{/0}$) of ATP hydrolysis;	CO1, CO6
	C	High energy rich bio-organic compound; hydrolysis of phosphocreatine in muscle; exergonic and endergonic reaction	CO1, CO6
	Unit 2	**Biological oxidation and reduction**	
	A	Redox reactions; reduction potentials; standard reduction potentials; Nernst equation;	CO2, CO6
	B	Universal electron carriers (NAD+, NADP+ and FAD, flavoproteins); Mitochondrial electron carriers; Sequences of electron carriers;	CO2, CO6
	C	ETC in mitochondria; Functions of ETC complex; Ubiquinone, cytochromes, Iron sulfur proteins	CO2, CO6

	Unit 3	**Chemistry of a biocatalyst**			
	A	Enzyme and chemical catalyst; role of enzyme, activation energy lowering; transition state intermediate; enzyme-substrate complex			CO3, CO6
	B	Enzyme specific chemical reaction: Oxidoreductase, transferase, hydrolase and isomerase			CO3, CO6
	C	Mode of enzyme action: lock and key hypothesis, induced fit hypothesis, Acid base catalysis, covalent catalysis.			CO3, CO6
	Unit 4	**Anabolism and Catabolism**			
	A	Principles of anabolism and catabolism. Biochemistry of Glycolysis			CO4, CO6
	B	Kreb's cycle, β-oxidation, and transamination reaction			CO4, CO6
	C	urea cycle, pyrimidine, and purine biosynthesis			CO4, CO6
	Unit 5	**Hormone chemistry**			
	A	Chemical signaling of hormones -endocrine, paracrine, autocrine,			CO5, CO6
	B	Neuroendocrine mechanisms. Classification of Hormones			CO5, CO6
	C	Structure of hormones, Steroid and non-steroid hormones			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ETE	
		25%	15%	40%	
	Text Book/s *	1.Cox, M.M. and Nelson, D.L. (2008) : Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York, USA 2.Reginald H. Garrett • Charles M. Grisham(2010) : Biochemistry, 4th edition 3.Raven, Johnson, Mason, Losos, Singer: Biology, 9th edition, Mc Graw Hill Publication 4.Reece, Urry, Cain, Wasserman and Minosky, Jackson: Campbell Biology, 10th edition, Pearson Group Publication.			
	Other References	Sadava, Hillis, Heller and Berenbam : Life the science of biology, 9th edition, W.H Freeman and Company. Donald T Hynie : Biological thermodynamics,2nd edition, Cambridge University Press			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	3	2	1	2	2	2	2	2	2	1	1
CO2	3	2	3	3	2	2	1	1	1	1	1	2	1
CO3	3	3	2	3	2	2	2	1	2	2	2	2	1
CO4	3	2	2	2	2	3	1	1	1	1	1	1	1
CO5	3	2	2	2	2	2	2	1	1	1	1	1	1
CO6	3	2	2	2	2	2	2	1	1	1	1	1	1

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: VI**
1	Course Code	CHT3107
2	Course Name	Nanomaterials: Synthesis and Applications
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Type	AEC
5	Course Objective	1.Teach the advanced methods towards the synthesis of nano materials. 2.Demonstrate the advanced methods towards the synthesis of nanomaterials/nanocomposites. 3.Discuss the mechanical and magnetic behaviour of nano materials. 4.Illustrate the basics and phenomenon associated with the electrical and optical behaviour. 5.Explain modern spectroscopic and microscopic methods towards the characterization of nano materials. 6. Demonstrate the novel materials from synthetic, analysis and application perspectives.

6	Course Outcomes	CO1:Define and classify nanomaterials based on size, structure, and dimensionality, including clusters and quantum dots. CO2:Explain the size-dependent physical and chemical properties of nanomaterials, including optical, magnetic, and mechanical behaviour. CO3:Demonstrate the synthetic approaches for the preparation of metal and metal oxide nanoparticles, including chemical and bio-inspired methods. CO4:Analyse nanomaterial characterization techniques such as UV–Visible spectroscopy and FTIR for interpreting structural and functional properties. CO5:Assess the technological and biomedical applications of nanomaterials in catalysis, biosensing, and medical diagnostics. CO6:Integrate knowledge of synthesis, properties, characterization, and applications to evaluate advanced nanomaterials for interdisciplinary technological applications.	
7	Course Description	The Value Added Course on Chemistry of Materials aims to teach the modern and advanced methods of synthesis, characterization and properties of novel nanomaterials.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to nanomaterials**	
	A	Introduction: Definitions, Classification of nanomaterials,	CO1, CO2, CO6
	B	Size & Scale, Units Scaling, Atoms, Molecules,	CO1, CO2, CO6
	C	Clusters and Quantum Dots	CO1, CO2, CO6
	Unit 2	**Properties of nanomaterials**	
	A	Properties and Size dependence of properties	CO2, CO3, CO6
	B	Chemical, Optical properties	CO2, CO3, CO6
	C	Magnetic Mechanical properties	CO2, CO3, CO6
	Unit 3	**Nanomaterial Synthesis**	
	A	Chemical synthesis of metal/metal oxide nanoparticles	CO3, CO4, CO6

	B	Bio-inspired synthesis of metal/metal oxide nanoparticles			CO3, CO4, CO6
	C	Nanocomposite fabrication on a polymer matrix			CO3, CO4, CO6
	Unit 4	**Nanomaterial characterization techniques**			
	A	Introduction to characterization techniques for nanomaterials			CO4, CO5, CO6
	B	Interpretation of the SPR band by UV-Vis			CO4, CO5, CO6
	C	Functional group identification by FTIR spectrum of nanomaterials			CO4, CO5, CO6
	Unit 5	**Applications of nanomaterials**			
	A	Applications in bio-sensing			CO4, CO5, CO6
	B	Catalytic applications of nanomaterials			CO4, CO5, CO6
	C	Biological/bio-medical applications			CO4, CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ETE	
		25%	15%	60%	
	Text Book/s *	Cao, G., & Wang, Y. (2011). *Nanostructures and nanomaterials: Synthesis, properties and applications* (2nd ed.). World Scientific. Rao, M. S. R., & Singh, S. (2015). *Nanoscience and nanotechnology: Fundamentals to frontiers*. Wiley India. Hornyak, G. L., Dutta, J., Tibbals, H. F., & Rao, A. K. (2008). *Introduction to nanoscience*. CRC Press. Edelstein, A. S., & Cammarata, R. C. (Eds.). (1998). *Nanomaterials:*			

	Other References:	*Synthesis, properties and applications*. Institute of Physics Publishing. Murty, B. S., Shankar, P., Raj, B., Rath, B. B., & Murday, J. (2013). *Textbook of nanoscience and nanotechnology*. Springer India.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	1	1	1	1	1	1	1	1	1	1	2	1
CO2	3	2	1	1	1	1	1	1	1	1	1	2	2
CO3	2	2	2	1	1	1	1	1	1	1	1	2	2
CO4	2	3	2	1	2	1	1	1	1	1	2	2	2
CO5	2	2	2	1	2	2	1	1	1	1	2	2	3
CO6	3	3	2	1	2	2	1	2	2	2	3	3	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: VI**
1	Course Code	CHR3102
2	Course Name	**Research-Based Learning -4 (RBL-4)**
3	Credits	0
4	Contact Hours (L-T-P)	0-0-2
	Course Type	RBL
5	Course Objective	The aim of the course is to give the students an opportunity to perform a research project within the field of chemistry under supervision according to an individual study plan, to summarize the results in a research report and present the results of the project.
6	Course Outcomes	CO1: Remember basic experimental methods and procedures used to solve scientific tasks. CO2: Understand the process of data collection, evaluation, and basic statistical treatment where relevant. CO3: Apply appropriate time management, collaboration skills, and theoretical knowledge in practical scientific work. CO4: Analyze and reflect upon the relevance of experimental work through written and oral communication. CO5: Evaluate experimental results and document findings effectively in the form of a research report.

		CO6: Create independent solutions by demonstrating critical and creative thinking in scientific investigations.			
7	Course Description	The aim of the course is to give the students an opportunity to perform a research project within the field of chemistry under supervision according to an individual study plan, to summarize the results in a research report and present the results of the project.			
8	Outline syllabus				CO Mapping
	Unit 1	**Identifying the research problem** Selection of a research problem based on the application on a particular field of science and technology			CO1, CO2, CO6
	Unit 2	**Literature search and formulation of scientific methods** Rigorous literature searches and collection of data for performance and execution of methods			CO1, CO2, CO6
	Unit 3	**Managing time and execution of scientific methodology** Solving the research problem by meticulous time management, planning, and well-standardized methods to link theoretical and practical knowledge			CO3, CO6
	Unit 4	**Research Presentation in a scientific forum** Discussion and presentation of research problem on a scientific forum and also in front of peers' students and friends			CO4, CO6
	Unit 5	**Making of a scientific report** Making of a scientific report, including results, graphs, a table with future remarks justifying the research problem, checking the similarity index, and submitting it to the competent authority			CO5, CO6
	Mode of examination	Theory/Jury/Practical/Viva (Assessment will be made based on Rubrics)			
	Weightage Distribution	CA	MTE	ETE	
		40%	-	60%	
		Suggested Readings: Research Methodology: Methods and Techniques by CR Kothari. Research Methodology: A Step-by-Step Guide for Beginners by Ranjit			

	Text Book/s *	Kumar. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by J. David Creswell and John W. Creswell **Reference Books** Qualitative Research: A Guide to Design and Implementation by Elizabeth J. Tisdell and Sharan Merriam
	Other References	Qualitative Inquiry and Research Design: Choosing Among Five Approaches by Cheryl N. Poth and John W. Creswell.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	2	2	2	1	1	1	2	1	2	2	2
CO2	1	2	3	3	2	2	3	1	2	1	2	2	2
CO3	2	2	3	3	2	2	2	1	2	1	2	2	2
CO4	2	2	2	2	2	2	1	1	2	1	2	2	3
CO5	2	2	2	2	2	2	2	1	2	1	2	2	3
CO6	2	2	2	2	2	2	1	2	2	1	2	2	3

School		Sharda School of Engineering and Sciences (SSES)	
Department		Chemistry & Biochemistry	
Programme Code		SBR0102	
Programme Name		Bachelor of Science (Chemistry)	
Specialisation/Minor			
Batch:2026-2028		**Semester-VII**	
1	**Course Code**	**CHT4101**	
2	**Course Title**	**Advanced Inorganic Chemistry I**	
3	**Credits**	4	
4	**Contact hours**	4-0-0	
	Course Status	Core	
5	Course Objectives	1. To provide an insight into the bonding and structure of coordination compounds. 2. To explain the spectral and magnetic behaviour of coordination compounds. 3. To provide a thorough knowledge of the chemistry and application of inner transition metals. 4. To discuss various spectroscopic methods for the structure elucidation of inorganic compounds. 5. To explain the basics of radioactivity as well as various radioanalytical techniques. 6. To impart knowledge about structure, bonding, and application of inorganic compounds and radiochemistry.	
36	Course Outcome	CO1: Explain various theories of metal-ligand bonding and nuclear stability. CO2: Utilize the magnetic properties of inner transition metals and transition metal complexes. CO3: Apply the redox and spectral properties of inner transition complexes CO4: Analyse the electronic, EPR, ORD, and Mossbauer spectroscopy of transition metal complexes. CO5: Explain the application of spectroscopic and radio-analytical techniques. CO6: Evaluate various aspects of modern inorganic chemistry.	
7	Course Description	This course includes basic concepts of metal –ligand bonding, magnetic and electronic properties of coordination compounds, and their characterization techniques. Chemistry of inner transition metals and nuclear chemistry are also discussed in this course.	
8	Outline Syllabus		CO mapping
	Unit 1	Metal-ligand Bonding	
	A	Overview of crystal field and ligand field theories of 4-, 5-and 6-coordinated complexes, d-orbitals splitting in	CO1,CO6

		linear, trigonal, octahedral, square planar, tetrahedral, square pyramidal, trigonal-bipyramidal and cubic complexes	
	B	measurement of CFSE (d^1 to d^{10}) in weak and strong ligand fields, JahnTeller distortion, nephelauxetic series	CO1,CO6
	C	Molecular orbital theory (MOT) of coordination compounds: Composition of ligand group orbitals, molecular orbital energy diagrams of octahedral, tetrahedral, square planar complexes including both s and p bonding, angular overlap model	CO1,CO6
	Unit 2	Electronic Spectra and Magnetic Properties of Transition Metal Complexes	
	A	Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d^1 - d^9 states), calculations of Dq, B, and β parameters	CO2,CO4,CO6
	B	charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates, and their stereochemical information	CO2,CO4,CO6
	C	anomalous magnetic moments, magnetic exchange coupling, temperature-independent paramagnetism (TIP) of complexes, and the spin crossover phenomenon. Effect of temperature on their magnetic properties	CO2,CO4, CO6
	Unit 3	Chemistry of Inner Transition Elements	
	A	General discussion on the properties of the f-block elements.	CO2,CO3, CO6
	B	Redox, Spectral, and Magnetic properties.	CO2,CO3, CO6
	C	Use of Lanthanide compounds as shift reagents. Photophysical properties of Lanthanide complexes.	CO2,CO3, CO6
	Unit 4	Characterization Techniques	
	A	EPR spectroscopy-basic principle, hyperfine and superhyperfine lines, anisotropy, g values, application in selected inorganic compounds.	CO3,CO4,CO5, CO6
	B	Mossbauer Spectroscopy-Gamma ray emission and absorption by nuclei, Mossbauer effect — conditions, Doppler effect, instrumentation, chemical shift examples, quadrupole effect,	CO3,CO4,CO5, CO6
	C	Use of Mössbauer spectra in chemical analysis, typical spectra of iron and tin compounds.Optical rotatory dispersion (ORD) and circular dichroism (CD).	CO3,CO4,CO5, CO6
	Unit 5	Nuclear Chemistry	
	A	Nuclear structures and nuclear stability. Nuclear models ; radioactivity and nuclear reactions. Detection and measurement of radiation. Tracer techniques.	CO1,CO5, CO6

	B	Study of chemical reactions, isotope exchange reactions, kinetic isotope effect, nuclear activation analyses, Principle of nuclear detection, gas detector, ionization chamber, proportional and G. M. detector.			CO1,CO5, CO6
	C	*Radioactive Techniques:* Detection and measurement of radiation- GM ionization and proportional counters. Radiometric analysis: Isotope dilution analysis, age determination, neutron activation analysis (NAA) and their applications. Radiation hazards and safety measures.			CO1,CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text book/s*	1.Inorganic Chemistry, J.E. Huhey, Harper & Row.			
	Other References	1.Concise Inorganic Chemistry,J. D. Lee, Elbs with Chapman and Hall, London. 2.The Chemical bond, J.N.Murre l, SFA Kettle and JM. Tedder, Wiley, New York. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	3	2	2	2	1	1	2	-	-	-	2
CO4	3	3	2	2	2	2	1	-	1	-	-	-	2
CO5	3	3	2	3	3	2	2	-	1	-	-	-	3
CO6	3	3	3	3	3	3	2	2	2	2	3	2	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/Minor		
Batch:2026-2028		**Semester: VII**
1	**Course Code**	**CHT4102**
2	**Course Name**	**Advanced Organic Chemistry-I**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**4-0-0**
	Course Type	**Core**
5	Course Objective	This course aims to 1. Analyze delocalized chemical bonding mechanisms, including resonance, hyperconjugation, aromaticity, and tautomerism. 2. Examine thermodynamic and kinetic requirements influencing reaction mechanisms and apply key concepts such as the Hammond postulate, Curtin-Hammett principle, and catalytic processes in organic reactions. 3. Differentiate between classical and non-classical carbocations and their rearrangements and explain the reactivity of carbanions, free radicals, carbenes, nitrenes, and benzynes. 4. Identify elements of symmetry and chirality in organic molecules and understand stereochemical concepts such as stereospecificity, stereoselectivity, and asymmetric synthesis. 5. Perform conformational analysis of cyclic systems and determine their effects on chemical reactivity. Also, evaluate stereochemical factors influencing nucleophilic additions, substitutions, and elimination reactions
6.	Course Outcomes	CO1: Extend the concepts of delocalized bonding (resonance, hyperconjugation, and tautomerism) and apply aromaticity principles, including Hückel's rule, to explain the stability and reactivity of organic molecules. CO2: Utilize kinetic and thermodynamic principles, along with reaction mechanisms with or without intermediates, to predict the pathways of organic transformations. CO3: Apply the principles of reactive intermediates in organic reactions to determine the stereochemical outcomes of organic transformations.

		CO4: Analyze the mechanistic pathways and stability of reactive intermediates involved in stereoselective and stereospecific reactions. CO5: Compare the mechanisms and stereochemical outcomes of organic reactions through conformational and configurational analyses. CO6: Evaluate reaction mechanisms and synthetic strategies for organic transformations by integrating concepts of aromaticity, reaction mechanisms, intermediates, and stereochemistry.	
7	Course Description	This course provides an in-depth exploration of advanced organic chemistry, focusing on bonding, reaction mechanisms, intermediates, and stereochemistry. It covers delocalized chemical bonding, aromaticity, and reaction pathways, emphasizing kinetic and thermodynamic principles. The study of key reaction intermediates such as carbocations, carbanions, and free radicals enhances the understanding of organic transformations. Stereochemical concepts, including chirality, conformational analysis, and asymmetric synthesis, are explored to predict molecular behavior in various reactions. Through theoretical and applied perspectives, this course equips students with the skills necessary for research and industrial applications in organic chemistry	
8	Outline syllabus		CO Mapping
	Unit 1	**Nature of Bonding in Organic Molecules**	
	A	**Delocalized chemical bonding:** conjugation, cross conjugation, resonance, hyperconjugation, tautomerism;	CO1, CO6
	B	**Criteria for aromaticity:** Huckel's 4n+2 electron rule for benzenoid and nonbenzenoid aromatic compounds; Application in carbocyclic and hESErocyclic systems, n-annulenes, heteroannulene, fullerenes, C-60, cryptates, azulenes.	CO1, CO6
	C	**Current concepts of aromaticity:** Anti-aromatic, non-aromatic and homoaromatic compounds, Effect of tautomerism and hyperconjugation on aromaticity.	CO1, CO6
	Unit 2	**Reaction Mechanism - Structure and Reactivity**	
	A	**Types of reaction mechanisms:** substitutions, eliminations, additions, rearrangements, thermodynamic and kinetic requirements	CO2, CO6
	B	Hammond postulate, Curtin-Hammett principle, transition states and intermediates, **catalysis:** electrophilic catalysis, acid and base catalysis	CO2, CO6
	C	**Methods of determination of reaction mechanism methods**: Detection of intermediates, Stereochemical and chemical evidences, Identification of products, isotopic labelling and cross-over experiments.	CO2, CO6
	Unit 3	**Reaction Intermediates**	

	A	**Carbocations:** Classical and nonclassical, phenonium ions, norbornyl system, common carbocation rearrangement: Wagner Meerwein rearrangement, Demjonove rearrangement, and Pinacol-pinacolone rearrangement			CO3, CO6
	B	**Carbanions:** formation, stability and their reactions. HSAB principle and its applications			CO3, CO6
	C	**Free radicals:** formation, stability and reactions, cage effects, radical cations and radical anions; **Carbene:** Synthesis, structure and reactions of singlet and triplet carbene, nitrenes, Benzyne.			CO3, CO6
	Unit 4	**Stereochemistry I**			
	A	Elements of symmetry, chirality (centre, axis, and plane), molecules with more than one chiral center, threo and erythro isomers, and optical purity			CO4, CO6
	B	Topicity of ligand and faces and their nomenclature, stereogenecity, chirogenicity, and pseudosymmetry, stereospecific and stereoselective reactions			CO4, CO6
	C	**Asymmetric synthesis:** Chiral auxiliaries, methods of asymmetric induction- substrate, reagent and catalyst-controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination, **Resolution** – optical and kinetic			CO4, CO6
	Unit 5	**Stereochemistry II**			
	A	**Conformational analysis of cyclic systems:** Cyclohexane and its derivatives (mono- and di-substituted), fused (decalins) and bridged bicyclic systems,			CO5, CO6
	B	**Nucleophilic addition to carbonyl group:** Cram, Franklin Ahn Model, Cieplak effect, Effect of conformation on the reduction of cyclic ketones, nucleophilic substitution on cyclohexane substrates, cyclohexane epoxide formation and opening			CO5, CO6
	C	Elimination reactions of cyclohexyl halides, de-amination of 2-aminocyclohexanols, elimination vs substitution competition and neighboring group participation reactions of acyclic and cyclic molecules.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text Book	1. Organic Chemistry, R. T. Morrison and R. N. Boyd, (1992) 6th Edition, Prentice-Hall.			

		2. Reaction Mechanism in Organic Chemistry, (1976) 1st Edition, S. M. Mukherji and S. P. Singh, Macmillan. 3. Stereochemistry, P. S. Kalsi, (1994), 2nd Edition, New Age International.
	Other references	1. Advanced Organic Chemistry Reactions: Mechanism and Structure, Jerry March, (1992) 4th Edition, John Wiley. 2. Stereochemistry of Organic Compounds by ELudwig Eleil, Samual H. Wilen, (1995) T.M.H Edition, Tata McGraw-Hill Publishing Company. 3. Stereochemistry of Organic Compounds: Principles and Applications by D. Nasipuri, (1994) 2nd Edition, New Age International Publishers.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	3	2	2	2	1	1	2	-	-	-	2
CO3	3	2	1	1	1	2	-	-	-	-	-	-	2
CO4	3	3	2	2	2	2	1	-	1	-	-	-	2
CO5	3	3	3	2	2	2	1	1	2	-	-	-	2
CO6	3	3	3	3	3	3	2	2	2	2	3	2	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: VII**
1	Course Code	CHT4103
2	Course Name	Advanced Physical Chemistry-I
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
5	Course Type	Core

6	Course Objective	1. To provide the understanding of physical states of matter and their practical applications. To define how the initially primitive models of real gases in physical chemistry are elaborated to take into account more detailed observations. 2. To understand the concept of partial molar quantities and their variation with temperature and pressure. 3. The concept of ensembles, partition function and their applications in studying gaseous molecules. 4. To understand the concept and different theories of ions and electrolyte interactions 5.To discuss the theoretical aspects of chemical kinetics and the importance of rate equations and different theories for studying the kinetics of complex reactions. 6. To provide an in-depth analysis of various phenomenon, laws and applications of States of Matter, Thermodynamics, Electrochemistry, Phase Equilibrium and Chemical Kinetics	
7	Course Outcomes	CO1: Explain fundamental concepts of states of matter and thermodynamic principles governing chemical systems. CO2: Apply crystallographic and statistical methods to understand molecular structure and thermodynamic properties. CO3: Analyze thermodynamic and statistical approaches to chemical equilibria and energy distributions. CO4: Interpret electrochemical behavior of ionic solutions using activity and interaction theories. CO5: Analyze adsorption, intermolecular interactions, and electrical double-layer phenomena in solutions. CO6: Evaluate reaction mechanisms and rate theories in relation to thermodynamic and kinetic principles.	
8	Course Description	The course is framed to give broad view of states of matter, chemical potential, concepts of electrical double layer in solutions and various models to explain it. Concept of existence of different phases in the form of phase diagrams and their existence with changing variables.	
9	Outline syllabus		CO Mapping
	Unit 1	**States of Matter**	
	A	(a) Gaseous State : Maxwell–Boltzmann distribution of molecular velocities of gases (b) Liquid State: Structure of liquids, Radial distribution functions	CO1, CO2, CO3, CO6
	B	Monte–Carlo method, Molecular dynamics (c) Solid State: Types of solids, Debye- Scherrer method of X-ray structure analysis of crystals, indexing of reflections,	CO2, CO3, CO6

	C	structure of simple lattice and X-Ray intensities, structure factor and its relation to intensity and electron density, Rietveld analysis, particle size of crystallites.	CO2, CO3, CO6
	Unit 2	**Thermodynamics**	
	A	Essentials of thermodynamics, fugacity, standard state of real gases, the relation between fugacity and pressure, Partial molar quantities, chemical potential and Gibbs-Duhem equation,	CO1, CO3, CO6
	B	Classius – Clayperon equation; law of mass action and its thermodynamic derivation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, determination of partial molar volume,	CO3, CO6
	C	thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), third law of thermodynamics, residual entropy, meaning and scope of irreversible thermodynamics.	CO3, CO6
	Unit 3	**Statistical Thermodynamics**	
	A	Concept of distribution, Thermodynamic probability and most probable distribution. Ensembles, Canonical, grand canonical and microcanonical ensembles.	CO2, CO3, CO6
	B	Partition function - Translational, Rotational, Vibrational and Electronic partition functions, calculation of thermodynamic properties in terms of partition function. Applications of partition functions.	CO2, CO3, CO6
	C	Heat capacity behaviour of solids - Chemical equilibria and equilibrium constant in terms of partition functions, Fermi-Dirac statistics, distribution law, Bose-Einstein statistics - distribution law, Evaluation of Lagrange's undeterrmined multipliers.	CO3,CO6
	Unit 4	**Electrochemistry**	
	A	Debye-Huckel theory of ion- ion interactions, Debye-Huckel limiting law of activity coefficients and its limitations,	CO4,CO6
	B	Debye - Huckel -Onsager treatment for aqueous solutions and its limitations, Wein effect, Debye – Falkenhagen effect.	CO4,CO6
	C	The electrode-electrolyte interface: The electrical double layer -The Helmholtz-Perrin parallel plate model, the Gouy-Chapman diffuse-charge model and the Stern model, excess function	CO4, CO5, CO6
	Unit 5	**Chemical Kinetics**	
	A	Simple collision theory of reaction rates, Arrhenius equation and activated complex theory (ACT),	CO3, CO5,CO6

		thermodynamic treatment, chain reactions (hydrogen-halogen reactions) decomposition of N_2O_5			
	B	Theory of unimolecular reactions: Lindemann – Hinshelwood mechanism of unimolecular reactions, RRKM and Slater treatment,			CO3, CO5,CO6
	C	Factors affecting rate of chemical reactions in solution Effect of solvent and ionic strength (Primary salt effect) on rate constants, secondary salt effect.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text book/s*	1. Atkins P. W., Physical Chemistry, Oxford University Press, New York. 2. Kapoor K. L., Textbook of Physical Chemistry (Volume 1) 3. Kapoor K. L., Textbook of Physical Chemistry (Volume 3) 4. Kapoor K. L., Textbook of Physical Chemistry (Volume 5) 5. Puri, Sharma and Pathania, A Textbook of Physical Chemistry, Vishal Publishing Corp.			
	Other References	1. Levine, I. N., Physical Chemistry, Tata McGraw Hill Pub. Co. Ltd., New Delhi. 2. Singh N. B., Gajbiye N.S. and Das S. S., Comprehensive Physical Chemistry, New Age publishers, New Delhi 3. Laidler K. J., Harper & Row, Chemical Kinetics, New York. 4. McQuarrie D. A. and Simon J. D., Physical Chemistry			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	3	2	2	2	1	1	2	-	-	-	2
CO4	3	3	2	3	3	2	2	-	1	-	-	-	3
CO5	3	3	3	3	3	3	2	2	2	2	3	2	3
CO6	3	2	2	2	2	2	1	1	-	-	-	-	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2030		**Semester: VII**
1	**Course Code**	**CHT4104**
2	**Course Name**	**Analytical Chemistry-I**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**4-0-0**
	Course Type	**Core**
5	Course Objective	1. Provide and enrich the students with analytical techniques, various types of errors knowingly/ unknowingly introduced, accuracy, and confidence limits in the analytical process. 2. Provide detailed insight into chemical equilibrium and its effect in the chemical analysis of the analyte. 3. Provide detailed technical knowledge of various chromatographic separation techniques based on physical state, contact, and separation mechanism. 4.Provide detailed technical knowledge of gas, thin-layer chromatographic, integrated LC-MS, and GC-MS separation techniques for qualitative and quantitative analysis. 5. Enable the students to study the thermal behaviour of different compounds, and study the temperature-dependent decomposition process and structural elucidation of unknown analytes. CO6:Estimate the temperature-dependent weight loss in the compound and model, and optimize a suitable temperature condition for further chemical processing.
6	Course Outcomes	CO1:Explain the scope, objectives, and classification of analytical methods, and interpret statistical treatment of errors in chemical analysis. CO2: Apply equilibrium concepts to calculate pH, construct titration curves, and analyze acid-base reactions in aqueous systems. CO3: Analyze chromatographic principles, resolution, and efficiency, and evaluate the performance of column chromatography for the separation of solutes.

		CO4: Evaluate advanced chromatographic techniques, including gas chromatography, HPLC, TLC, and hyphenated methods (LC-MS, GC-MS) for qualitative and quantitative analysis. CO5:Summarize the interconnections among equilibrium, chromatography, and thermal analysis techniques to demonstrate a holistic understanding of analytical chemistry. CO6: Design experimental strategies using thermal analysis methods (TG, DTA, DSC) to characterize materials and interpret thermograms for quantitative and qualitative applications.	
7	Course Description	Analytical chemistry I emphasizes various factors, such as types of errors, accuracy, and precision in chemical analysis, concepts of chemical equilibrium and its effects on qualitative and quantitative estimation, Chromatographic separation, and Thermal analysis.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Analytical Chemistry**	
	A	Scope & objectives of Analytical chemistry and chemical analysis, Classification of analytical methods. Errors in chemical analyses- Accuracy and precision	CO1,CO6
	B	Types of error-determinant, indeterminate and gross. Nature of random errors, statistical treatment of random errors, standard deviation of calculated results, reporting of calculated data	CO1,CO6
	C	ways of expressing accuracy and precision. variance and confidence limit. Comparison of mean with true values, regression analysis (least-square method for linear plots)	CO1,CO6
	Unit 2	**Concept of Equilibrium**	
	A	General treatment of equilibria in aqueous medium involving monoprotic weak acids and weak bases, and salts of weak acids and weak bases	CO2,CO6
	B	Activity and activity coefficient; Effect of electrolytes on chemical equilibria, Calculation of pH	CO2,CO6
	C	Constructing titration curves from charge balance and mass balance equations, Acid-base titrations, and the theory of pH indicators.	CO2,CO6
	Unit 3	**Chromatographic Methods-I**	
	A	General principle, classification of chromatographic methods based on physical state, contact, and separation mechanism	CO3,CO6
	B	Nature of partition forces. Chromatographic behavior of solutes. Chromatographic resolution, selectivity factor and column efficiency.	CO3,CO6

	C	Column chromatography**:** Nature of column materials, Preparation of the column, Solvent systems, detection methods and applications.	CO3,CO6
	Unit 4	**Chromatographic Methods-II**	
	A	**Gas chromatography**- principle, experimental technique, carrier gas, sample injection, column, detector and application	CO4,CO6
	B	High Performance Liquid Chromatography (HPLC): instrumentation- solvent and reservoirs, pumping system, sample injection, Column, detectors	CO4,CO6
	C	**Thin layer chromatography:** coating of materials, preparation of TLC, Solvents, methods of detection and applications. Theory and application of LC-MS, Pyrolysis GC-MS, Thermal Desorption GC-MS.	CO4,CO6
	Unit 5	**Thermal Analysis**	
	A	Principle, different methods of thermal analysis, i) Thermo gravimetric methods of analysis(TG/DTG): Instrumentation, thermogram and information from thermogram, factors affecting thermogram, applications TGA for quantitative analysis (TG analysis of $CaC_2O_4.H_2O$, $CuSO_4.5H_2O$, dolomite ore, etc.)	CO5,CO6
	B	Problems based TGA, ii) Differential Thermal Analysis (DTA): Instrumentation, general principles, differential thermogram, DTA and TG curve together, Applications (DTA analysis of mixture of polymers, DTA of CaC_2O_4 H_2O, DTA of $CuSO_4$ $5H_2O$).	CO5,CO6
	C	Differential Scanning Calorimetry (DSC): Principle, Instrumentation, and Applications (DSC curve of polyethylene terephthalate, DSC curve for isothermal crystallization of polyethylene, DSC of phenacetin), thermometric titrations, Evolved gas analysis.	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MTE: 15% / ETE: 60%	
	Text book/s*	1.Analytical Chemistry-An Introduction, 7th Edition,D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Saunders College Publishing, Philadelphia, London.	
	Other References	1. Modern Methods of Chemical Analysis, 2nd Edition,R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, John Wiley, New York. 2. Analytical Chemistry, 5th Edition,G. D. Christian, John Wiley & Sons, New York.	

		3. Analytical Chemistry: Principles, 2nd Edition,J. H. Kennedy, Saunders Holt, London.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	3	2	2	2	1	1	2	-	-	-	2
CO4	3	3	2	2	2	2	1	-	1	-	-	-	2
CO5	3	3	2	3	3	2	2	-	1	-	-	-	3
CO6	3	3	3	3	3	3	2	2	2	2	3	2	3

School		Sharda School of Engineering and Sciences (SSES)	
Department		Chemistry & Biochemistry	
Programme Code		SBR0102	
Programme Name		Bachelor of Science (Chemistry)	
Specialisation/Minor			
Batch:2026-2028		**Semester: VII**	
1	Course Code	**CHP4101**	
2	Course Name	**Advanced Inorganic Chemistry Lab I**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Type	Core	
5	Course Objective	To perform the qualitative test on unknown inorganic compounds i.e. preliminary tests, tests for extra elements. To understand the basic concept of separation of cations from a mixture. To apply the gravimetric technique for the separation of cations. To learn the preparation of a given inorganic complex. To analyze the prepared complexes with spectroscopic methods.	
6	Course Outcomes	CO1: Demonstrate the technique of analysis of cations and anions in a known sample. CO2: Identify cations and anions present in a given mixture. CO3: Identify interfering radicals present in the given sample. CO4: Analyse quantitatively Copper, Zinc, Nickel, Aluminium using volumetric and complexometric techniques. CO5: Estimate and synthesis of transition metal coordination complexes. CO6: Evaluate qualitative and quantitative analysis and synthesis of metal complexes.	
7	Course Description	The chemistry lab course is designed to make students understand the technique of analysis of cations and anions in a given mixture. The students also learn various techniques, such as gravimetric and volumetric methods, and will also learn to synthesize and analyze the inorganic complexes by spectrophotometric techniques.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on Qualitative Analysis**	
	A	Qualitative analysis of anions: Arsenide, Arsenate, Borate, Bromide, Carbonate, Oxalate, Phosphite, Phosphate, Sulphate	CO1, CO2, CO3,CO6
	B	Qualitative analysis of Cation: Aluminium,	CO1, CO2,

		Ammonium, Antimony, Arsenic, Barium, Bismuth, Cadmium, Calcium, Cobalt, Copper, Ferric, Ferrous,			CO3,CO6
	C	Qualitative analysis of Cation: Molybdenum, Vanadium, Chromium, Selenium, Tellurium, Cerium			CO1, CO2, CO3,CO6
	Unit 2	**Practical related to Qualitative Analysis of salt mixture**			
	A	Analysis of salt mixture-1 qualitatively			CO1,CO2, CO3,CO6
	B	Analysis of salt mixture-2 qualitatively			CO1,CO2, CO3,CO6
	C	Analysis of salt mixture-3 qualitatively			CO1,CO2, CO3,CO6
	Unit 3	**Practical related to Quantitative analysis Gravimetrically**			
	A	Quantitative analysis of copper and Nickel gravimetrically			CO4,CO5, CO6
	B	Quantitative analysis of copper and Nickel gravimetrically			CO4,CO5, CO6
	C	Quantitative analysis of Copper gravimetrically			CO4,CO5, CO6
	Unit 4	**Practical related to volumetric estimation**			
	A	Quantitative analysis of aluminum volumetrically			CO4,CO6
	B	Quantitative analysis of aluminum volumetrically			CO4,CO6
	C	Quantitative analysis of aluminum volumetrically			CO4,CO6
	Unit 5	**Practical related to Synthesis and characterization of Complexes**			
	A	Synthesis and characterization of $[Ni(NH_3)_6Cl_2]$			CO5,CO6
	B	Synthesis and characterization of $K[Cr(C_2O_4)_2(H_2O)_2]$			CO5,CO6
	C	Synthesis and characterization of $[Cr(en)_3]Cl_3$			CO5,CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*				
	Other References	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.			
		Vogel quantitative analysis, 6^{th} Ed			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	3	2	2	2	1	1	2	-	-	-	2
CO3	3	2	1	1	1	2	-	-	-	-	-	-	2
CO4	3	3	2	2	2	2	1	-	1	-	-	-	2
CO5	3	3	3	2	2	2	1	1	2	-	-	-	2
CO6	3	3	3	3	3	3	2	2	2	2	3	2	3

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/Minor		
Batch:2026-2028		**Semester: VII**
1	**Course Code**	**CHP4102**
2	**Course Name**	**Advanced Organic Chemistry Lab I**
3	**Credits**	**1**
4	**Contact Hours (L-T-P)**	**0-0-2**
	Course Type	**Core**
5	Course Objective	This course aims to 1. Develop proficiency in qualitative and quantitative organic analysis techniques. 2. Equip students with practical skills in optical activity measurement and stereochemical analysis. 3. Enable students to synthesize, purify, and characterize organic compounds. 4. Provide hands-on experience in chromatography techniques for compound separation. 5. Enhance problem-solving and analytical skills essential for research and industrial applications.
6	Course Outcomes	CO1: Explain the principles of qualitative analysis of organic compounds and identify the components present in binary organic mixtures using systematic laboratory procedures. CO2: Apply polarimetry and kinetic methods to determine the specific rotation of optically active compounds and the kinetics of sucrose inversion. CO3: Make use of suitable quantitative analytical methods to estimate the concentration of organic compounds such as phenol, aniline, and glucose in given samples. CO4: Examine the reaction conditions and mechanisms in the synthesis of aromatic compounds such as p-bromoaniline, p-nitroaniline, and picric acid through electrophilic substitution reactions. CO5: Compare the separation efficiency of chromatographic techniques, including thin-layer chromatography and paper chromatography, for organic compounds. CO6: Evaluate experimental results obtained from qualitative analysis, optical activity measurements, estimations, organic synthesis, and chromatographic separations to interpret the identity, purity, and behavior of organic compounds.

7	Course Description	This practical course provides hands-on training in essential organic chemistry techniques, including qualitative and quantitative analysis, synthesis, and chromatography. Students will learn to identify organic compounds in binary mixtures, measure optical activity, estimate aniline concentration, and synthesize organic molecules. Additionally, chromatographic techniques such as thin-layer chromatography (TLC) and Column Chromatography will be used for compound separation. Emphasizing analytical and problem-solving skills, this course prepares students for research and industrial applications in organic chemistry.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on Qualitative binary mixture analysis of organic compounds**	
	A	To analyze the mixture of two components. (Mixture 1)	CO1, CO6
	B	To analyze the mixture of two components. (Mixture 2)	CO1, CO6
	C	To analyze the mixture of two components. (Mixture 3)	CO1, CO6
	Unit 2	**Practical based on the measurement of the specific rotation of an optically active compound**	
	A	To determine the specific rotation of a glucose/fructose/ tartaric acid solution	CO2, CO6
	B	To determine the kinetics of the inversion of sucrose	CO2, CO6
	C	To determine the kinetics of the inversion of sucrose	CO2, CO6
	Unit 3	**Practical related to the estimation of organic compounds**	
	A	To estimate the amount of Phenol in the given solution	CO3, CO6
	B	To estimate the amount of Aniline in the given solution	CO3, CO6
	C	To estimate the amount of Glucose in the given solution	CO3, CO6
	Unit 4	**Practical related to Synthesis of Organic Compounds**	
	A	To synthesize p-bromoaniline (Aromatic Electrophilic substitutions)	CO4, CO6
	B	To synthesize p-nitroaniline (Aromatic Electrophilic substitutions)	CO4, CO6
	C	To synthesize picric acid from phenol (Aromatic Electrophilic substitutions)	CO4, CO6
	Unit 5	**Practical related to Chromatography of Organic Compounds**	
	A	To separate a mixture of dyes using a thin-layer chromatography (TLC) plate and optimize the ratio of the solvent mixture for efficient separation.	CO5, CO6
	B	To prepare the chromatographic plate and compare its efficiency with the paper chromatographic technique for the separation of a mixture of two pigments	CO5, CO6

	C	To separate a mixture of amino acids by thin-layer chromatography (TLC) and identify the test amino acids by measuring their Rf values.		CO5, CO6
	Mode of examination	Practical/Viva		
	Weightage Distribution	CA	CE	ESE
		30%	30%	40%
	Text book/s*	1. Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia, V.K., Dhingra, S. (2004), University Press. 2. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Ahluwalia, V.K., Aggarwal, R. (2004), University Press 3. Practical Organic Chemistry: Volume I, Pasricha, S., Chaudhary, A. (2021), I K International Publishing House Pvt. Ltd, New Delhi		
	Other References	1. Quantitative Organic Analysis, Part 3, Vogel, A.I. (2012), Pearson Education. 2. Practical Organic Chemistry, Mann, F.G., Saunders, B.C. (2009), Pearson Education.		

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	3	2	2	2	1	1	2	-	-	-	2
CO3	3	2	1	1	1	2	-	-	-	-	-	-	2
CO4	3	3	2	2	2	2	1	-	1	-	-	-	2
CO5	3	3	3	2	2	2	1	1	2	-	-	-	2
CO6	3	3	3	3	3	3	2	2	2	2	3	2	3

School		Sharda School of Engineering and Sciences (SSES)	
Department		Chemistry & Biochemistry	
Programme Code		SBR0102	
Programme Name		Bachelor of Science (Chemistry)	
Specialisation/Minor			
Batch:2026-2028		**Semester: VII**	
1	**Course Code**	**CHP4103**	
2	**Course Name**	**Advanced Physical Chemistry Lab I**	
3	**Credits**	**1**	
4	**Contact Hours (L-T-P)**	**0-0-2**	
5	**Course Type**	**Core**	
6	Course Objective	1. To find the individual strengths of acids and salts via thermometric titrations, conductometric titrations, precipitation titrations, and pH metric titrations. 2. Find the heat of neutralization using Calorimetry. 3. To calculate the dissociation tendency of the acids. 4. To construct the phase diagrams of binary and ternary systems. 5. To learn software handling for chemistry problems.	
7	Course Outcomes	CO1: Apply thermometric and calorimetric experiments to determine enthalpy changes in neutralization reactions. CO2: Determine dissociation constants and critical solution temperatures using pH, conductivity, and solubility measurements. CO3: Apply electroanalytical techniques such as conductometric and potentiometric titrations for quantitative analysis. CO4: Analyze separation and quantitative estimation of chemical species using chromatographic and titration methods. CO5: Interpret experimental titration data to determine composition and strength of chemical systems. CO6: Process and interpret experimental data using statistical tools and graphical analysis in Microsoft Excel.	
8	Outline syllabus		CO mapping
	Unit 1	**Quantitative Analysis - I**	
	A	To determine the concentration of two acids, HCl and ethanoic acid, by thermometric titration, and use it to calculate the enthalpy change of neutralization	CO1,CO6
	B	Calculate the heat of neutralization for the NaOH and HCl mixture using a Bomb Calorimeter.	CO1,CO6

	C	To study precipitation titration between KCl and $AgNO_3$ conductometrically and determine the strength of the given solution of $AgNO_3$	CO1,CO6
	Unit 2	**Quantitative Analysis - II**	
	A	To determine the dissociation constant of acetic acid using (a) a pH meter and (b) a conductivity meter, and compare the results	CO2,CO6
	B	Study of the variation of mutual solubility temperature with concentration for the phenol-water system and determination of the critical solubility temperature (CST).	CO2,CO6
	C	To deterrmine the strength of H_3PO_4 by titration with standard NaOH using pH meter	CO2,CO6
	Unit 3	**Quantitative/Qualitative Assessment - I**	
	A & B	To determine the strength of strong acid and weak acid conductometrically by titrating against standard NaOH solution	CO3,CO6
	C	To estimate the amount of ferrous ions in a given solution potentiometrically.	CO3,CO6
	Unit 4	**Quantitative/Qualitative Assessment -II**	
	A	To study the separation of dyes by thin layer chromatography (TLC)	CO3,CO4,CO6
	B	To determine the amount of $BaCl_2$ in a given solution by conductometric titrations	CO3,CO4,CO6
	C	Study the conductometric titration of hydrochloric acid with sodium carbonate	CO3,CO4,CO6
	Unit 5	**Data Handling**	
	A & B	To calculate Mean, Median, Mode, Standard deviation, Variance, Range by using Microsoft Excel	CO5,CO6
	C	To calculate and draw the first and second derivative of given data on excel sheet.	CO5,CO6
	Mode of examination	Practical/Viva	
	Weightage Distribution	CA: 30% / CE: 30% / ESE: 40%	
	Text book	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.	
	Other References	Vogel's "Textbook of quantitative Analysis", Pearson.	

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	3	2	2	2	1	1	2	-	-	-	2
CO4	3	3	2	3	3	2	2	-	1	-	-	-	3
CO5	3	3	3	3	3	3	2	2	2	2	3	2	3
CO6	3	2	2	2	2	2	1	1	-	-	-	-	2

School		Sharda School of Engineering and Sciences (SSES)	
Department		Chemistry & Biochemistry	
Programme Code		SBR0102	
Programme Name		Bachelor of Science (Chemistry)	
Specialisation/Minor			
Batch:2026-2028		**Semester: VII**	
1	Course Code	CHP4104	
2	Course Name	Basic Chemistry Softwares	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Type	Core	
5	Course Objective	Students will gain knowledge and skills on the various important software tools used in chemistry. They will learn how to plot a graph in Microsoft Excel, origin, draw, and visualize the chemical structure in ChemDraw, origin, CCDC, etc. Students will also develop presentation skills in this course. Students will know of: • Drawing the graph in Microsoft Excel, Origin • Drawing and visualizing the chemical structure in ChemDraw, origin, CCDC • Students will also develop presentation skills in this course.	
6	Course Outcomes	CO1:Explain and utilize Microsoft Excel tools for data analysis, graph plotting, and basic calculations. CO2:Construct and illustrate chemical structures using ChemDraw and ChemCraft software. CO3:Demonstrate and analyze graphical data using Origin software for scientific interpretation. CO4: Visualize, interpret, and construct chemical and crystal structures using CCDC and Mercury tools. CO5:Explain and evaluate the importance of citation and referencing in scientific research articles. CO6: Identify, explain, and apply various computational and analytical software tools used in chemistry.	
7	Course Description	This course introduces the most frequent and important software and tools in chemistry for making and analyzing the structure and basics of Microsoft Excel and PowerPoint. Students will be capable of utilizing this software knowledge during their research and higher studies.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Microsoft Excel**	
	A	Download Microsoft Office 365 and the Excel program, and view the basics of Excel, and Excel spreadsheets for data	CO1, CO2, CO6

		entry, and create simple formulas in an Excel spreadsheet to analyze data.	
	B	Introduction to Excel Charting, Chart and Graph Editing, Formatting Chart elements, Handling Graph in Chart	CO1, CO3, CO6
	C	Application of Excel in chemistry with a few examples	CO1, CO6
	Unit 2	**ChemDraw and ChemSketch**	
	A	Introduction of ChemDraw, chemical name to structure conversion, chemical structure to name conversion	CO2, CO3, CO6
	B	NMR spectrum simulation, structure clean up, 3D chemical structure.	CO2, CO2, CO6
	C	Introduction to ChemSketch, creating and modifying images of chemical structures, writing and performing chemical equations and diagrams.	CO2, CO6
	Unit 3	**Origin lab: Origin and OriginPro Masterclass**	
	A	Downloading and installing the origin software, Learning the basic interface of Origin and OriginPro,	CO3, CO4, CO6
	B	Scatter plot, Line plot, customizing graphs to presentation quality levels, How to plot columns, bar, and stacked plots.	CO3, CO6
	C	Functional plots Statistics like cross-tabulation, chi-square analysis, etc. Mathematics on Data Linear and non-linear fitting with built-in models	CO3, CO4, CO6
	Unit 4	**Software to Visualize the Structure**	
	A	Mercury 4.0: from visualization to analysis, design, and prediction, Three-dimensional visualization of X-ray crystal structure.	CO4, CO5, CO6
	B	ORTEP: Three-dimensional visualization of the X-ray crystal structure of organic and inorganic compounds	CO4, CO6
	C	CSD(CCDC): Deposition method of three-dimensional X-ray crystal structure of organic and inorganic compounds	CO4,CO5, CO6
	Unit 5	**Software to manage references/citations**	
	A	Introduction to Reference/Citation	CO4, CO5, CO6
	B	Various methods and formats of Reference/citation in a research article	CO5, CO6
	C	Mendeley: Managing references and citations.	CO5, CO6
	Mode of examination	Assignments, Quizzes & Viva	

PO →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9		PO 11	PSO1	PSO2

CO ↓										PO 10			
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	3	2	2	2	1	1	2	-	-	-	2
CO3	3	2	1	1	1	2	-	-	-	-	-	-	2
CO4	3	3	2	2	2	2	1	-	1	-	-	-	2
CO5	3	3	3	2	2	2	1	1	2	-	-	-	2
CO6	3	3	3	3	3	3	2	2	2	2	3	2	3

School		Sharda School of Engineering and Sciences (SSES)	
Department		Chemistry & Biochemistry	
Programme Code		SBR0102	
Programme Name		Bachelor of Science (Chemistry)	
Specialisation/Minor			
Batch:2026-2028		**Semester: VIII**	
1	**Course Code**	**CHT4105**	
2	**Course Name**	**Advanced Inorganic Chemistry II**	
3	**Credits**	**3**	
4	**Contact Hours (L-T-P)**	**3-0-0**	
	Course Type	**Core**	
5	Course Objective	1. To introduce the basics concept of molecular symmetry and group theory. 2. To demonstrate the various applications of group theory in spectroscopy. 3. To provide an introduction to basic concepts of organometallic chemistry. 4. To explain to the student the various applications of organometallic chemistry in industry. 5. To provide information on various industrially important organometallic compounds. 6. To provide structure, bonding, and reactivity of transition metal carbonyls, nitrosyls, and phosphine complexes.	
6	Course Outcomes	CO1: Explain the various aspects of molecular symmetry and organometallic chemistry CO2: Demonstrate synthesis, classification, properties, and stability of organometallic complexes. CO3: Apply group theory and molecular symmetry to understand the principles of vibrational spectroscopy. CO4: Analyse the structure and reactivity of transition metal alkyl, aryl, alkene, arene, carbonyl, nitrosyl, and carbine complexes CO5: Assess industrial applications of organometallic compounds. CO6: Evaluate advanced organometallic chemistry and group theory.	
7	Course Description	The course includes the basic concept of group theory and its application in chemistry, as well as the organometallic chemistry of transition metals.	
8	Outline syllabus		CO Mapping
	Unit 1	Molecular symmetry	
	A	Introduction, Meaning and examples of different symmetry elements and generated operations; and	CO1,CO3,CO6

		general rules, Derivation of matrices for rotation; reflection; rotation; reflection and inversion operations;	
	B	Symmetry operations of all the molecular point groups (C_n, D_n, C_{nh}, D_{nb},C_{nv}, D_{nd}, S_n, T, T_d and T_h ; Determination of the classes of operations by similarity transform method (only C_{2v}, C_{2h}, C_{3v}) and general rules	CO1, CO3, CO6
	C	Defining properties of 'group'; Types of groups, Subgroups; reducible and irreducible representations	CO1, CO3, CO6
	Unit 2	Application of Group Theory	
	A	Construction of character table for C_{2v} and C_{3v} point group	CO3,CO6
	B	Optical activity and dipole moment	CO3, CO6
	C	Application of group theory to electronic and vibrational spectroscopy	CO3, CO6
	Unit 3	Organometallic Chemistry-I	
	A	General Characteristics of organometallic compounds, Ligand hapticity, electron count for different types of organometallic compounds, 16 and 18 electron rule and exceptions, Fluxionality in organometallic complexes.	CO1,CO2,CO5,CO6
	B	Synthesis, structure and bonding of organolithium compounds	CO1,CO2,CO5,CO6
	C	Organometallic reagents in homogeneous catalytic reactions (Hydrogenation, hydroformylation, isomerisation, polymerisation).	CO1,CO2,CO5,CO6
	Unit 4	Organometallic Chemistry-II	
	A	General synthetic routes, nature of bond and structural characteristics of alkyl, aryl, alkene alkynes complexes of transition metals.	CO2,CO4,CO5,CO6
	B	Structure and bonding of metallocenes.	CO2,CO4,CO5,CO6
	C	Synthesis, structure and reactivity of metal carbene and carbynes	CO2,CO4,CO5,CO6
	Unit 5	Organometallic Chemistry-III	
	A	Ligand behavior of CO, General methods of preparation, structures, bonding, and vibrational spectra of metal (Fe, Ru, Os, Cr, Ni) carbonyls.	CO2,CO4,CO6
	B	Ligand behavior of NO (NO^+, NO^- and bridging NO), preparation, structures, bonding of nitrosyls of Cr, Fe and Ru	CO2,CO4,CO6

	C	Preparation, structure, bonding and reactivity of metal phosphines. Comparison of phosphine and carbonyl ligands in terms of bonding.			CO2,CO4,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	15%	60%	
	Text book/s*	1. Inorganic Chemistry, J.E. Huhey, Harper & Row. 2.Organometallic Chemistry, R.C.Mehrotra and A.Singh, New Age International.			
	Other References	1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley 2. Introduction to Ligand fields, B.N. Figgis, Wiley, New York. 3. The Organometallic Chemistry of the Transit ion Metals, R.H. Crabtree, John Wiley. 4. Transition metal chemistry, Fundamental concept and applications, A.Yamamoto, John Wiley, 1986.			

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	2	1	2	2	2	-	-	-	-	-	-	2
CO2	3	3	3	2	2	2	1	1	2	-	-	-	2
CO3	3	3	2	2	2	2	1	-	1	-	-	-	2
CO4	3	3	2	3	3	2	2	-	1	-	-	-	3
CO5	3	3	3	3	3	3	2	2	2	2	3	2	3
CO6	3	2	2	2	2	2	1	1	-	-	-	-	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/Minor		
Batch:2026-2028		**Semester: VIII**
1	**Course Code**	**CHT4106**
2	**Course Name**	**Advanced Organic Chemistry II**
3	**Credits**	**3**
4	Contact Hours (L-T-P)	3-0-0
	Course Type	Core
5	Course Objective	This course aims to: 1. Develop an in-depth understanding of single bond (C- C) formation strategies and explore the role of enolates, enamines, and organometallic reagents in organic synthesis. 2. Develop the critical thinking to analyze the conditions required for C=C bond formation 3. Introduce metal-catalyzed carbon- carbon bond formation techniques and their applications. 4. Examine oxidation and reduction reactions, including stereochemical aspects and selectivity. 5. Analyze key name reactions and molecular rearrangements in organic synthesis
6	Course Outcomes	CO1: Interpret the principles and reaction mechanisms of C–C bond formation using enolates/enamines and elimination or olefination reactions for C=C bond formation in organic synthesis. CO2: Utilize suitable methods of metal-catalysis to form C-C/C=C bonds along with organometallic chemistry to predict products in organic transformations. CO3: Apply oxidation strategies and rearrangement reactions to achieve targeted functional group transformations in organic synthesis. CO4: Analyze the mechanistic pathways and selectivity of oxidation and reduction reactions used in advanced organic synthesis. CO5: Compare the mechanisms of reduction reactions and molecular rearrangements involved in important name reactions.

		CO6 : Design and evaluate multi-step synthetic strategies for organic molecules by integrating C–C bond formation, olefination, oxidation, reduction, and rearrangement reactions.	
7	Course Description	This course provides a comprehensive understanding of modern organic synthesis, focusing on carbon-carbon (C-C) and carbon-carbon double bond (C=C) formation strategies. It covers the chemistry of enolates, enamines, and organometallic reagents, along with metal-catalyzed coupling reactions such as Suzuki, Heck, and Sonogashira. Key oxidation and reduction methodologies, including stereoselective transformations, are explored in detail. Additionally, the course examines important name reactions and molecular rearrangements, emphasizing their mechanisms and applications in organic synthesis. By integrating theoretical knowledge with practical applications, this course prepares students for advanced research and industrial challenges in organic chemistry.	
8	Outline syllabus		CO Mapping
	Unit 1	**Single bond (C-C) formations**	
	A	**Chemistry of enolates:** Thermodynamic and kinetic enolates, lithium and boron enolates in aldol and Michael reactions, alkylation and acylation of enolates, Enamines and its analogy with enolates	CO1, CO6
	B	**Organometallic chemistry:** organolithium, organomagnesium (Grignard), organozinc, organocopper (Gilman & Normant) reagents in synthesis	CO1, CO2, CO6
	C	**Metal-catalyzed C-C bond formations:** Negishi, Heck, Suzuki, and Sonogashira	CO1, CO2, CO6
	Unit 2	**Double bond (C=C) formations**	
	A	**Elimination reactions:** Hoffmann vs. Saytzev's rule, Cope elimination, Phospohorus, nitrogen and sulfur ylids, Wittig reaction, Wittig-Horner reaction	CO2, CO3, CO6
	B	Tebbe olefination, Julia olefination, Mannich reaction, Robinson annulation, Peterson olefination, McMurry reaction, Shapiro reaction, selenoxide elimination	CO2, CO4, CO6
	C	**Olefin metathesis:** Schrock and Grubb catalyst, ring closing metathesis, enyne metathesis, Thorpe reaction	CO2, CO3, CO6
	Unit 3	**Oxidation**	
	A	**Alkene oxidation:** alkenes to carbonyls with bond cleavage, alkenes to alcohols/carbonyls without bond cleavage (Wacker oxidation),	CO3, CO6
	B	Sharpless asymmetric dihydroxylation, Prevost reaction and Woodward modification	CO3, CO6

	C	**Oxidation of Alcohols:** alcohols to carbonyls, alcohols to acids or esters, phenols (Fremy's salt), Swern oxidation.	CO3, CO4, CO6
	Unit 4	**Reduction**	
	A	**Catalytic reduction** (Pt, Pd, Ni), Dissolving metal reductions (alkali metals in Liq. NH_3 and Zn, Sn),	CO4, CO5, CO6
	B	**Reduction by hydride transfer reagents** (Complex hydrides of Li and Na); Stereoselectivity of reduction with small hydride donors;	CO4, CO6
	C	**Reduction with non-metals:** HI, Diimides and hydrazine	CO4, CO6
	Unit 5	**Name Reactions and Molecular Rearrangements**	
	A	Hoffmann, Lossen, Curtius, Schmidt rearrangement	CO5, CO6
	B	Mechanism of Baeyer Villiger, Favorskii rearrangement, Sommelet-Hauser rearrangement	CO5, CO6
	C	Baylis-Hillman reaction, Henry reaction, Ritter reaction, Sakurai reaction, Tishchenko reaction, Ugi reaction	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MTE: 15% / ETE: 60%	
	Text Book/s*	1. Organic Reactions and Mechanisms, P.S. Kalsi, (2002) 2nd Edition, New Age International Publishers. 2. Organic Chemistry, R. T. Morrison and R. N. Boyd, (1992) 6th Edition, Prentice-Hall. 3. Reaction Mechanism in Organic Chemistry, (1976) 1st Edition, S. M. Mukherji and S. P. Singh, Macmillan.	
	Other references	1. Advanced Organic Chemistry Reactions: Mechanism and Structure, Jerry March, (1992) 4th Edition, John Wiley. 2. Organic Chemistry, Francis A. Carey, (1996) 3rd Edition, The McGraw-Hill Companies, Inc. 3. Modern Methods of Organic Synthesis South Asia Edition W. Carruthers, Iain Coldham, (2004) 4th Edition, Cambridge University Press 4. Principles of Organic Synthesis, R.O.C. Norman, (1978) 2nd Edition, Chapman and Hall	

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2

CO1	3	3	3	2	2	2	1	1	2	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	2	3	3	2	2	-	1	-	-	-	3
CO4	3	2	1	2	2	2	-	-	-	-	-	-	2
CO5	3	3	3	3	3	3	2	2	2	2	3	2	3
CO6	3	2	2	2	2	2	1	1	-	-	-	-	2

School		Sharda School of Engineering and Sciences (SSES)	
Department		Chemistry & Biochemistry	
Programme Code		SBR0102	
Programme Name		Bachelor of Science (Chemistry)	
Specialisation/ Minor			
Batch:2026-2028		**Semester:VIII**	
1	**Course Code**	**CHT4107**	
2	**Course Name**	**Advanced Physical Chemistry II**	
3	**Credits**	**3**	
4	**Contact Hours (L-T-P)**	**3-0-0**	
	Course Type	**Core**	
5	Course Objective	1. To familiarise students with the theoretical and mathematical aspects of quantised energy levels of a particle in a box, 2. To introduce the theoretical concept of the hydrogen atom and the hydrogen molecule, and the hydrogen molecule ion. 3. To infer the concept of Charge on colloids, electro kinetic phenomenon's, and different theories on colloids 4. To prioritise the surface phenomena and different equations and theories to explain them. 5. To describe equilibrium processes of one and more than one component systems, such as congruent, peritectic, and Monotectic Systems.	
6	Course Outcomes	CO1: Explain quantum mechanical principles and their application to atomic structure and bonding. CO2: Apply quantum mechanical approaches to describe atomic structure and hydrogen atom wave functions. CO3: Analyze colloidal systems and electrokinetic phenomena using double-layer theories. CO4: Interpret adsorption behavior and surface interactions using adsorption isotherms. CO5: Evaluate micellization, surface activity, and intermolecular interactions in solution systems. CO6: Analyze phase equilibria and phase diagrams using Gibbs phase rule and thermodynamic principles.	
7	Course Description	Concept of Quantum mechanics and its applications in MOT and VBT were shared with students. Theories of colloids and concepts of surface chemistry were discussed. The phase diagram of different component systems were discussed and explained how to plot them.	
8	Outline syllabus		CO Mapping
	Unit 1	**Quantum Mechanics**	

	A	Matter waves, The Uncertainty principle, the wave nature of the electron, Postulates of Quantum Mechanics, Commutation of operators, Eigen value and Eigen function. Angular momentum operator, Ladder operator.	CO1, CO2, CO6
	B	The wave equation, Particle in one dimensional box, particle in three-dimensional box, Degeneracy.	CO2,CO6
	C	Hydrogen atom: Schrodinger wave equation, Transformation of coordinates, separation of variable in polar spherical coordinates and its solution, probability distribution function, radial distribution function.	CO2,CO6
	Unit 2	**Chemical Bonding**	
	A	Born Oppenheimer Approximation, The variation method, Ground state energy of the hydrogen atom,	CO1, CO2, CO6
	B	Huckel molecular orbital theory of conjugated systems, Secular equations, delocalisation energy,	CO2, CO5, CO6
	C	MOT and Valence bond theory- Hydrogen molecule.	CO1, CO2, CO5, CO6
	Unit 3	**Colloids**	
	A	Introduction, Origin of the charges, electro-kinetic phenomena : electrophoresis, electro osmosis, sedimentation and streaming potential.	CO3,CO6
	B	The concept of electrical double layer and various models to explain its structure and properties,	CO3, CO5, CO6
	C	DLVO theory and stability of colloids. Smoluchowski theory of kinetics of coagulation and distribution of colloids aggregates.	CO3, CO5, CO6
	Unit 4	**Surface Chemistry and Micelles**	
	A	Surface tension and surface free energy; Pressure across an interface: Laplace equation, Kelvin equation.	CO4,CO6
	B	Adsorption in liquid systems: Gibbs adsorption isotherm; Adsorption on solids: Langmuir isotherm, BET isotherm.	CO4, CO5, CO6
	C	Micelles-Surface active agents, micellization, hydrophobic interaction, critical micellar concentration (cmc), factors affecting cmc of surfactants, micro emulsions, reverse micelles.	CO5,CO6
	Unit 5	**Phase Equilibria**	
	A	Statement and meaning of the terms in Gibbs phase rule; phase equilibria of water, Helium and Carbon systems;	CO6, CO1
	B	Two component solid-liquid equilibria (example of Cu-Ni alloy, Bi - Cd system and $CuSO_4 – H_2O$ System): simple eutectic; congruent melting type;	CO5,CO6
	C	peritectic type and monotectic type phase diagrams, concept of Phase equilibria of three component systems	CO5,CO6

	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		25%	15%	60%
	Text book/s*	1. Atkins P. W., Physical Chemistry, Oxford University Press, New York. 2. Levine I. N., Physical Chemistry, Tata McGraw Hill Pub. Co. Ltd., New Delhi. 3. Adamson A. W., Physical Chemistry of Surfaces, John Wiley and Sons.		
	Other References	1. Day M. C. and Selbin J., Theoretical Inorganic Chemistry. 2. Pashley R. M. and Karaman M. E., Applied Colloid and Surface Chemistry, Wiley Publications. 4. Singh N. B., Gajbhiye N. S. and Das S. S. Comprehensive Physical Chemistry, New Age publishers, New Delhi. 5. McQuarrie D. A. and Simon J. D., Physical Chemistry.		

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	3	3	2	2	2	1	1	2	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	2	3	3	2	2	-	1	-	-	-	3
CO4	3	2	1	2	2	2	-	-	-	-	-	-	2
CO5	3	3	3	3	3	3	2	2	2	2	3	2	3
CO6	3	2	2	2	2	2	1	1	-	-	-	-	2

School		Sharda School of Engineering and Sciences (SSES)	
Department		Chemistry & Biochemistry	
Programme Code		SBR0102	
Programme Name		Bachelor of Science (Chemistry)	
Specialisation/Minor			
Batch:2026-2028		**Semester: VIII**	
1	**Course Code**	**CHP4105**	
2	**Course Title**	**Advanced Inorganic Chemistry Lab II**	
3	**Credits**	**1**	
4	**Contact Hours (L-T-P)**	**0-0-2**	
	Course Status	**Core**	
5	Course Objective	To learn about types of titration and estimation of elements of alloys, and learn the techniques of jobs method and characterization of metal complexes	
6	Course Outcomes	CO1: Explain the theory and techniques of complexometric and redox titration. CO2: Apply the Job's method and masking-demasking techniques. CO3: Analyse Ca in milk powder, dolomite, and other mixtures. CO4: Analyse Fe^{2+}, Fe^{3+}, and Ca^{2+} in mixture. CO5: Estimate and synthesis of transition metal coordination complexes. CO6: Evaluate quantitative analysis and characterization of metal complexes.	
7	Course Description	The course aims to appraise the students to learn basic methods of titration and characterisation of given material. It will enable students to analyse various materials like steel and alloys.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical related to analysis of samples**	
		Sub unit – a ,b, c	CO1, CO3,CO6
	Unit 2	**Practical related to determination of elements in a mixture**	
		Sub unit –a, b, c	CO2,CO6
	Unit 3	**Practical based to analysis of ferro alloys and steel**	
		Sub unit- a, b, c	CO1,CO4,CO5,CO6
	Unit 4	**Practical related to Applications of jobs method**	
		Sub unit – a, b, c	CO2,CO3,CO4,CO6

	Unit 5	**Practical based to synthesis and characterization of metal complexes.**			
					CO5,CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE	ESE	
		30%	30%	40%	

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	3	3	2	2	2	1	1	2	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	2	3	3	2	2	-	1	-	-	-	3
CO4	3	2	1	2	2	2	-	-	-	-	-	-	2
CO5	3	3	3	3	3	3	2	2	2	2	3	2	3
CO6	3	2	2	2	2	2	1	1	-	-	-	-	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2028		**Semester-II**
1	Course Code	**CHP4106**
2	Course Name	**Advanced Organic Chemistry Lab II**
3	Credits	**1**
4	Contact Hours (L-T-P)	**0-0-2**
	Course Type	**Core**
5	Course Objective	This course aims to 1. Develop hands-on experience in the qualitative analysis of organic compound mixtures. 2. Enhance understanding of fundamental organic synthesis techniques and reaction mechanisms. 3. Introduce students to purification techniques such as chromatography for separating organic compounds. 4. Provide experience in instrumental techniques like UV and IR spectroscopy for product identification. 5. Reinforce laboratory safety, precision, and best practices in organic chemistry experiments.
6	Course Outcomes	CO1: Explain the principles and techniques involved in the separation and purification of solid organic compounds CO2: Apply the qualitative analysis method to find individual components present in binary organic mixtures through systematic qualitative analysis. CO3: Apply the method of synthesis of selected organic compounds by following standard laboratory procedures, including reaction setup, monitoring reaction progress, isolation, and purification of products. CO4: Examine spectral data obtained from Ultraviolet (UV) and Infrared (IR) spectroscopy for the characterization and structural confirmation of synthesized organic compounds. CO5: Evaluate appropriate chromatographic techniques such as thin-layer chromatography (TLC) and column chromatography for the separation, analysis, and purification of organic compounds. CO6: Assess and maintain safe laboratory practices by properly handling instruments, chemicals, and glassware, while recording and documenting experimental observations accurately.

7	Course Description	This course provides an in-depth exploration of qualitative and synthetic techniques in organic chemistry. Students will analyze binary mixtures, perform organic syntheses, and apply chromatographic separation methods. They will also gain hands-on experience in instrumental analysis for product identification. By the end of the course, students will develop essential laboratory skills necessary for research and industrial applications in organic chemistry			
8	Outline syllabus				CO Mapping
	Unit 1	**Qualitative analysis of organic compounds-I**			
	A	To analyze the mixture of two components. (Mixture 1)			CO1, CO2, CO6
	B	To analyze the mixture of two components. (Mixture 2)			CO1, CO2, CO6
	C	To analyze the mixture of two components. (Mixture 3)			CO1, CO2, CO6
	Unit 2	**Qualitative analysis of organic compounds-II**			
	A	To analyze the mixture of two components (Mixture 4)			CO1, CO2, CO6
	B	To analyze the mixture of two components. (Mixture 5)			CO1, CO2, CO6
	C	To analyze the mixture of two components. (Mixture 6)			CO1, CO2, CO6
	Unit 3	**Organic synthesis-I**			
	A	To prepare *m*-phenylenediamine form *m*-dinitrobenzene			CO3, CO6
	B	To prepare Methyl orange using aniline. Identify the product with M.P., UV, and IR analysis.			CO3, CO6
	C	To prepare Methyl red using anthranilic acid. Identify the product with M.P., UV, and IR analysis.			CO3, CO6
	Unit 4	**Organic synthesis-II**			
	A	To prepare o-Chlorobenzoic acid from phthalic anhydride.			CO4, CO6
	B	To prepare 2,4-dihydroxy ethylbenzene using resorcinol. Identify the product with M.P. and IR analysis.			CO4, CO6
	C	To synthesize o-and p-nitro aniline by two two-step process			CO4, CO6
	Unit 5	**Separation of Organic compounds**			
	A	To separate Organic compounds with the help of the Column Chromatographic technique and report the yield of pure components (sample1).			CO5, CO6
	B	To separate Organic compounds with the help of the Column Chromatographic technique and report the yield of pure components (sample2)			CO5, CO6
	C	To extract the mustard oil from mustard seed using the soxhlet extraction technique			CO5, CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	

	Text book/s*	1. Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia, V.K., Dhingra, S. (2004), University Press. 2. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Ahluwalia, V.K., Aggarwal, R. (2004), University Press 3. Practical Organic Chemistry: Volume–I, Pasricha, S., Chaudhary, A. (2021), I K International Publishing house Pvt. Ltd, New Delhi
	Other References	1. Quantitative Organic Analysis, Part 3, Vogel, A.I. (2012), Pearson Education. 2. Practical Organic Chemistry, Mann, F.G., Saunders, B.C. (2009), Pearson Education.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	3	2	2	2	2	1	-	1	-	-	-	2
CO2	3	3	3	2	2	2	1	1	2	-	-	-	2
CO3	3	3	2	3	3	2	2	-	1	-	-	-	3
CO4	3	2	1	2	2	2	-	-	-	-	-	-	2
CO5	3	3	3	3	3	3	2	2	2	2	3	2	3
CO6	3	3	2	2	2	2	1	-	1	-	-	-	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2028		**Semester-VIII**
1	**Course Code**	**CHP4107**
2	**Course Name**	**Advanced Physical Chemistry Lab II**
3	**Credits**	**1**
4	**Contact Hours (L-T-P)**	**0-0-2**
	Course Type	**Core**
5	Course Objective	Instruments such as spectrophotometers, conductometers, polarimeters, and potentiometers are extensively utilized in research laboratories and industrial applications. Therefore, understanding fundamental instruments, experiments, and advanced techniques is essential for Master's students. The course offers students comprehensive training in the operation of various instruments, enabling them to construct adsorption curves and thermometric titration curves and compute atomic parameters.
6	Course Outcomes	CO1:Apply conductometric and potentiometric titrations for quantitative analysis. CO2:Apply adsorption and thermometric methods to study adsorption and neutralization processes. CO3: Determine solubility product and critical micelle concentration of chemical systems. CO4:Analyze reaction kinetics using polarimetry and spectrophotometry. CO5:Apply computational techniques for molecular parameter calculations. CO6: Interpret titration data using salt-line and double alkali methods.
7	Course Description	This lab provides hands-on training in essential analytical instruments, including spectrophotometers, conductometers, polarimeters, and potentiometers, which are widely used in research and industrial applications. This course equips students with the skills to operate these instruments effectively, enabling them to perform advanced experiments such as constructing adsorption curves and thermometric titration curves and computing atomic parameters. Emphasizing both theoretical and practical aspects, the lab enhances students' understanding of instrumental techniques, preparing them for careers in scientific research, quality control, and industrial chemistry**.**

8	Outline syllabus		CO Mapping
	Unit 1	**Practical-based Conductometer and Potentiometer**	
	A	To estimate the normality of oxalic acid in given solutions, conductometrically (a) Solution of pure oxalic acid The solution has acetic acid and oxalic acid	CO1, CO6
	B	To estimate the normality of oxalic acid in given solutions, conductometrically Solution having HCl and oxalic acid The solution has acetic acid and oxalic acid	CO1, CO6
	C	To find out the composition of Zinc ferrocyanide precipitate on adding $ZnSO_4$ potentiometrically.	CO1, CO4, CO6
	Unit 2	**Practical based on Adsorption and Thermometric Titration**	
	A	To verify the Freundlich and Langmuir adsorption isotherms by studying the adsorption of oxalic acid on activated charcoal.	CO2, CO3
	B	To verify the Freundlich and Langmuir adsorption isotherms by studying the adsorption of acetic acid on activated charcoal.	
	C	To determine the concentration of a strong acid by thermometric titration and use it to calculate the enthalpy of neutralization.	CO2, CO4
	Unit 3	**Practical based on Solubility product and CMC**	
	A & B	Find the solubility and solubility product of the sparingly soluble salt in water.	CO3, CO6
	C	Find the CMC of a given surfactant and, hence, calculate ΔtGmix of the surfactant.	CO3, CO5
	Unit 4	**Practical based on Polarimeter and Spectrophotometer**	
	A	Find out the rate constant of acid-catalysed hydrolysis of sucrose by polarimeter. Study the rate equation for mutarotation of D-glucose in water using polarimeter.	CO4, CO6
	B & C	To deterrmine the concentration of $KMnO_4$ solution after adsorption using UV/Visible spectrophotometer.	CO4,CO2
	Unit 5	**Computational Modeling, Salt line and Double Alkali Method**	

	A	To calculate the atomic parameters using density function calculations and molecular simulations.		CO5, CO4
	B & C	Titrate using conductometer a moderately strong acid (salicylic/mandelic acid) by the (a) salt-line method (b) double alkali method.		CO1, CO6
	Mode of examination	Practical and/or Viva		
	Weightage Distribution Text book/s	CA	CE	ESE
		30%	30%	40%
	Other References	Practical Physical Chemistry by B. D. Khosla, R. Chand and Co., New Delhi		

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	3	3	2	2	2	1	1	2	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	2	3	3	2	2	-	1	-	-	-	3
CO4	3	3	3	3	3	3	2	2	2	2	3	2	3
CO5	3	2	1	2	2	2	-	-	-	-	-	-	2
CO6	3	3	2	2	2	2	1	-	1	-	-	-	2

School		Sharda School of Engineering and Sciences (SSES)
Department		Chemistry & Biochemistry
Programme Code		SBR0102
Programme Name		Bachelor of Science (Chemistry)
Specialisation/ Minor		
Batch: 2026-2028		**Semester-VIII**
1	**Course Code**	CHR4101
2	**Course Title**	Project
3	**Credits**	4
4	**Contact Hours (L-T-P)**	0-0-12
5	**Course Type**	**Dissertation**
6	**Course Objective**	This course will help to ensure that students can: Demonstrate advanced knowledge of the role of scientific research. Analyze contributions to the disciplines related to the different fields of science and technology. Able to take out optimal research methods based on the content Understands methodology by the character of cognitive activity Aim of the scientific task
7	**Course Outcomes**	CO1: Interpret the main rules of handling scientific and technical literature. CO2: Relate different types of scientific research and hypotheses. CO3: Understand the advanced level of classification of methods by the level of investigation. CO4: Inspect the line of approach to overcome the research gap CO5: Assess their skills in establishing relations between complex topics. CO6:Evaluate important characteristics within technological research and development.
8	**Course Description**	This course will deepen the student's understanding of research in general, and basic science and technological research in particular. The students are expected to apply knowledge of methodology, concepts, philosophical problems, and creative mapping in this course to their own fields of exploration to get optimal results.

PO → / CO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1	3	3	3	2	2	2	1	1	2	-	-	-	2
CO2	3	3	2	2	2	2	1	-	1	-	-	-	2
CO3	3	3	2	3	3	2	2	-	1	-	-	-	3
CO4	3	3	3	3	3	3	2	2	2	2	3	2	3
CO5	3	2	1	2	2	2	-	-	-	-	-	-	2
CO6	3	3	2	2	2	2	1	-	1	-	-	-	2