Sharda School of Engineering and Science

Department of Chemistry & Biochemistry

Programme Structure

DEGREE
in
B.Sc. (Hons./Hons. with Research) in Chemistry
Programme Code: SBR0102

Batch: 2025-2029

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

- Transformative educational experience
- Enrichment by educational initiatives that encourage global outlook
- Develop research, support disruptive innovations and accelerate entrepreneurship
- Seeking beyond boundaries

Core Values

- Integrity
- Leadership
- Diversity
- Community

Vision of 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

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

Vision of Department of Chemistry & Biochemistry

Strive to achieve excellence in teaching and research in the field of Chemistry and Biochemistry and to build human resource for solving contemporary problems

Mission of Department of Chemistry & Biochemistry

- Providing distinctive and relevant education in Chemistry and Biochemistry to students.
- 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.
- Nurturing innovation by carrying out world class research and scholarly work
- Promoting interdisciplinary research in collaboration with national/international laboratories/Institutions.

-

Programme Educational Objectives (PEO)

PEO-1: To produce graduates having a strong background of basic science, interdisciplinary Sciences and ability to use the knowledge and tools.

PEO-2: To produce graduates who can demonstrate technical competence in the field of chemical sciences and develop solutions of the complex problems.

PEO-3: To produce graduates having professional competence and skills in the field of science to serve the society globally.

PEO- 4: 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.

Map PEOs with Mission Statements:

PEO Statements	University Mission 1	University Mission 2	University Mission 3	University Mission 4
PEO1	3	1	2	3
PEO2	3	2	1	3
PEO3	2	1	2	2
PEO4	1	3	2	1
PEO5	2	1	2	1

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

Programme Outcomes (PO's)

Science Graduates will have:

1. **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.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex problems reaching substantiated conclusions using principles of physical sciences, and chemical sciences.
3. **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.
4. **Conduct investigations**: Conduct laboratory experiments safely, use research-based knowledge, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **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.
6. **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
7. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the scientific practices.
8. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams.
9. **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.
10. **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.
11. **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.

Programmer Specific Outcomes (PSO)

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.

Mapping of Program Outcome Vs Program 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)

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).

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 1

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
	Paper ID	**Code**	**Course Name**	L	T	P			
1	32123	CHT1101	Fundamentals of Chemistry	3	1	0	4	Core	CC
2	32124	CHT1102	Basics of Analytical Chemistry	3	0	0	3	Core	CC
3	32212/ 31699	CHT1202/ CMS102	Plant Biochemistry/ Descriptive Statistics/Minor/MOOC	3	0	0	3	Elective	Minor/DSE
4	32213	CHT1203	Human Health & Nutritional Disorders	2	0	0	2		INS
5	16254	ARP101	Communicative English-1	1	0	2	2	Pre-Requisite	AEC
6		EVT1129	Environment Education	2	0	0	2	Pre-Requisite	VAC
Practical/Viva-Voice/Jury									
7	32125	CHP1101	Basic Analytical Chemistry Lab	0	0	2	1	Co Requisite	CC
8		VOB105	Modern trends in chemical analysis: Step forward from laboratory to industry	0	0	6	3	Co Requisite	SEC
			TOTAL CREDITS				20		

[#]MOOC course may be opted from SWAYAM/NPTEL on prior approval from MOOC coordinator.

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 2

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre- Requisite /Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	32126	CHT1103	Inorganic Chemistry-1	4	0	0	4	Core	CC
2	32127	CHT1104	Physical Chemistry-I	3	0	0	3	Core	CC
3		CHT1105	Quantum Mechanics and molecular spectroscopy/ Minor/MOOC	3	0	0	3	Minor	Minor/ DSE
4		ARP102	Communicative English-II	1	0	2	2	Pre- Requisite	AEC
5	32128	CHT1106	Indian Metallurgy (IKS)	2	0	0	2	Co-Requisite	VAC
6			Mulya Prawah	2	0	0	2	Co-Requisite	VAC
Practical/Viva-Voice/Jury									
7	32129	CHP1102	Physical Chemistry Lab-I	0	0	2	1	Core	CC
8		AI3601	Introduction to AI	2	0	2	3	Co Requisite	SEC
						TOTAL CREDITS	20		

[#]MOOC course may be opted from SWAYAM/NPTEL on prior approval from MOOC coordinator.
Skill based course of 4 credits is mandatory for students who exist the Programme after completing one year.

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 3

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite / Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE
				L	T	P			
Theory Subject									
1.	32130	CHT2101	Inorganic Chemistry-II	4	0	0	4	1.	32130
2.	32131	CHT2102	Organic Chemistry-I	4	0	0	4	2.	32131
3.	32223/ 31702	CHT1206/ BDA217	Introduction to Developmental biology/ Data preparation and data cleaning/MOOC/Minor	3	0	0	3	3.	32223/ 31702
4.	32132	CHT2103	Introduction to Engineering Materials	2	0	0	2	4.	32132
5.			Indian Language	2	0	0	2	5.	
6.			AI Principles	0	1	2	3	6.	
Practical/Viva-Voice/Jury									
7.	32133	CHP2101	Inorganic Chemistry Lab-I	0	0	2	1	7.	32133
8.	32134	CHP2102	Organic Chemistry Lab-I	0	0	2	1	8.	32134
9.	32135	CHR2101	RBL-1	0	0	4	0	9.	32135
TOTAL CREDITS							20		

[#]MOOC course may be opted from SWAYAM/NPTEL on prior approval from MOOC coordinator.

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 4

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite / Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE
				L	T	P			
Theory Subject									
1.	32136	CHT2104	Organic Chemistry-II	4	0	0	4	Core	CC
2.	32137	CHT2105	Physical Chemistry-II	4	0	0	4	Core	CC
3.	32138	CHT2106	Basics of Pharmaceuticals	4	0	0	4	Core	CC
4.	32229	CHT2208	Enzyme and Catalysis/Minor/ MOOC #	3	0	0	3	Co Requisite	Minor/DSE
5.	32139	CCP4001	Community Connect	0	0	4	2	Co Requisite	AEC
Practical/Viva-Voice/Jury									
6.	32140	CHP2103	Pharmaceutical Chemistry lab	0	0	4	2		CC
7.	32141	CHR2102	Research Based Learning-2	0	0	4	1	Co Requisite	Research Project
8.		NV3009	AI application on Basic Sciences	0	0	4	0	Co Requisite	VAC
			TOTAL CREDITS				**20**		

#MOOC course may be opted from SWAYAM/NPTEL on prior approval from MOOC coordinator.
Skill based course of 4 credits is mandatory for students who exist the Programme after completing one year

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 5

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite /Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5. VAC
				L	T	P			
Theory Subject									
1	32142	CHT3101	Organic Chemistry III	4	0	0	4	Core	CC
2	32143	CHT3102	Inorganic Chemistry III	4	0	0	4	Core	CC
3	32144	CHT3103	Basics of Spectral Techniques	3	1	0	4	Core	CC
4	32145	CHT3104	Physical Chemistry-III	4	0	0	4	Core	CC
Practical/Viva-Voice/Jury									
5	32146	CHP3101	Organic Chemistry Lab-II	0	0	4	2	Co Requisite	CC
6	32147	CHP3102	Inorganic Chemistry Lab-II	0	0	4	2	Co Requisite	CC
7	32148	CHR3101	Research Based Learning-3	0	0	2	0	Co Requisite	Research Project
TOTAL CREDITS							20		

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 6
Without Apprenticeship

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE
				L	T	P			
Theory Subject									
1	32149	CHT3105	Chemistry in Action/Minor	4	0	0	4		Minor/ DSE
2	32150	CHT3106	Chemical Energetics and Radiochemistry/Minor	4	0	0	4		Minor/ DSE
3		CHT3209	Biological Chemistry/Minor	4	0	0	4		Minor/ DSE
4	32151	CHT3107	Nanomaterials: Synthesis and Applications /MOOC*	3	0	0	3	Co Requisite	Interdisciplinary
5		ARP306	Campus to Corporate/ Foreign Language	0	1	2	2	Co Requisite	AEC
6		AI3602	AI Driven Solution in Basic Sciences	0	0	4	0	Co Requisite	VAC
7		INC001	Industry Connect	0	0	4	2		INC
Practical/Viva-Voice/Jury									
8	32152	CHR3102	Research Based Learning-4	0	0	2	1	Co Requisite	Research Project
						TOTAL CREDITS	20		

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 6
With Apprenticeship

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE
				L	T	P			
Theory Subject									
1	32153	CHA3101	Apprenticeship	0	0	40	20		
Practical/Viva-Voice/Jury									
						TOTAL CREDITS	20		

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor Degree)
Batch: 2025-29
Term: 7
4- Year UG Degree (Honours)
Inclusive of optional Apprenticeship

S. No.		Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4 4. DSE
				L	T	P			
Theory Subjects									
1.	32159	CHT4101	Advanced Inorganic Chemistry-I	4	0	0	4	CC	Core
2.	32160	CHT4102	Advanced Organic Chemistry-I	4	0	0	4	CC	Core
3.	32161	CHT4103	Advanced Physical Chemistry-I	4	0	0	4	CC	Core
4.	32162	CHT4104	Advanced Analytical Chemistry-I	3	1	0	4	CC	Core
5.		CHT4301*	Advanced Quantum Mechanics*	4	0	0	4		Minor
Practical									
6.	32163	CHP4101	Advanced Inorganic Chemistry Lab-I	0	0	2	1	CC	Core
7.	32164	CHP4102	Advanced organic Chemistry Lab-I	0	0	2	1	CC	Core
8.	32165	CHP4103	Advanced Physical Chemistry Lab-I	-	-	2	1	CC	Core
9.	32166	CHP4104	Basic Chemistry Software's	-	-	2	1	CC	Core
		TOTAL CREDITS					**20**		

***ONLY for students going for Apprenticeship & requires Minor with Major Degree**

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 8
4- Year UG Degree (Honours)
Without Apprenticeship

S. No.		Course Code	Course	Teaching Load			Credits	Core/Elective Pre-Requisite/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4 4. DSE
				L	T	P			
	THEORY SUBJECTS								
1	32169	CHT4105	Advanced Inorganic Chemistry-II	3	0	0	3	CC	Core
2	32170	CHT4106	Advanced Organic Chemistry-II	3	0	0	3	CC	Core
3	32171	CHT4107	Advanced Physical Chemistry-II	3	0	0	3	CC	Core
4		CHT4109	Science and Technology of Nanomaterials	3	1	0	4		Minor/DSE
	PRACTICAL SUBJECTS								
5	32173	CHP4105	Advanced Inorganic Chemistry Lab-II	0	0	2	1	CC	Core
6	32174	CHP4106	Advanced Organic Chemistry Lab-II	0	0	2	1	CC	Core
7	32175	CHP4107	Advanced Physical Chemistry Lab-II	0	0	2	1	CC	Core
8	32176	CHR4101	Project	0	0	8	4	Project	Dissertation
	TOTAL CREDITS						20		

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 8
With Apprenticeship

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE
				L	T	P			
Theory Subject									
1		CHA4101	Apprenticeship	0	0	40	20		
Practical/Viva-Voice/Jury									
						TOTAL CREDITS	20		

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 7
(Honours with Research)
Inclusive of optional Apprenticeship

S. No.		Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requisite/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE
				L	T	P			
THEORY SUBJECTS									
1.	32159	CHT4101	Advanced Inorganic Chemistry-I	4	0	0	4	CC	Core
2.	32160	CHT4102	Advanced Organic Chemistry-I	4	0	0	4	CC	Core
3.	32161	CHT4103	Advanced Physical Chemistry-I	4	0	0	4	CC	Core
4.	32162	CHT4104	Advanced Analytical Chemistry-I	3	1	0	4	CC	Core
5.		CHT4301	Advanced Quantum Mechanics/Minor	4	0	0	4	CC	Minor/DSE
6.			Project (Minor Project)*	**0**	**0**	**6**	**3**	Project	Research Project
		TOTAL CREDITS					**20**		

Project (Minor Project)*: Research Project -(12): 03 Credits evaluation will be done in VII Semester

Programme Structure
Sharda School of Engineering and Science
B.Sc. (Hons./Hons. with Research) in Chemistry (with/without Minor)
Batch: 2025-29
Term: 8
(Honours with Research)

S. No.		Course Code	Course	Teaching Load			Credits	Core/Elective Pre-Requisite/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC =4. DSE
				L	T	P			
THEORY SUBJECTS									
1.	32169/ 32170	CHT4105/ CHT4106	Advanced Inorganic Chemistry-II/ Advanced Organic Chemistry-II	3	0	0	3	CC	Core
2.	32171	CHT4107	Advanced Physical Chemistry-II/Minor	3	0	0	3		DSE/minor
PRACTICAL SUBJECTS									
3.	32173/ 32174	CHP4105/ CHP4106	Advanced Inorganic Chemistry Lab-II/ Advanced Organic Chemistry Lab-II	0	0	2	1	CC	Core
4.	32175	CHP4107	Advanced Physical Chemistry Lab-II	0`	0	2	1	CC	Core
5.			Project (Major)*	0	0	18	9	Project	Dissertation
	TOTAL CREDITS						20		

Project (Major Project)∗: Research Project -(12): 09 Credits evaluation will be done in VIII Semester. 03 Credits evaluation was counted in VII Semester

Couse Module

Semester-1

Course Title: Fundamentals of Chemistry

School: SSES		**Batch:**2025-29		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic Year:2025-26**		
Branch: Chemistry				
1	**Course Code**	CHT1101		
2	**Course Title**	**Fundamentals of Chemistry**		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	3-1-0		
5	**Course Type**	Compulsory	Major	Theory
6	**Course Objective**	Students will gain an understanding of Periodic properties of elements. Current bonding models for simple inorganic and organic molecules in order to predict structures and important bonding parameters. Molecular polarity and weak chemical forces. The basics of organic chemistry give the most primary and utmost important knowledge and concepts of organic Chemistry, theoretical picture in multiple stages in an overall chemical reaction. Reactive intermediates, transition states and states of all the bonds broken and formed, reaction mechanism. Stereochemistry of simple organic molecules.		
7	**Course Outcomes (CO)**	After completing this course student will be able to: CO1: discuss the contribution of Indian chemists and periodic properties of elements CO2: describe simple bonding theories of molecules. explain molecular polarity and weak chemical forces CO4: interpret mechanism of organic reactions. CO5: illustrate stereochemistry of simple organic molecules. CO6: apply the knowledge to solve simple scientific problems.		
8	**Course Description**	This course includes introduction to Indian ancient Chemistry and the contribution of Indian Chemists, describes molecular polarity, weak chemical forces, chemical bonding, periodic properties of elements, organic reaction intermediate, reaction mechanism, stereochemistry.		

9	**Outline Syllabus**		CO Mapping
	Unit 1	**Ancient Indian Chemistry & Periodic Properties of Elements**	
	A	Introduction to Indian Ancient Chemistry and contribution of Indian Chemists. Brief discussion, factors affecting and variation trends of following properties in groups and periods.	CO1
	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.	CO1, CO6
	C	Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach)	CO1, CO6
	Unit 2	**Simple Bonding theories of Molecules**	
	A	Valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry.	CO2, CO6
	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, CO6
	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, 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.	CO3, CO6
	B	Polarizing power and polarizability. Fajan's rules and consequences of polarization. Hydrogen bonding.	CO3, CO6
	C	Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process. Lattice energy and Born-Haber cycle, solvation energy, and solubility of ionic	CO3, CO6

		solids.	
	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.	CO4
	B	Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).	CO4, CO6
	C	General mechanism of different organic reactions, Energy considerations.	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 projection and Sawhorse formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.	CO5, CO6
	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.	CO5, CO6
	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: 25% / MSE: 25% / ESE: 75%	
	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. 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.

CO-PO & CO-PSO mapping

Pos / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT1101.1	2	1	-	-	1	-	1	2	1	-	1	-	-
CHT1101.2	2	1	-	-	1	-	1	2	1	-	1	-	-
CHT1101.3	2	1	-	-	1	-	1	2	1	-	1	-	-
CHT1101.4	2	1	-	-	1	-	1	2	1	-	1	-	-
CHT1101.5	2	1	-	-	1	-	1	2	1	-	1	-	-
CHT1101.6	1	1	-	-	1	-	1	2	1	-	1	-	-

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

Course Title: Basic Analytical Chemistry

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2025-26**		
Branch: Chemistry		**Semester: 1**		
1	**Course Code**	**CHT1102**		
2	**Course Title**	**Basic of Analytical Chemistry**		
3	**Credits**	3		
4	**Contact Hours (L-T-P)**	3-0-0		
5	**Course Type**		Minor	Theory
6	**Course Objective**	1. Provide and enrich the students to analytical techniques, various types of errors knowingly/ unknowingly introduced, accuracy and confidence limit in analytical process. 2. Equip the students with the knowledge of making different kinds of standard solutions and how to standardize the secondary standards and determining the strength of unknown solution volumetrically. 3. Inculcate the theoretical and experimental knowledge of volumetric and gravimetric quantitative analysis in presence of interfering agents. 4. Provide theoretical and experimental knowledge qualitative analysis of various cations and anions in a pure sample mixture of 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 correlation between theoretical aspect of qualitative and quantitative analysis of cations, anions and molecular systems		
7	**Course Outcomes**	CO1: Prepare different types of standard solutions for quantitative estimation of unknown analyte CO2: Correlate and apply theoretical knowledge to estimate the unknown analyte volumetrically CO3: Correlate and apply theoretical knowledge to estimate the unknown analyte gravimetrically CO4: Understand the various principles of chemistry and apply them for qualitative analysis of various cations and anions in pure and impure samples of analysis CO5: Model the analytical procedure to analyse the industrial samples applying the theoretical concepts of volumetry and gravimetry. CO6: Correlate theoretical aspect of qualitative and quantitative analysis of cations, anions and molecular systems		

8	**Course Description**	Analytical chemistry I comprises of 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	
9	**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, CO6
	B	Types of Errors- Systematic, random and Gross; definition of terms: mean and median, precision and accuracy	CO1, CO6
	C	Absolute and relative error, Random errors. Sources of error in experimental data, standard deviation, relative standard deviation, statistical analysis of data	CO1, 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, 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, CO6
	C	Precipitation titrations; Redox titrations, calculation of equivalent weight. Theoretical aspects of titration curves and end point evaluation; Choice of indicators in each case.	CO2, CO6
	Unit 3	**Gravimetric Analysis**	
	A	Basic principle, Precipitation reactions; precipitation methods; conditions of precipitation; nucleation; particle size	CO3, CO6
	B	Crystal growth; Colloidal state; aging; impurities in the analytical precipitate; co-precipitation	CO3, CO6
	C	Precipitation from homogenous solution; washing of precipitate; drying and ignition of precipitate; Applications	CO3, CO6
	Unit 4	**Qualitative analysis-I**	
	A	Qualitative analysis and its type; systematic analysis of anions in terms of dilute and concentrate sulphuric acid group (CO_3^{2-}, NO_2^- , S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$)	CO4, CO6
	B	systematic analysis of anions in terms of dilute and concentrate sulphuric acid group (CH_3COO^-, F^- ,Cl^- , Br^- , I^- , $C_2O_4^{2-}$, NO_3^-)	CO4, 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, CO6
	Unit 5	**Qualitative analysis-II**	
	A	Basic principles involved in analysis of cations and anions and solubility products, common ion effect.	CO5, CO6
	B	Principle involved in division of cations into groups and group reagent. 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 zero group).	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25%	MSE: 25%	ESE: 50%
	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. 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. Harris, D. C. (2020). *Quantitative chemical analysis* (10th ed.). W.H. Freeman.	

CO-PO & CO-PSO mapping

CO vs PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT1102.01	3	2	3	3	3	2	2	1	1	2	3	3	3
CHT1102.02	3	3	3	3	3	2	2	1	1	2	3	3	3
CHT1102.03	3	3	3	3	3	2	2	1	1	2	3	2	3

CHT1102.04	3	3	2	3	3	2	2	2	2	2	3	3	2
CHT1102.05	3	3	3	3	3	3	2	2	2	3	3	2	3
CHT1102.06	3	3	3	3	3	3	2	2	2	3	3	3	3

Course Title: Human Health & Nutritional Disorders

School: SSES		**Batch**: 2025-29		
Programme: Bachelor of Science (Hons/Hons with Research) in Chemistry		**Academic Year**: 2025-26		
Branch: Chemistry		**Semester**: I		
1	**Course Code**	CHT1203		
2	**Course Title**	Human Health & Nutritional Disorders		
3	**Credits**	2		
4	**Contact Hours(L-T-P)**	2-0-0		
5	**Course Type**	Compulsory	Inter/Multi-disciplinary Course	Theory
6	**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		
7	**Course Outcomes**	CO1: Define the basic terminology related to vital parameters and understand the concept of human nutrition. CO2: Apply the understanding of therapeutic nutrition and anti-nutritional factors in day-to-day life. CO3: Analyze the role of electrolytes and blood gases in maintaining balance and normal functioning of the body. CO4: Classify the enzymes of detoxification and their role in scavenging free radicals from the body. CO5: Outline various metabolic disorders and understand the measures to overcome them. CO6: Understand the role of food and nutrients in health and disease, evaluate nutrition information, assess nutritional status, and apply knowledge to various healthcare settings.		
8	**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.		
9	**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 susceptible population		CO1,CO6
	Unit 2	**Nutrition and Health**		

	A	Therapeutic nutrition, phytochemicals and health benefits, spices and health benefits	CO2,CO 6
	B	Malnutrition and obesity, food for diabetic and high BP patient	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	MSE	ESE
		25%	25%	50%

	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

Mapping: CO Vs POs and PSOs

POs &PSOs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO11	PSO1	PSO2
CHT1203.1	2	1	2	1	1	1	1	1	1	2	1	2	1
CHT1203.2	2	1	2	-	2	2	1	1	1	2	1	2	1

CHT1203.3	3	-	3	1	1	-	1	-	-	2	-	3	2
CHT1203.4	3	2	3	2	2	1	1	1	1	2	2	3	3
CHT1203.6	3	1	2	1	2	2	1	1	1	2	-	3	2
CHT1203.6	2	2	2	1	1	1	1	1	1	1	1	2	2

Course Title: Plant Biochemistry

School: SSES		**Batch**: 2025-29		
Programme: Bachelor of Science (Hons/Hons with Research) in Chemistry		**Academic Year**: 2025-26		
Branch: Chemistry		**Semester**: I		
1	**Course Code**	CHT1202		
2	**Course Title**	Plant Biochemistry		
3	**Credits**	03		
4	**Contact Hours(L-T-P)**	3-0-0		
5	**Course Type**	DSE		Theory
6	**Course Objective**	This course aims to educate student about the mechanism and physiology life processes in plants. To understand the mechanism of various physiological processes related to plant life.		
7	**Course Outcomes**	**CO1**: To understand the various physiological life processes in plants **CO2**: Familiar with light and dark reactions of photosynthesis, comparison C3, C4 and CAM plants, respiration, plant growth regulators, stress physiology **CO3**: To understand the role of various hormones, signalling compounds, thermodynamics, and enzyme kinetics **CO4**: Understand the significance of the nitrogen cycle in fixing atmospheric nitrogen and the role of microorganisms in nitrogen fixation and its regulation, N_2 metabolism. **CO5**: Understand secondary plant metabolism, biosynthesis, and function of major secondary plant product classes like terpenoids, alkaloids and flavonoids etc. **CO6**: To Understand the mechanism of various plant physiology and their role in regulating plant growth and development.		
8	**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 about the social and environmental issues, significance of plants and their relevance to the national economy.		
9	**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; antitranspirants; 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, CO 6
	B	Photosystem structure and function, Electron transport pathways in chloroplast membranes	CO2, CO 6
	C	ATP synthesis in chloroplasts, Organization and regulation of photosynthetic Complexes, Carbon reactions: the Calvin‑Benson cycle	CO2, CO 6
	Unit 3	**Plant growth regulators**	
	A	Introduction to phytohormones, Auxins, Gibberellins, Abscisic acid, Cytokinins, Ethylene, Jasmonic acid	CO3, CO 6
	B	Structure Auxins, Gibberellins, Abscisic acid, Cytokinins, Ethylene, Jasmonic acid	CO3, CO 6
	C	Function and biosynthesis of Auxins, Gibberellins, Abscisic acid, Cytokinins, Ethylene, Jasmonic acid	CO3, CO 6
	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, CO 6
	B	Symbiotic nitrogen fixation, Ammonia uptake and transport, Nitrate uptake and transport	CO4, CO 6
	C	Nitrite reduction, Nitrate signaling, Interaction between nitrate assimilation and carbon metabolism	CO4, CO 6
	Unit 5	**Secondary metabolites**	
	A	Terpenoids, Biosynthesis of the basic five‑carbon unit, Repetitive additions of C5 units	CO5, CO 6
	B	Alkaloids, Alkaloid biosynthesis, Biotechnological application of alkaloid biosynthesis research	CO5, CO 6
	C	Phenolic compounds, Phenolic biosynthesis, The phenylpropanoid‑acetate pathway, The phenylpropanoid pathway, Universal features of phenolic biosynthesis	CO 5, CO 6
	Mode of examination	Theory	

	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%

	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.

CO-PO & CO-PSO Mapping

POs &PSOs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT1202.1	1	3	2	3	1	3	2	2	2	2	2	1	1
CHT1202.2	2	3	2	3	2	3	1	1	1	1	3	2	1
CHT1202.3	2	3	2	3	2	2	2	1	2	2	1	2	1
CHT1202.4	2	2	2	3	2	3	1	1	1	1	2	1	2
CHT1202.5	2	2	2	3	2	2	2	1	1	1	1	1	2
CHT1202.6	2	2	2	2	2	2	2	1	1	1	1	1	2

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

Course Title: Basic Analytical Chemistry Lab

School: SSES		**Batch 2025-26**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2025-26**		
Branch: Chemistry		**Semester 1**		
1	**Course Code**	**CHP1101**		
2	**Course Title**	**Basic Analytical Chemistry Lab**		
3	**Credits**	01		
4	**Contact Hours (L-T-P)**	0-0-2		
5	**Course Type**	Compulsory		Practical
6	**Course Objective**	1. To develop an understanding of cation and anion analysis. 2. To develop skills to gravimetric analysis. 3. To create the skills for estimation of metal ions. 4. To strengthen the basic principles of titration through estimation of acids 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 chemical industry.		
7	**Course Outcomes (CO)**	After the completion of this course, the students will be able to CO1: demonstrate the methods of cation and anion analysis. CO2: develop the methods for gravimetric analysis CO3: describe and conduct the estimation of metal ions CO4: conduct the estimation of acids and alkali contents CO5: demonstrate the method of chloride content measurement in water. CO6: understand the need of good lab practices and finally apply the laboratory skills in research and chemical industry		
8	**Course Description**	This course includes laboratory methods and tests related to acid and basic radical analysis, functional group test, estimation of metals ions, estimation of acids and alkali contents in commercial products and water analysis.		
9	**Outline Syllabus**			CO Mapping
	Unit 1	**Qualitative Analysis**		
	A	Analysis of Acid radicals		CO1, CO6
	B	Analysis of Basic Radicals (Zero group and Ist group)		CO1, CO6
	C	Viva		CO1, CO6

	Unit 2	**Gravimetric Analysis**	
	A, B	Estimation of Barium as barium sulphate in barium chloride solution.	CO2, CO6
	C	Viva	CO2, CO6
	Unit 3	**Estimation of Metals Ions**	
	A	Estimation of iron content in a given sample using external and internal indicator method.	CO3, CO6
	B	Estimation of iron content in a given sample using internal indicator method.	CO3, CO6
	C	Estimation of copper using thiosulphate.	CO3, 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, B	Determination of chloride ion content in a given water sample by Mohr's method.	CO5, CO6
	C	Viva	CO5, CO6
	Mode of examination	Theory/Jury/Practical/Viva	
	Weightage Distribution	CA	ESE
		60%	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.	

CO-PO & CO-PSO mapping

Pos / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP1101.1	3	2	2	2	1	1	2	2	1	1	1	1	1
CHP1101.2	2	2	2	2	1	1	2	2	1	1	1	1	1
CHP1101.3	3	2	2	3	1	1	2	2	1	1	1	1	1
CHP1101.4	3	2	2	3	1	1	2	2	1	1	1	1	1
CHP1101.5	3	2	2	3	1	1	2	2	1	1	1	2	1

CHP1101.6	2	2	1	2	1	1	2	2	1	1	1	1	1

Course title: Modern Trends in Chemical Analysis: Step Forward from Laboratory to Industry

School: SSES		**Batch: 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic Year: 2025-26**		
Branch: Chemistry		**Semester: I**		
1	**Course Code**	**VOB105**		
2	**Course Title**	Modern Trends in Chemical Analysis: Step Forward from Laboratory to Industry		
3	**Credits**	3		
4	**Contact Hours (L-T-P)**	0-0-6		
5	**Course Type**	Vocational	SEC	Practical
6	**Course Objective**	Chemical Safety and Ethical Handling of Chemicals Standard Procedure for Cleaning Glassware in Analytical Laboratories Calibration of Laboratory Apparatus (Pipettes, Burettes, Thermometers, etc.) Preparation of Buffer Solutions (Acidic, Basic, and Phosphate Buffers) Water Quality Analysis (e.g., Hardness by EDTA, Turbidity Measurement) Recrystallization, Filtration, and Drying Techniques		
7	**Course Outcomes**	Upon successful completion of course, students will be able CO1: To understand the use of protective apparel and first aid and the safe disposal of chemicals in laboratory. CO2: To calibrate and operate laboratory apparatus with accuracy and precision CO3: To prepare chemical buffers. CO4: To perform basic water quality analysis CO5: Able to recrystallize compounds.		

		CO6: Able to handle the laboratory processes, equipment, and chemical handling procedures.	
8	**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.	
9	**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, laboratory ventilation.	CO1, CO6
	B	Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, Material safety data sheet.	CO1, CO6
	C	Safe storage and disposal of waste chemicals; Recovery, recycling and reuse of laboratory chemicals and Viva	
	Unit 2	**Calibration and Setups of laboratory apparatus**	
	A	Calibration of various laboratory apparatus (Pipette, Burette)	CO2, CO6
	B	Calibration of a Thermometer Using Standard Temperature Points	CO2, CO6
	C	Typical assemblies of apparatus setups for distillation and reflux, along with their laboratory use, including simple, fractional, steam, and vacuum distillation.	
	Unit 3	**Preparation of Buffer**	
	A	To prepare an acidic buffer with CH_3COOH and CH_3COONa and observe the change in pH on addition of acid and base.	CO3, CO6
	B	To prepare a basic buffer with NH_4OH and NH_4Cl and observe the change in pH on addition of acid and base.	
	C	To prepare phosphate buffer with NaH_2PO_4 and Na_2HPO_4 and observe the change in pH on addition of acid and base.	
	Unit 4	**Water Quality analysis**	

	A	Estimation of hardness of water by EDTA titration method.	CO4, CO6
	B	Determination of turbidity in water using a turbidity meter.	CO4, CO6
	C	Analysis of pH and Conductivity in water samples.	
	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.	
	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	Theory/Jury/Practical/Viva	
	Weightage Distribution	CA: 60%	ESE: 40%
	Text Book/s *	Mendham, J. (2009). *Vogel's quantitative chemical analysis* (6th ed.). Pearson. 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	

CO-PO & CO-PSO mapping

CO vs PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
VOB105.01	3	2	2	3	2	3	3	2	2	2	3	2	3
VOB105.02	3	3	3	3	3	2	2	2	2	2	3	3	3

VOB105.03	3	2	3	3	2	2	2	1	1	2	3	2	2
VOB105.04	3	2	2	3	3	3	2	1	1	2	3	2	3
VOB105.05	3	2	3	3	2	2	2	1	1	2	3	2	3
VOB105.06	3	3	3	3	3	3	3	2	2	2	3	3	3

Semester 2

Course Title: Inorganic Chemistry-I

School: SSES		**Batch: 2025-2029**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2025-26**		
Branch: Chemistry		**Semester: II**		
1	**Course Code**	**CHT1103**		
2	**Course Title**	**Inorganic Chemistry-I**		
3	**Credits**	**4**		
4	**Contact Hours (L-T-P)**	**3-1-0**		
5	**Course Status**	Compulsory	Major	Theory
6	**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 the knowledge about characteristic properties of s block elements 3.To illustrate the knowledge about characteristic properties of p block elements. 4.To describe redox chemistry of inorganic compounds. 5. Make it comprehended various metallurgical processes.		
7	**Course Outcomes**	Students will be able to: CO1: Acquire knowledge of various theories about acids and bases and apply them in real life problems CO2: Gain knowledge about the properties and uses of s-block elements CO3: Gain knowledge about the properties and uses of p-block elements CO4: Understand redox chemistry of inorganic compounds.		

		CO5: Explain the metallurgical process. CO6: Explain different properties of inorganic elements, redox behavior and metallurgical process.	
8	**Course Description**	This course describes the acid-base properties of compounds, chemistry of s block and p block elements. This course also includes redox properties of elements and metallurgical processes.	
11	**Outline syllabus**		**CO Mapping**
	Unit 1	**Acids and Bases**	
	A	Concepts of Acids and Bases : Arrhenius concept ; Bronsted – Lowry concept ; Acidity and Basicity on the basis of stability of conjugate acid base pair	CO1, CO6
	B	Lewis acid – base concept ; Usanovich Concept; Superacids,	CO1, CO6
	C	HSAB principle and its applications, Amphoterism, Lux-Flood concept	CO1, CO6
	Unit 2	**Chemistry of s-block Elements**	
	A	General trends of variation of electronic configuration, metallic nature, oxidation states,	CO2, CO6
	B	Properties and reactions of some selected compounds such hydrides, halides, oxides, oxyacids	CO2, CO6
	C	complex chemistry in respect of s-block elements (Group 1 and group 2)	CO2, 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, CO6
	B	Oxides: Oxides of nitrogen, phosphorus, sulphur. Oxoacids: Oxoacids of nitrogen, phosphorus, peroxoacids of sulphur.	CO3, CO6
	C	Halides: Halides of nitrogen and phosphorus	CO3, CO6
	Unit 4	**Redox chemistry**	
	A	Oxidation-reduction as electron transfer process, oxidizing and reducing agents	CO4, CO6

	B	Ion-electron method of balancing redox reaction			CO4, 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, CO6
	Unit 5	**Metallurgy**			
	A	Chief mode of occurrence of metal based on standard electrode potential. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent.			CO5, CO6
	B	Method of purification of metals; Electrolytic Kroll process, Van Arkel-de Boer process			CO5, CO6
	C	Mond's process; electrolytic reduction			CO5, CO6
	Mode of examination				
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	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.			
	Suggestive Digital Platforms / Web Links	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.			

CO-PO & CO-PSO mapping

PO vs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT1103.01	3	3	2	2	2	3	2	1	2	2	3	3	3

CHT1103.02	3	2	2	2	2	3	2	1	1	2	3	3	3
CHT1103.03	3	2	2	2	2	3	2	1	1	2	3	3	3
CHT1103.04	3	3	2	2	2	3	2	1	2	2	3	3	3
CHT1103.05	3	3	3	3	3	3	2	2	2	3	3	3	3
CHT1103.06	3	3	3	3	3	3	2	2	2	3	3	3	3

Course Title: Physical Chemistry-1

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2025-26**		
Branch: Chemistry		**Semester: II**		
1	**Course Code**	**CHT1104**		
2	**Course Title**	**Physical Chemistry I**		
3	**Credits**	**3**		
4	**Contact Hours (L-T-P)**	**3-0-0**		
5	**Course Type**	**Compulsory**	**Major**	**Theory**
6	**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 the understanding of physical states of matter and how they are related to daily life application		
		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 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.		
7	**Course**	1. To understand the laws of solid-state chemistry and the arrangement of ions/atoms/molecules in a crystal lattice		
		2. To provide the understanding of physical states of matter and how they are related to daily life application		
		3. To define how the initially primitive models of real gases in physical		

	Outcomes	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 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.	
8	**Course Description**	Course emphasizing on the various solid state structures and its correlation to atomic coordinated, distinguishing properties of liquid state, physical properties of molecules in solutions and gaseous state, thermochemistry aspects of chemical process.	
9	**Outline Syllabus**		**CO Mapping**
	Unit 1	Solid State	
	A	Crystalline and amorphous solids, crystal lattices and unit cell,	CO1, CO6
	B	Crystal systems -types, close packing, packing fraction, Crystal density, Ionic Radii, radius ratio.	CO1, CO6
	C	X–Ray diffraction: Bragg's law, Structures of NaCl, KCl and CsCl (qualitative treatment only), Point Defects.	CO1, CO6
	Unit 2	Liquid State	
	A	Qualitative treatment of the structure of the liquid state	CO2, CO6
	B	Physical properties of liquids: vapor pressure, surface tension, coefficient of viscosity and their determination.	CO2, CO6
	C	Effect of addition of various solutes on surface tension and viscosity. Temperature variation of viscosity of liquids and comparison with that of gases.	CO2, CO6
	Unit 3	Solution	
	A	Colligative properties, Roult's law, Deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature composition curves of ideal and non-ideal solution	CO3, CO6
	B	Azeotropes, Partial miscibility of liquids: critical solution temperature,	CO3, CO6
	C	Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, Solvent extraction.	CO3, CO6
	Unit 4	Gaseous State	
	A	Kinetic theory of gases, derivation of Ideal gas equation, Maxwell distribution of molecular velocities and molecular energies,	CO4, CO6
	B	Deviation of gases from ideal behaviour, compressibility factor (Z), van der Waal's equation of state and its application to explain deviation of gases.	CO4, CO6
	C	Critical constant of gas in terms of van der Waal's	CO4, CO6

		constant: derivation of P_c , T_c and V_c.	
	Unit 5	Kinetics and Catalysis	
	A	Molecularity and order, differential and integrated form of rate expressions for zero order, first order reactions	CO5, CO6
	B	differential and integrated form of rate expressions for second order reactions, experimental methods of the determination of rate laws	CO5, CO6
	C	Catalysis, positive and negative catalysis, Characteristics of catalytic reactions, Heterogeneous catalysis and homogeneous catalysis. Activation energy	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25%	MSE: 25%	ESE: 50%
	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	1.Glasston, Physical Chemistry	

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT1104.1	3	3	2	3	1	3	1	3	3	1	3	2	3
CHT1104.2	3	3	2	3	2	3	1	3	1	2	3	3	3
CHT1104.3	3	3	1	3	2	3	2	3	2	1	3	2	3
CHT1104.4	3	3	2	3	2	3	2	3	2	2	3	3	3
CHT1104.5	3	3	2	3	1	3	2	3	2	1	3	3	3
CHT1104.6	3	3	1	3	1	3	1	3	1	2	3	3	3

Course Title: Quantum Mechanics and Molecular Spectroscopy

School: SSES		**Batch 2025-29**
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2025-26**
Branch: Chemistry		**Semester: II**
1	**Course Code**	**CHT1105**
2	**Course Title**	**Quantum Mechanics and Molecular Spectroscopy**
3	**Credits**	3
4	**Contact**	3-0-0

	Hours (L-T-P)			
5	**Course Type**	Minor	Minor	Theory
6	**Course Objective**	Course Objective The objectives of the course are to 1. Master fundamental quantum mechanical principles and problem-solving techniques 2. Develop working knowledge of terminology and tools used by quantum chemists. 3. Learn how quantum mechanics manifests itself in nature and experimental science. 4. Become expert in understanding the theory of molecular spectroscopy. 5. Develop basic skills required for analysis of chemical structures. 6. Develop the analytical skills required to solve real world problems.		
7	**Course Outcomes**	The student will be able to CO1: Understand the concepts of quantum mechanics and its mathematical interpretation. CO2: Learn to solve simple systems of chemical interest using quantum mechanics concepts CO3: Apply the concepts of quantum mechanics and its mathematical interpretation for atoms and molecules comprising a simple system. CO4: Learn the theoretical background behind rotational spectroscopy and its application to solve chemical problems CO5: Learn the theoretical background behind vibrational spectroscopy and its application to solve chemical problems CO6: Apply the concept of quantum mechanics and molecular spectroscopy to solve scientific problems CO6: Apply the concept of quantum mechanics and molecular spectroscopy to solve scientific problems		
8	**Course Description**	This course is framed to give elementary concept of quantum mechanics followed by its applications in simple systems of chemical interest. Also, fundamental concepts in molecular spectroscopy based on Rotational and vibrational spectroscopy are discussed.		
9	**Outline Syllabus**			CO Mapping
	Unit 1	**Quantum mechanics I: Introduction to QM**		
	A	Failure of classical mechanics, Blackbody radiation, Ultraviolet catastrophe, Planck's radiation law, Photoelectric effect, Concept of quantization, atomic spectra,		CO1, CO6
	B	wave particle duality, uncertainty principle, wave-function and its interpretation, well-behaved function and requirements for an acceptable wave function,		CO1, CO6
	C	Schrödinger wave equation, significance of Ψ and Ψ^2		CO1, CO6
	Unit 2	**Quantum mechanics II**		

	A	Operator formalism, Hamiltonian (energy) operator	CO2, CO6
	B	Eigen functions and eigen values, expectation values measurement, postulates of quantum mechanics,	CO2, CO6
	C	Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function	CO2, CO6
	Unit 3	**Quantum mechanics III: Application of QM**	
	A	particle in box (1D box), energy states, sketching of wave-function and probability densities for 1D box,	CO3, CO6
	B	Particle in 3D box,	CO3, CO6
	C	Concept of degeneracy	CO3, CO6
	Unit 4	**Rotational Spectroscopy**	
	A	Introduction to electromagnetic radiation, regions of the spectrum, Interaction of electromagnetic radiation with molecules and various types of spectra	CO4, CO6
	B	Rotational spectroscopy of diatomic molecules: rigid rotor model, selection rules	CO4, CO6
	C	Determination of bond length, effect of isotopic substitution	CO4, CO6
	Unit 5	**Vibrational Spectroscopy**	
	A	Infrared spectrum: Energy levels of simple harmonic oscillator,selection rules	CO5, CO6
	B	pure vibrational spectrum, intensity, Hooke's laws election rule,	CO5, CO6
	C	determination of force constant and qualitative relation of force constant and bond energies	CO5, CO6
	Mode of examination	Theory	

	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%

	Text Book/s *	1. Levine, I. N., Busch, D. H., & Shull, H. (2009). *Quantum chemistry* (Vol. 6). Upper Saddle River, NJ: Pearson Prentice Hall. 2. Pavia, D. L. *et al. Introduction to Spectroscopy*, 5th Ed. Cengage Learning India Ed.
	Other References	1. McQuarrie, D. A. (2008). *Quantum chemistry*. University Science Books. *2.* Eyring, H. (1944). J. Walter and GE Kimball. *Quantum Chemistry*, 346. 3. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press (2015).

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT1105.01	3	3	1	2	1	1	1	2	2	2	1	3	3
CHT1105.02	2	3	1	2	1	2	1	2	2	2	1	2	3
CHT1105.03	2	2	1	2	1	1	1	2	2	2	1	3	3
CHT1105.04	3	3	1	2	1	1	1	2	2	2	2	3	3

CHT1105.05	3	2	1	2	1	1	1	2	2	2	1	3	3
CHT1105.05	3	2	1	2	1	1	1	2	2	1	2	3	3

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

Course Title: Indian Metallurgy

School: SSES		Batch: 2025-2029		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		Academic Year: 2025-2026		
Branch:		Semester: II		
1	**Course Code**	CHT1106		
2	**Course Title**	Indian Metallurgy		
3	**Credits**	2		
4	**Contact Hours (L-T-P)**	2-0-0		
5	**Course Type**	(Indian Knowledge system)	VAC	Theory
6	**Course Objective**	The objectives of course are to: develop an understanding about the metallurgy. explain the Vedic concept of metallurgy. discuss the concept of metals occurrence. provide detailed knowledge of extraction of metals. inculcate the understanding of different methods of purification of metals. provide an in-depth understanding of metallurgical process of different metals.		
7	**Course Outcomes**	Students will be able to: CO1: Summarize the history of metallurgy CO2: Acquainted with the development of metallurgy of different metals in India. CO3: Acquire knowledge about occurrence of metals. CO4: Select the extraction process suitable to particular metal. CO5: Develop knowledge about purification of different elements. CO6: Explain the development of extraction of metals in Indian continent, extraction and purification of metals.		

8	**Course Description**	This course takes in detail the history of metallurgy in different eras and Indian subcontinent. The steps of extraction and purification of metals are explained.	
9	**Outline Syllabus**		CO Mapping
	Unit 1	**Origin of metallurgy**	
	A	History of metallurgy in Indian subcontinent, Metals and ores in Neolithic period.	CO1, CO6
	B	Technique of early copper smelting in Bronze and Iron Age	CO1, CO6
	C	Prevalence of ironsmith and other metal workers in the pre-modern era.	CO1,CO6
	Unit 2	**Development of ancient metallurgy in India**	
	A	Vedic reference of ancient Indian metallurgy	CO2, CO6
	B	Copper, Gold, Bronze and Tin metallurgy in ancient India	CO2, CO6
	C	Development of Iron and steel metallurgy	CO2, CO6
	Unit 3	**Occurrence of metals**	
	A	Abundance of metals, chief modes of occurrence of metals based on standard electrode potentials	CO3, CO6
	B	Types of Metals and classification.	CO3, CO6
	C	Tools & Techniques for Metal Smelting with examples, Metalworks in pre modern India (metalworking practice in in NE India)	CO3, CO6
	Unit 4	**Extraction of metals**	
	A	Indian Metal Works: Modern Mining Techniques, Extraction of Cu, Zn, Au, Fe and Al.	CO4, CO6
	B	Extraction methods: Calcination, Roasting,	CO4, CO6
	C	Froth floatation, Smelting and electromagnetic separation	CO4, CO6
	Unit 5	**Purification of metals**	
	A	Methods of purification of metals: Mond's Process,	CO5, CO6

		Electrolytic refining, Kroll process,		
	B	Van-Arkel de-Boer process,		CO5, CO6
	C	Electrolytic Reduction and hydrometallurgy.		CO5, CO6
	Mode of examination	Theory		
	Weightage Distribution	CA	MSE	ESE
		25 %	25 %	50%
	Text Book/s *	Textbook reference: 1. Seetharaman, S. (Ed.). (2005). *Fundamentals of metallurgy*. Woodhead Publishing. 2. Miessler, G. L., & Tarr, D. A. (2010). *Inorganic chemistry* (4th ed.). Pearson Education. Website Link: https://vedicheritage.gov.in/vedic-heritage-in-present-context/metallurgy/ https://en.wikipedia.org/wiki/History_of_metallurgy_in_the_Indian_subcontinent		
	Other References	Lee, J. D. (1996). *Concise inorganic chemistry* (5th ed.). Chapman and Hall. Tylecote, F. (2002). *A history of metallurgy* (2nd ed.). Maney Publishing.		

CO-PO & CO-PSO mapping

Cos Vs Pos PSOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CHT1106.01	3	2	2	1	1	2	2	1	1	1	2	2	2
CHT1106.02	3	2	2	1	1	2	2	1	1	1	2	2	2
CHT1106.03	3	2	2	1	2	2	2	1	1	1	2	2	3
CHT1106.04	3	3	3	2	2	2	2	1	1	2	2	2	3
CHT1106.05	3	3	3	2	2	2	2	1	1	2	2	2	3

CHT1106.06	3	3	3	2	2	2	2	1	1	2	2	2	3

Course Title: Physical Chemistry lab-1

School: SSES		Batch 2025-29		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		Academic year 2025-26		
Branch: Chemistry		Semester: II		
1	**Course Code**	CHP1102		
2	**Course Title**	Physical Chemistry Lab-1		
3	**Credits**	1		
4	**Contact Hours (L-T-P)**	0-0-2		
5	**Course Type**	Compulsory	Major	Practical
6	**Course Objective**	To develop the skills required for the preparation of standard solutions To introduce students to the concept of pH and the use of pH meters To provide experimental understanding of colligative properties To enable students to study chemical kinetics experimentally To investigate the influence of impurities on physical properties of liquids To familiarize students with the concept of critical solution temperature (CST)		
7	**Course Outcomes**	Able to prepare primary standard and secondary standard solutions. Understand the importance of pH and pH meter. Able to understand the colligative properties. Understand the kinetics of reaction and rate law. Understand the role of impurities in solvent and how the properties of liquid changes on its addition. Able to find out the critical solution temperature.		
8	**Course Description**	To learn methods for quantitative estimation of different chemical species by various volumetric methods		
9	**Outline Syllabus**			**CO Mapping**
	Unit 1	**Able to prepare primary standard and secondary standard solutions and use pH meters.**		CO1, CO6
	A	To prepare a standard solution of sodium hydroxide and use it to standardize a given solution of HCl.		CO1, CO6

	B	To determine the strength of a given HCl solution by titrating it against 0.1 N NaOH solution pH metrically.	CO1, CO6
	C	To determine the strength of a given HCl solution by titrating it against 0.1 N Na_2CO_3 solution pH metrically.	CO2, CO6
	Unit 2	**Understand the importance of pH and pH meter**	
	A	To measure the pH of natural samples such as lemon juice, vinegar, tap water, soda, etc.	CO2, CO6
	B	To find the pH of a weak acid at various concentrations and calculate its dissociation constant.	CO3, CO6
	C	To calibrate the pH meter using standard buffer solutions (e.g., pH 4, 7, and 10).	CO3, CO6
	Unit 3	**Experimental Study of Colligative Properties**	
	A	To determine the depression in freezing point of water using a solution of a non-volatile solute (e.g., benzoic acid or urea).	CO4, CO6
	B	To demonstrate the colligative property of elevation in boiling point.	CO4, CO6
	C	To demonstrate the phenomenon of osmosis using semi permeable membranes.	CO4, CO6
	Unit 4	**Understand the kinetics of reaction and rate law**	
	A	Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.	CO5, CO6
	B	To study the kinetics of the reaction between potassium iodide and potassium persulphate and determine the rate law.	CO5, CO6
	C	To determine the rate constant and order of the reaction of hydrolysis of an ester catalyzed by an acid.	CO5, CO6
	Unit 5	**Understand the role of impurities in solvents and how the properties of liquids change on its addition.**	
	A	To observe the elevation in boiling point when a non-volatile solute (e.g., NaCl or sugar) is added to water.	CO4, CO6
	B	Determination of the critical solution temperature and composition of the phenol-water system and study of the effect of impurities on it.	CO4, CO6
	C	Determination of the critical solution temperature and composition of the phenol-water system and study of the effect of impurities on it.	CO4, CO6
	Mode of examination	**Practical**	
	Weightage Distribution	**CA**	**ESE**
		60 %	**40%**
	Text Book/s*	1. O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.	

	Other References	Eastman, E. D., & Rollefson, G. K. (1947). *Physical chemistry* (p. 307). McGraw-Hill. Pauling, L. (1970). *General chemistry* (pp. 459–460). Dover Publications.

Semester-3

Course Title: Inorganic Chemistry-II

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester-III**		
1	**Course Code**	**CHT2101**		
2	**Course Title**	**Inorganic Chemistry-II**		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Major	Theory
6	**Course Objective**	The main objective of this course is to: 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 stability of complexes. 5. Relate the magnetic properties with elements. 6. Apply the knowledge to interpret the magnetic nature of a given compound.		
7	**Course Outcomes**	CO1. Understanding of the basic concepts of bonding in d-block elements. CO2. Able to explain the decrease atomic radius of inner transition elements CO3 . Understanding of the basic concepts of bonding in transition metal complexes. CO4. Understanding of the stability of a complex on the basis of various factors CO5. Explain the magnetic results of transition metals complexes. CO6.Ability to explain the bonding, stability and magnetic behavior of transition metal complexes.		

8	**Course Description**	This course enables the student to understand the chemistry of d and f block elements. The bonding, isomerism, magnetic properties of coordination compounds are described.	
9	**Outline Syllabus**		CO Mapping
	Unit 1	**Chemistry of d-block elements**	
	A	Characteristic properties of 3d elements: ionic radii; oxidation states; complexation tendency	CO1, CO6
	B	Catalytic properties and electronic spectral properties. Spectrophotometric estimation of metal ions.	CO1, CO6
	C	Stability of various oxidation states and e.m.f. (Latimer, Frost diagrams). Comparison of 3d elements with 4d & 5d elements	CO1, 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, CO6
	B	Lanthanide and Actinide Contraction.	CO2, CO6
	C	Occurence and principles of separation of lanthanides and actinides	CO2, CO6
	Unit 3	**Coordination Chemistry-I**	
	A	Werner's theory, nomenclature, stereochemistry of complexes with coordination number 4,5,6; Isomerism in coordination complexes.	CO3, CO6
	B	Important applications of coordination compounds and chelates. Theories of metal-ligand bonding in transition metal complexes	CO3, CO6
	C	valence bond theory of coordination compounds with specific reference to CN^-, NH_3, OH^-, and limitations.	CO3, CO6
	Unit 4	**Coordination Chemistry-II**	
	A	A brief outline of thermodynamic stability of metal complexes (methods of determination excluded).	CO4, 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, CO6

	C	Colur of complexes, Theory behind colour, Colour in transition and inner transition elements	CO4, 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	MSE	ESE
		25%	25%	50%

	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.

CO-PO & CO-PSO mapping

PO vsCOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT2101.01	3	2	1	2	2	2	1	1	1	1	3	3	2
CHT2101.02	3	2	1	2	2	2	1	1	1	1	3	3	2
CHT2101.03	3	3	2	2	2	2	1	1	1	2	3	3	3

CHT2101.04	3	3	2	3	2	2	1	1	1	2	3	3	3
CHT2101.05	3	3	2	3	3	2	1	1	1	2	3	3	3
CHT2101.06	3	3	3	3	3	2	1	2	1	3	3	3	3

Course Title: Organic Chemistry-1

School: SSES		**Batch 2025-26**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester III**		
1	**Course Code**	CHT2102		
2	**Course Title**	Organic Chemistry-I		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Major	Theory
6	**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		
7	**Course Outcomes (CO)**	After completing the course students will be able to: CO1: understand the synthesis, physical and chemical properties of alkanes, alkenes and alkynes CO2: explain the structure, reactivity of benzene, its homologues, and polynuclear aromatic hydrocarbons CO3: interpret the structure, synthesis and reactivity of alkyl and aryl halides CO4: identify and categorize many functional groups like alcohol, and phenol and their reactivity CO5: describe the structure, synthesis and properties of ethers, and epoxides		

		CO6: demonstrate the chemistry of organic compounds	
8	**Course Description**	This course enables the students to generalize the structure properties relationship of alkanes, alkenes, alkynes. It also gives in-depth idea about synthesis and properties of various compounds alcohol, phenol, alkyl aryl halides, ethers, epoxide by different methods.	
9	**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, 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, 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, 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, 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, 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, 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	CO3, CO6

		solvent etc.; nucleophilic substitution vs elimination			
	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, 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. Preparation and properties of polyhydric alcohols: glycols and glycerol.			CO4, CO6
	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, CO6
	C	**Thiols:** Nomenclature, synthesis and important reactions.			CO4, 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	MSE	ESE	
		25%	25%	75%	
	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.			

CO-PO & CO-PSO mapping

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT2102.01	3	2	2	2	2	2	2	1	1	1	1	1	1
CHT2102.02	3	3	3	3	3	1	2	1	1	1	1	1	1
CHT2102.03	3	2	3	3	3	1	2	1	1	1	1	1	1
CHT2102.04	3	2	3	3	3	1	2	1	1	1	1	1	1
CHT2102.05	3	2	3	3	3	1	2	1	1	1	1	1	1
CHT2102.06	3	2	3	3	3	1	2	1	1	1	1	1	1

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

Course Title: Introduction to Engineering Materials

School: SSES		**Batch 2025-29**	
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**	
Branch: Chemistry		Semester-III	
1	Course Code	CHT2103	
2	Course Title	Introduction to Engineering Materials	
3	Credits	2	
4	Contact Hours (L-T-P)	2-0-0	
4	Course Status	Theory	Multidisciplinary, Major
7	Course Objective	The main objective of this course is to: 1. Explain the Various type of Engineering Materials and its classification. 2. Illustrate the knowledge about the cements and its types. 3. Understand the action of different types of engineering materials such as composites 4. Acquire knowledge about formulation of ceramics and refractories. 5. Acquire thorough proficiency in the types and behaviour of nanomaterials, Metal-organic framework, Covalent-organic framework. 6. Describe technologically engineering materials, construction materials, inorganic polymers, Metal organic frameworks, nanomaterials and their properties.	
8	Course Outcomes	The student will be able to: CO1. Understand the importance of Engineering Materials in industry. CO2. Know about chemistry of various type of cements and its industrial importance.	

		CO3. Acquire knowledge about manufacturing, and processing of composite. CO4. Have knowledge of inorganic polymers, ceramics and Refractories. CO5. Gain insight into the synthesis, properties, and applications of MOFs and COFs CO6. Acquire critical thinking capabilities about engineering materials, construction materials, ceramics, composites, metal-organic frameworks and their properties.	
9	Course Description	This course describes the chemistry of engineering materials and nanomaterials with emphasis on polymers. This course satisfies the requirement of B.Sc chemistry honors' programme.	
10	Outline syllabus		CO Mapping
8	**Unit 1**	**Engineering materials**	
	A	Introduction to Engineering Materials, Type and various types of Engineering materials	CO1, CO6
	B	Glass and related compounds, Composition, mechanical and fabricating characteristics	CO1, CO6
	C	Characteristics and its applications of composites in advanced technologies	CO1, CO6
8	**Unit 2**	**Cement**	
	A	Cement: Raw material, composition, manufacturing process and application of Portland cement, Chemistry of setting of cement	CO2, CO6
	B	Refractories: Introduction, classification	CO2, CO6
	C	Properties, raw materials, manufacturing and applications	CO2, CO6
8	**Unit 3**	**Composites**	
	A	Introduction to composite materials: Definition of composites, Classification of composites; General characteristics of reinforcement- classification.	CO3, CO6
	B	Polymer matrix composites: Thermoplastic and thermosetting resins; Commonly used matrix reinforcement system; Fibre, Flake and particulate reinforced composites, Reinforcements used in PMC'	CO3, CO6

		glass, carbon, aramids.; Thermoset matrices for aerospace components- polyesters, epoxies, phenolics. Thermoplastic matrices for advanced composites			
	C	Nanocomposites: Nano particle dispersion in polymer matrix,.			CO3, CO6
5	**Unit 4**	**Ceramics**			
	A	Introduction to ceramic materials; Classification of ceramics,			CO4, CO6
	B	Mechanical behavior of ceramics, Glass and glass ceramics.			CO4, CO6
	C	Applications of ceramics in advanced technologies			CO4, CO6
4	**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
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	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. Kaskel, S. (2016). *The chemistry of metal–organic frameworks: Synthesis, characterization, and applications*. Wiley-VCH.			

CO-PO & CO-PSO mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT2103.01	3	2	1	1	1	2	1	1	1	1	2	2	2
CHT2103.02	3	2	2	2	2	3	1	1	1	1	2	2	3
CHT2103.03	3	2	3	2	2	2	1	2	2	1	2	2	3
CHT2103.04	3	2	2	2	2	2	1	1	1	1	2	2	2
CHT2103.05	3	3	2	2	3	2	2	1	1	1	1	3	3
CHT2103.06	3	3	3	3	3	3	2	2	2	2	3	3	3

Course Title: Organic Chemistry Lab-1

School: SSES		**Batch 2025-29**
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**
Branch: Chemistry		**Semester III**
1	**Course Code**	CHP2102
2	**Course Title**	Organic Chemistry Lab-I
3	**Credits**	1
4	**Contact Hours (L-T-P)**	0-0-2
5	**Course Type**	Compulsory (Practical)
6	**Course Objective**	1. To learn methods forpurification 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.
7	**Course Outcomes**	Students will be able to CO1: Separation of organic compounds from mixture CO2: Elemental analysis in organic compounds CO3: Identification of functional group in organic compounds CO4: Analysis of organic compound CO5: Apply knowledge to identify given organic compound. CO6:Execute the volumetric analysis experiments for organic compounds
8	**Course Description**	This course gives an idea about detection of organic elements/functional groups in a sample

9	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, CO6
	B	Filtration/Purification of organic compounds by recrystallization using Organic solvent (Naphthalene)	CO1, CO6
	C	Determination of the melting points of above compounds and report the yields of pure compounds.	CO1, CO6
	Unit 2	**Purification of Organic Compounds-2**	
	A	To perform the purification of crude naphthalene by sublimation method and calculate the percentage yield and M.P.	CO2, CO6
	B,C	To determine the solubility of given organic acid(oxalic acid)	CO2, CO6
	Unit 3	**Element detection in organic compounds(N, S, halogen)**	CO2, 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, CO6
	C	To Analyze the presence of extra elements (N, S, halogens) other than C, H, &O in the given organic compound	CO3, CO6
	Unit 4	**Functional group Analysis**	CO3, CO6
	A	To analyze the presence of functional group/s in the given organic compounds	
	B,C	To identify primary, secondary, tertiary alcohols	CO4, CO6
	Unit 5	**Synthesis of Organic compounds**	
	A	To execute Nitration of Benzene	CO5, CO6
	B	To perform the synthesis of Iodoform	CO5, CO6
	C	To perform Synthesis of Phenolphthalein	CO5, CO6
	Mode of examination	Practical	
	Weightage Distribution	CA: 60%	ESE: 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.

CO-PO & CO-PSO mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP2102.1	3	2	1	2	3	1	1	2	3	1	1	1	1
CHP2102.2	3	1	1	1	3	1	1	2	3	1	1	1	1
CHP2102.3	3	2	1	2	3	1	1	2	3	1	1	1	1
CHP2102.4	3	2	1	2	3	1	1	2	3	1	1	1	1
CHP2102.5	3	2	1	2	3	1	1	2	3	1	1	1	1
CHP2102.6	3	1	1	1	3	1	1	1	3	1	1	2	2

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

Course Title: Inorganic Chemistry Lab-I

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester-III**		
1	**Course Code**	**CHP2101**		
2	**Course Title**	Inorganic Chemistry Lab-I		
3	**Credits**	1		
4	**Contact Hours (L-T-P)**	0-0-2		
5	**Course Type**	Compulsory	Major	Practical
6	**Course Objective**	The main objectives of this course to teach the students about the detection of cation and anions qualitatively. This course also aims to teach the student the quantitative estimation of metal ions by various analytical techniques.		
7	**Course Outcomes**	CO1: Understand the technique of analysis of cations and anions in a given mixture. CO2: Identify and perform the confirmatory tests on the cations. CO3: Design the plan to identify the cations and anions in a given mixture. CO4: To prepare solutions of different strength and standardize them CO5: To understand complexometric titration in quantitative estimation CO6: To understand different types of analysis of ions in a mixture.		
8	**Course Description**	Qualitative and quantitative determination of elements from a mixture.		
9	**Outline**			CO Mapping

	Syllabus		
	Unit 1	**Practical based on qualitative analysis of anion**	
		Quantitative analysis of anions: Bromide, Carbonate, Chloride, Fluoride, Iodide, Nitrate	CO1, CO6
	Unit 2	**Practical based on qualitative analysis of cation**	
		Quantitative analysis of cation : Aluminium, Ammonium, Antimony, Arsenic, Barium, Bismuth, Cadmium, Calsium, Lead, Magnisium, Mercury, Strontium, Tin	CO2, CO6
	Unit 3	**Practical based on qualitative analysis of cation and anion in a mixture**	
		Qualitative analysis of cation and anion in an unknown mixture	CO3, CO6
	Unit 4	**Practical based on complexometric titration**	
		1. Analysis of Dolomite 2. Analysis of Ca in milk powder	CO4, CO6
	Unit 5	**Practical related to redox reaction**	
		Quantitative determination of Cr and Fe in a mixture Quantitative determination of Fe^{2+} and Fe^{3+} in a mixture	CO5, CO6
	Mode of examination	Theory/Jury/Practical/Viva	
	Weightage Distribution	CA: 60%	ESE: 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.	

CO-PO & CO-PSO Mapping

COs \ POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP2101.01	3	2	2	3	2	2	1	1	1	1	2	3	2
CHP2101.02	3	3	2	3	2	1	1	1	1	1	2	3	2
CHP2101.03	2	3	3	3	2	2	1	2	2	2	3	3	3
CHP2101.04	3	2	2	3	2	2	1	1	1	1	2	3	2
CHP2101.05	3	3	2	3	2	2	1	1	1	1	2	3	3
CHP2101.06	3	3	2	3	2	2	1	2	1	1	3	3	3

Course Title: Introduction to Developmental Biology

School: SSES		**Batch**: 2025-29		
Programme: Bachelor of Science (Hons/Hons with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester**: III		
1	**Course Code**	CHT1206		
2	**Course Title**	Introduction to Developmental Biology		
3	**Credits**	03		
4	**Contact Hours(L-T-P)**	3-0-0		
5	**Course Type**	DSE		Theory
6	**Course Objectives**	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		
7	**Course Outcomes**	CO1: Acquire knowledge about basic concepts of developmental processes. CO2: Distinguish between fertilization, the formation of germ layers, and the organization of the body plan. CO3: Gain detailed insight into the molecular events of embryogenesis. CO4: Describe different model systems and their roles in understanding human development and related disorders. CO5: Explore stem cells and their functions in development. CO6: Explain the significance of regenerative medicine, its current applications, and advancements in stem cell research.		
8	**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.		
9	**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, CO 6
	B	Key signaling pathways in development: Fgf, Hedgehog, Wnt, TGFß, and Notch. Cadherins in establishing intercellular connections	CO2, CO 6
	C	Role of extracellular matrix in development: Concepts of induction, competence, and senescence.	CO2, CO 6
	Unit 3	**Study on model organisms**	
	A	*Caenorhabditis elegans:* Study of cell lineage, mosaic development and organogenesis (vulva formation).	CO3, CO 6
	B	*Drosophila melanogaster:* Role of maternal effect genes, morphogens and zygotic genes (Gap genes to homeotic genes) in axis formation and body patterning.	CO3, CO 6
	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, CO 6
	Unit 4	**Stem cells and their implications in treatment strategies**	
	A	Stem cells and their types, and their	CO4, CO 6
	B	Pluripotent cells, Induced pluripotent stem cells	CO4, CO 6
	C	stem cells applications in human development and diseases. Ethical issues.	CO4, CO 6
	Unit 5	**Developmental defects and the role of teratogens**	
	A	Chemical, physical and biological agents which can cause developmental defects.	CO5, CO 6
	B	Brief discussion of alcohol and retinoic acid as teratogenic agents.	CO5, CO 6

	C			CO 5, CO 6
	Mode of examination	Theory		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	Text Book/s *	Alberts, B. (2015) Molecular Biology of the Cell. 6th Edition, Garland Science, Taylor and Francis Group, New York. 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 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		

CO-PO & CO-PSO Mapping

POs &PSOs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT1206.1	1	3	2	3	1	3	2	2	2	2	1	1	2
CHT1206.2	2	3	2	3	2	3	1	1	1	1	2	1	2
CHT1206.3	2	3	2	3	2	2	2	1	2	2	2	1	2
CHT1206.4	2	2	2	3	2	3	1	1	1	1	1	2	1
CHT1206.5	2	2	2	3	2	2	2	1	1	1	1	2	1
CHT1206.6	2	2	2	2	2	2	2	1	1	1	1	2	1

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

Course Title: Research-Based Learning (RBL 001)

School: SSES		**Batch:2025-29**		
Programme: Bachelor of Science (Hons. / Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester:IV**		
1	**Course Code**	CHR2101		
2	**Course Title**	Research-Based Learning-1 (RBL-1)		
3	**Credits**	0		
4	**Contact Hours (L-T-P)**	0-0-4		
5	**Course Type**	Qualifying	DSE	Research Project
6	**Course Objective**	This course will help to ensure that students are able to Demonstrate advanced knowledge of the role of scientific research. Analyze contribution to the disciplines related to the different fields of science and technology. Able to take out optimal research methods by the content Understands methodology by the character of cognitive activity Aim of the scientific task		
7	**Course Outcomes**	The student will be able to CO1: Understand the main rules of handling scientific and technical literature CO2: To be able to understand different types of scientific research and hypothesis. CO3: Understand the advanced level of classification of methods by the level of investigation CO4: Extract the line of approach to overcome the research gap. CO5: Understand to improve their skills in establishing relations between complex topics. CO6: To acquire an overview of 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.		
9	**Outline Syllabus**			CO Mapping

	Mode of examination	Theory/Jury/Practical/Viva (Assessment will be made based on Rubrics)		
	Weightage Distribution	CA	CE	ESE
		30%	30%	40%
	Text Book/s*	**Suggested Readings:** Research Methodology: Methods and Technique 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 Qualitative Inquiry and Research Design: Choosing Among Five Approaches by Cheryl N. Poth and John W. Creswell		
	Other References			

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CHR2101.1	1	2	3	3	3	2	2	2	2	1	2	2	2
CHR2101.2	1	2	3	3	2	2	3	2	2	1	2	2	2
CHR2101.3	2	2	3	3	2	2	2	2	2	1	2	2	2
CHR2101.4	2	2	2	2	2	2	1	2	2	1	2	2	3
CHR2101.5	2	2	2	2	2	2	2	2	2	1	2	2	3
CHR2101.6	2	2	2	2	2	2	2	2	2	1	2	2	3

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

Semester-4

Course Title: Organic Chemistry II

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester- IV**		
1	**Course Code**	**CHT2104**		
2	**Course Title**	**Organic Chemistry-II**		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Major	Theory
6	**Course Objective**	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. Understand and interpret name reactions and their mechanisms involving oxygen-, sulphur-, and nitrogen-based organic functional groups. Analyse the physical and chemical properties, along with the characteristic reactions, of carbonyl-containing compounds. Identify mono- and dicarboxylic acids and evaluate their physical properties and typical chemical reactions. Examine the structure, reactivity, and synthetic importance of nitrogen- and sulphur-containing heterocycles. 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.		

7	**Course Outcomes**	Student will be able to CO1: Learn nucleophilic reactions of carbonyl compounds. CO2: Compare the structures, functions, and key chemical reactions of carboxylic acids and their derivatives CO3: Understand the basicity and reactivity of primary, secondary and tertiary amines. CO4: Differentiate between nitrites, nitrates and nitro compounds. CO5: Compare nitrogen & Sulphur containing Heterocycles. CO6: Develop understanding and critical thinking about carbonyl compounds, carboxylic acids and their derivatives, Sulphur and nitrogen containing functional groups, and heterocyclic compounds.	
8	**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.	
9	**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, 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, 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, CO6
	Unit 2	**Carboxylic Acids and their functional Derivatives**	
	A	Preparation, physical properties and reactions of monocarboxylic acid,	CO2, CO6

		Preparation and reactions of acid chlorides, anhydrides, esters and amides, Acetoacetic ester: keto-enol tautomerism, preparation by Claisen condensation, Acid hydrolysis and ketonic hydrolysis	
	B	Comparative study of nucleophilic substitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reaction	CO2, CO6
	C	Preparation of Dicarboxylic acid (succinic acid and adipic acid), Typical reactions of dicarboxylic acids	CO2, 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, 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, CO6
	C	Preparation and important reactions of nitriles and isonitriles, Diazonium Salts: Preparation and their synthetic applications.	CO3, 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, CO6
	B	Reduction of aliphatic & aromatic nitro compounds, Nucleophilic aromatic substitution reaction. Picric acid	CO4, CO6
	C	Preparation and important reactions of nitrate and nitrite compounds	CO4, CO6
	Unit 5	**Nitrogen & Sulphur containing Heterocycles**	
	A	Classification, Nomenclature, structure, aromaticity of thiophene, pyrrole, furan and pyridine. Basic nature of N-heterocycles	CO5, CO6
	B	Synthesis and mechanism of substitution reaction of 5 membered	CO5, CO6

		heterocycles.		
	C	Synthesis, reactions and mechanism of substitution reactions in Pyridine & Pyrimidines.		CO5, CO6
	Mode of examination	CA, MSE, ESE		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	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.		

CO-PO & CO-PSO mapping

Cos vs POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT2104.01	3	3	2	2	2	2	2	1	1	2	3	3	2
CHT2104.02	3	3	2	2	2	2	2	1	1	2	3	3	3
CHT2104.03	3	2	2	2	2	2	2	1	1	2	3	3	2
CHT2104.04	3	2	2	2	2	2	2	1	1	1	3	3	2
CHT2104.05	3	2	2	2	2	2	2	1	1	1	3	3	2
CHT2104.06	3	3	3	3	3	2	2	2	2	2	3	3	3

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

Course Title: Physical Chemistry-II

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester IV**		
1	**Course Code**	CHT2105		
2	**Course Title**	Physical Chemistry-II		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	CC	Major	Theory
6	**Course Objective**	The objectives of the course are: 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, indicators used in different analysis. 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 introduction the concept of photochemistry and their applications in photochemical reactions 6. To provide detailed knowledge of different processes needing the concept of ionic, chemical equilibria, surface chemistry, photochemistry and colloids.		

7	**Course Outcomes**	The student will be able to: CO1: Develop the knowledge of chemical equilibrium and its application in industrial processes. CO2: Master fundamental concept of ionic equilibrium and associated phenomenon. CO3: Understand the essential phenomenon' of surface chemistry and utilize them for processes such as minimizing corrosion. CO4: Apply the concepts to daily life applications such as soap action and surface active agents. CO5: Able to understand Various kinetic processes of photochemical reactions and measurement of quantum yield. CO6: Develop critical analytical thinking about ionic, chemical equilibria, surface chemistry, photochemistry and colloids to solve real world problems.	
8	**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.	
9	**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, CO6
	B	Variation of equilibrium constant with temperature - The Van't Hoff Equation;	CO1, CO6
	C	Le-chatelier's principle and its application to the formation of ammonia and phosgene, Le-chatelier's principle and physical equilibria.	CO1, 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, CO6
	B	dissociation constants of mono (acetic acid), di (carbonic acid) and triprotic (phosphoric acid) acids. Buffer solutions, its types and Henderson-Hasselbalch equation for calculation of pH, buffer capacity, Hydrolysis of salts; degree of hydrolysis and pH of salt solutions.	CO2, CO6

	C	Solubility and solubility product of sparingly soluble salts, applications of solubility product principle. Theory of acid–base indicators; selection of indicators and their limitations.			CO2, CO6
	Unit 3	**Colloids**			
	A	Classification, preparation, structure and stability of Colloids; Tyndall effect, The electrical double layer; Zeta potential;			CO3, CO6
	B	Coagulation of colloidal solution; Hardy-Shulze rule; Flocculation value; Electro kinetic properties; Electrophoresis; Electro-osmosis;			CO3, 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, CO6
	Unit 4	**Surface Chemistry**			
	A	Physical adsorption, chemisorption, Applications of Adsorption, Factors influencing adsorption,			CO4, CO6
	B	Freundlich adsorption isotherm			CO4, CO6
	C	Langmuir adsorption isotherm			CO4, 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, actinometry.			CO5, CO6
	C	Photosensitized reactions, Luminescence phenomena in photochemistry.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	75%	
	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.

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHE2105.01	3	3	1	2	1	1	1	2	2	2	1	3	3
CHE2105.02	2	3	1	2	1	2	1	2	2	2	1	2	3
CHE2105.03	2	2	1	2	1	1	1	2	2	2	1	3	3
CHE2105.04	3	3	1	2	1	1	1	2	2	2	2	3	3
CHE2105.05	3	2	1	2	1	1	1	2	2	2	1	3	3
CHE2105.05	3	2	1	2	1	1	1	2	2	1	2	3	3

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

Course Title: Enzyme and Catalysis

School: SSES		**Batch:** 2025-29		
Programme: Bachelor of Science (Hons/ Hons with Research) in chemistry		**Academic year 2026-27**		
Branch: chemistry		**Semester:** IV		
1	**Course Code**	CHT2207		
2	**Course Title**	Enzyme and Catalysis		
3	**Credits**	3		
4	**Contact Hours (L-T-P)**	3-0-0		
5	**Course Type**		Minor	Theory
6	**Course Objective**	To introduce the concept and importance of enzyme in the human body and living cell To have a deep understanding of the classification and identification of enzyme To familiarize with the factors effecting the enzyme velocity, like the temperature, p H and substrate To introduce the concept of enzyme kinetics and the equation given by Michaelis and Menton To introduce the various enzyme isolation and purification techniques from various sources		
7	**Course Outcomes**	**CO1**: Understand the mechanism of action of enzyme. **CO2**: Understand the various enzyme kinetics and will be able to correlate the Vmax, Km in the Michalis-Menton equation. **CO3**: Correlate the isolation technique of plant cell from that of animal and microbial cells. **CO4**: Explain the regulation strategies of allosteric enzyme and the mechanism of various inhibition process. **CO5**: Elaborate the various application of enzyme in different fields. **CO6**: Apply the overall concepts of enzymology in different field of biochemistry.		
8	**Course Description**	This course describes various theoretical practical concept of enzyme and their application in various field of industry		
9	**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,CO 6
	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 Michaelis-Menten equation its derivation, Line Weaver 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 un-competitive inhibition, Methanol poisoning	CO3, CO6
	C	Transpeptidase inhibition in bacteria and nerve gas inhibition	CO3, CO6
	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, CO6
	B	Different purification techniques of enzymes: Ammonium sulphate precipitation, dialysis, Gel filtration chromatography,	CO4, CO6
	C	Ion exchange chromatography, affinity chromatography, enzyme activity and specific activity	CO4, CO6
	Unit 5	Industrial Applications of enzyme	
	A	Applications of enzyme in beverage industry(soft drinks, fruit drinks and hard drinks	CO5, CO6
	B	Food processing industry and dairy industry, Pharmaceutical industry	CO5, CO6
	C	Medicine/drug, health and biosensor industry	CO5, CO6
	Mode of examination	**Theory**	
	Weightage Distribution	CA | MSE | ESE	
		25% | 25% | 50%	
		Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). *Biochemistry* (9^{th} ed.). New York, WH: Freeman ISBN-13: 9781319114671	

	Text Book/s *	Voet. D., Voet. J.G. (2013) Bi*ochemistry* (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd. ISBN: 978-1-11809244-6.
	Other References	Nicholas, C.P., Lewis, S. (1999). *Fundamentals of Enzymology* (3rd ed.). New York, Oxford University Press Inc. ISBN:0 19 850229 X.

CO/ PO/ PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PS11	PSO 1	PSO 2
CHT2207.1	3	3	2	2	1	-	-	-	-	3	3	2	3
CHT2207.2	2	2	1	2	1	-	-	-	-	2	3	2	1
CHT2207.3	3	2	2	3	1	-	-	-	-	2	3	2	3
CHT2207.4	2	2	2	2	1	-	-	-	-	2	3	3	2
CHT2207.5	2	2	3	3	2	-	-	-	-	3	3	2	3
CHT2207.6	3	2	2	2	2	-	-	2	3	3	3	3	3

Title: Basics of Pharmaceuticals

School: SSES	**Batch 2025-29**

Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester-IV**		
1	**Course Code**	CHT2106		
2	**Course Title**	Basics of Pharmaceuticals		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Multidisciplinary	Major	Theory
6	**Course Objective**	1. To learn about drug-receptor interactions, lead discovery, drug design and molecular mechanism 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		
7	**Course Outcomes**	CO1: Understand the basic sources of different drugs and the effect of physicochemical properties on drug action. CO2: Identify the fundamental principles of pharmacokinetics and pharmacodynamics. CO3: Have a sound knowledge of basic terminology of medicinal chemistry and concept of Pharmacoeconomics and rational prescribing of drugs with their legal aspects. CO4: Explain the biochemistry involved behind the drug action, mechanism of action of antibacterial, antiseptic agents and concept of drug resistance. CO5: Understand synthetic principles in drugs, lead discovery, drug design, drug development and its evaluation. CO6: Have a thorough grounding in Pharmaceutical Chemistry and basic knowledge in drug designing.		
8	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.		
9	**Outline Syllabus**			CO Ma

			ppi ng
	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	CO 1, CO 6
	B	Physicochemical properties of drugs: Partition coefficient, lipophilicity effects and parameters (log P, π-substituent constant), Hammett equation and electronic parameters (sigma), drug dissolution,	CO 1, CO 6
	C	Acid-base properties, surface activity, bioavailability, stereo chemical aspects of drug action , steric effects (Taft steric and molar refractivity), Hansch equation	CO 1, CO 6
	Unit 2	**Pharmacology - 1**	
	A	Pharmacokinetics: various modes of administration of 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	CO 2, CO 6
	B	Pharmacodynamics: site and mechanism of drug action, Basic idea about drug targets	CO 2, CO 6
	C	Concepts of agonists, antagonists, partial agonist and inverse agonist drugs	CO 2, CO 6
	Unit 3	**Pharmacology-2**	
	A	Definition of the following medicinal terms: soft drug, drug analogue, prodrug, drug efficacy and potency, LD50, ED50, drug toxicity	CO 3, CO 6
	B	drug addiction, spurious drugs, misbranded drugs, adulterated drugs, pharmacopoeia	CO 3, CO 6
	C	Quantitative aspect of drug action: analysis of dose response curve and therapeutic index (safety index) Factors affecting drug action and doses	CO 3, CO 6
	Unit 4	**Medicinal Biochemistry**	
	A	Introduction to development of antimicrobial agents, historical	CO

		development of antimicrobials, chemotherapy, use of synthetic compounds and antibiotic revolution	4, CO 6
	B	Mechanism of action at molecular level of selected antibiotics: inhibitors of cell wall: introduction to bacterial cell wall, peptidoglycan structure synthesis, mechanism of antibiotics inhibiting cell wall synthesis.	CO 4, CO 6
	C	cationic antibiotics, mechanism of action of antiseptics, disinfectants, and their comparison	CO 4, CO 6
	Unit 5	**Synthesis and Drug development**	
	A	Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti- inflammatory agents (Aspirin)	CO 5, CO 6
	B	Synthesis of the representative drugs of the following classes antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides); antiviral agents (Acyclovir)	CO 5, CO 6
	C	Development of new drugs: Introduction to computer aided drug design (CADD), Bioassays, screening of compounds. pre-clinical and clinical phases of drug evaluation	CO 5, CO 6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25%	MSE: 25%	ESE: 75%
	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	

POs / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2
CHT2106.1	3	2	3	2	3	2	1	1	1	2	2	1	1
CHT2106.2	3	2	3	2	3	2	1	1	1	2	2	1	1
CHT2106.3	3	2	3	2	3	1	1	1	1	2	2	1	1
CHT2106.4	3	2	3	2	3	2	1	1	1	2	2	1	1
CHT2106.5	3	2	3	2	3	1	1	1	1	2	2	1	1
CHT2106.6	3	2	3	2	3	2	1	1	1	1	2	1	2

Course Code: Community Connect

School: SSES		**Batch 2025-29**	
Program: B.Sc.		**Academic year 2026-27**	
Branch: Chemistry/ Chemistry		**Semester: IV**	
1	Course Code	**CCP4001**	
2	Course Title	Community Connect	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	Compulsory	
5	Course Objective	1. The objective of assigning the project related to community work is to expose our students to different social issues faced by the people in different sections of society. 2. This type of project work will help the students to develop better understanding of problems of people living in disadvantage position in the society, may be socially, medically, economically, or otherwise. 3. This type of live project work will help our students to connect their class-room learning with practical issues/problems in the society.	
6	Course Outcomes	Students will be able to: **CO1: Students develop awareness** of the social, health, and environmental challenges faced by the community **C02: Students are more appreciative** of socio-economic realities beyond textbooks and classrooms **CO3: Students learn to apply their knowledge** through research, awareness creation, and services for community benefit **CO4: Students are able to carry** out community-based projects with sincerity, teamwork and timely delivery **CO5: Students learn to respectfully engage** with communities with purposive intent to contribute to society and sustainable development **C06: Students are able to document and present** their community project findings in an academically robust manner	
7	Course Description	In Community Connect projects, students will learn how to identify problems of rural and underprivileged communities by conducting surveys, or will help the communities by providing services or solutions for the issues faced by them.	
8	Outline syllabus		CO Mapping
	Unit 1	Team/Group formation and Project Assignment. Problem Definition&Finalizing the problem statement, Resource	CO1, CO2

		requirement, if any.			
	Unit 2	Develop a useful questionnaire or service to the community that will aid in achieving the objectives of the project.			CO2,CO3. CO4
	Unit 3	Learn how to interact with the community members, whether in survey or service-based project – to help develop a more open mindset in the students.			CO3, CO4, CO5
	Unit 4	Analysis of survey data and/or impact on the community members.			CO3, CO4
	Unit 5	Demonstrate and justify their findings in light of the data they have gathered, or show the benefits to the community of the actions they have taken.			CO4, CO5, CO6
	Mode of examination	Practical /Viva			
	Weight age Distribution	CA	MSE	ESE	
		60%	NA	40%	

CO-PO & CO-PSO Mapping

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CCP4001.1	2	2	3	3	1	3	1	3	3	3	2	1	2
CCP4001.2	2	2	3	3	1	3	1	3	3	3	2	1	2
CCP4001.3	2	2	3	3	1	3	1	3	3	3	2	1	2
CCP4001.4	2	2	3	3	1	3	1	3	3	3	2	1	2
CCP4001.5	2	2	3	3	1	3	1	3	3	3	2	1	2
CCP4001.6	2	2	3	3	1	3	1	3	3	3	2	1	2

Course Title: Pharmaceutical lab

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch:		**Chemistry**		
1	**Course Code**	CHP2103		
2	**Semester**	IV		
3	**Course Title**	**Pharmaceutical lab**		
4	**Credits**	2		
5	**Contact Hours (L-T-P)**	0-0-4		
6	**Course Type**	Compulsory	Major	Practical
7	**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.		
7	**Course Outcomes**	Students will be able to: CO1: Understand the laboratory methods and tests related to analysis of various physico-chemical properties of drugs CO2: Learn to extract bioactive molecules from natural sources CO3: Perform basic steps involved in synthesis of drugs CO4: Perform the purification of organic compounds/drugs CO5: Execute elementary quantitative analysis of chemicals in drugs CO6: Utilize the basic concepts learn during this lab to deal with complex problems of pharmaceutical chemistry		
8	**Course Description**	To highlight the importance of Medicinal Chemistry in our lives and the fascination of working in a field that overlaps the disciples of Chemistry, Biology, Biochemistry, Pharmacology etc.		
9	**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*Ka* on Ionization and Solubility of Drugs (i)Paracetamol		CO1, CO6

		(ii) Aspirin	
	Unit 2	**Separation and analysis of bioactive compounds**	
	A	Analysis of ascorbic acid in Vitamin C tablet	CO2, CO6
	B	Free Radical Scavenger Activity: Determination of the Antioxidant Profile of Ascorbic acid and its comparison with bioactive Substances (aloevera, 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 (aloevera, pomegranate juice).	CO2, CO6
	Unit 3	**Synthesis and analysis**	
	A,B	To Synthesize potassium Salt of Benzilic acid and evaluation of its physico-chemical properties	CO3, CO6
	C	To Synthesize potassium Salt of Benzoic Acid and evaluation of its physico-chemical properties	CO3, CO6
		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,C	Synthesis of oil of wintergreen from salicylic acid	CO4, CO6
	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	ESE
		60%	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	

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP2103.1	3	2	3	3	3	2	2	1	1	2	2	1	2
CHP2103.2	3	2	3	3	3	2	2	1	1	2	2	1	2
CHP2103.3	3	2	3	3	3	1	2	1	1	2	2	1	2
CHP2103.4	3	3	3	3	3	2	2	1	1	2	2	1	2
CHP2103.5	3	3	3	3	3	1	2	1	1	2	2	2	3
CHP2103.6	3	3	3	3	3	2	2	1	1	1	2	2	3

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

Course Title: Research-Based Learning (RBL 002)

School: SSES		**Batch:2025-29**		
Programme: Bachelor of Science (Hons. / Hons. with Research) in Chemistry		**Academic year 2026-27**		
Branch: Chemistry		**Semester: IV**		
1	**Course Code**	CHR2102		
2	**Course Title**	Research-Based Learning -2 (RBL002)		
3	**Credits**	1		
4	**Contact Hours (L-T-P)**	0-0-4		
5	**Course Type**	**Research Project**	DSE	**Project**
6	**Course Objective**	This course will help to ensure that students are able to Demonstrate advanced knowledge of the role of scientific research. Analyze contribution to the disciplines related to the different fields of science and technology. Able to take out optimal research methods by the content Understands methodology by the character of cognitive activity Aim of the scientific task		
7	**Course Outcomes**	The student will be able to CO1: Understand the main rules of handling scientific and technical literature CO2: To be able to understand different types of scientific research and hypothesis. CO3: Understand the advanced level of classification of methods by the level of investigation CO4: Extract the line of approach to overcome the research gap. CO5: Understand to improve their skills in establishing relations between complex topics. CO6: To acquire an overview of 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.		
9	**Outline Syllabus**			CO Mapping
	Mode of examination	Theory/Jury/Practical/Viva (Assessment will be made based on Rubrics)		
	Weightage Distribution	CA	CE	ESE
		30%	30%	40%
	Text Book/s*	**Suggested Readings:** Research Methodology: Methods and Technique 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		

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CHR2102.1	1	2	3	3	3	2	2	2	2	1	2	2	2
CHR2102.2	1	2	3	3	2	2	3	2	2	1	2	2	2
CHR2102.3	2	2	3	3	2	2	2	2	2	1	2	2	2
CHR2102.4	2	2	2	2	2	2	1	2	2	1	2	2	3
CHR2102.5	2	2	2	2	2	2	2	2	2	1	2	2	3
CHR2102.6	2	2	2	2	2	2	2	2	2	1	2	2	3

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

SEMESTER-5

Course Title: Organic Chemistry-III

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		**Semester-V**		
1	**Course Code**	CHT3101		
2	**Course Title**	Organic Chemistry-III		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Major	Theory
6	**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.		
7	**Course Outcomes**	CO1: Explain the classification, structure, and chemical behavior of carbohydrates, including their conformations and interconversions. CO2: Classify, synthesize, and describe the physical and chemical properties of amino acids and their biological significance. CO3: Analyze the chemical nature and biological functions of oils, fats, and lipids, including their physical constants and membrane-related roles. CO4: Illustrate drug classification, nomenclature, structure-activity relationships, and describe the synthesis and pharmacological relevance of selected drugs. CO5: Describe the structure, natural occurrence, physiological action, and classification of alkaloids and terpenes, and explain key structural elucidation methods. CO6: Demonstrate an integrated understanding of biomolecules and natural products in relation to their biological, medicinal, and industrial significance.		

8	**Course Description**	Organic Chemistry-III encompasses carbohydrate, amino acids and peptides, oil, 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 substitution reaction of Furan, Pyrrole, Thiophene, Pyridine, Pyrimidine	
9	**Outline Syllabus**		CO Mapping
	Unit 1	**Carbohydrates**	
	A	Classification, biological importance, Reducing and non-reducing saccharides	CO1, CO6
	B	Haworth projections and conformational structures; Interconversions of aldoses and ketoses	CO1, CO6
	C	Killiani-Fischer synthesis and Ruff degradation, structure elucidation of fructose and glucose.	CO1, CO6
	Unit 2	**Amino acids**	
	A	Classification of α-Amino Acids, Essential and non-essential amino acids	CO2, CO6
	B	Synthesis of amino acids	CO2, CO6
	C	Chemical and Physical Properties	CO2, CO6
	Unit 3	**Oil, Fats & Lipids**	
	A	Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids	CO3, CO6
	B	Trans fats, Hydrogenation, Saponification value, Iodine number. Classification, Biological importance of triglycerides and phosphoglycerides and cholesterol	CO3, CO6
	C	Lipid membrane, Liposomes and their biological functions and underlying applications.	CO3, CO6
	Unit 4	**Drugs**	
	A	Introduction, Classification (based on therapeutic action), Nomenclature: Generic name, Brand name, Systematic name	CO4, CO6
	B	Requirements of an ideal drug, General aspects of drug action, structure-activity relationship, metabolism of drugs, Chemical structures, pharmacological activity,	CO4, CO6
	C	synthesis and uses of some important drugs: Aspirin, Paracetamol, Phenacetin, Chloramphenicol.	CO4, CO6
	~~**Unit 5**~~	**Natural Products**	
	~~**A**~~	Alkaloids & Terpenes: Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification	CO5, CO6
	~~**B**~~	Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.	CO5, CO6
	~~**C**~~	Natural Occurrence and classification of terpenes, isoprene rule.	CO5, CO6

	Mode of examination	Theory/Jury/Practical/Viva		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	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).		

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT3101.01	3	2	2	2	1	2	1	1	1	1	2	3	3
CHT3101.02	3	2	2	2	1	2	1	1	1	1	2	3	3
CHT3101.03	3	3	2	2	2	3	2	1	1	1	2	3	3
CHT3101.04	3	3	2	2	2	3	2	1	2	2	2	3	3
CHT3101.05	3	3	2	2	2	3	2	1	2	2	2	3	3
CHT3101.06	3	3	3	2	3	3	2	2	2	2	3	3	3

Course Title: Inorganic Chemistry-III

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		**Semester-V**		
1	**Course Code**	CHT3102		
2	**Course Title**	Inorganic Chemistry-III		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Major II	Theory
6	**Course Objective**	1. To provide the 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 the Bioinorganic Chemistry 5. To provide an introduction of photosynthesis and metalloenzymes. To gain insight about various topics in inorganic, organometallic and bioinorganic chemistry		
7	**Course Outcomes**	Students will be able to: CO1: Explain the molecular symmetry and point groups CO2: Gain insight about organometallic chemistry CO3: Explain the application of organometallic compounds CO4: Predict the importance of metal ions in biology		

		CO5: Understand structure and function of chlorophyll and metalloenzymes CO6: Know about the molecular symmetry, nuclear, organometallic and bioinorganic chemistry.			
8	**Course Description**	This course describes the organometallic and nuclear chemistry as well as bioinorganic chemistry. This course satisfies the requirement of B.Sc chemistry honors' programme.			
9	**Outline Syllabus**				CO Mapping
	Unit 1	**Basics of Molecular symmetry**			
	A	Introduction of molecular symmetry, symmetry operations, symmetry elements, classification, examples			CO1, CO6
	B	Molecular point groups and examples			CO1,CO6
	C	Group multiplication table, construction of character table (C_{2v} and C_{2h} point groups)			CO1,CO6
	Unit 2	**Basics of Organometallic chemistry-I**			
	A	Introduction- Definition and classification of organometallic compounds on the basis of hapticity and polarity of M-C bond; General characteristics, examples			CO2,CO6
	B	Effective atomic number (EAN), Isoelectronic and Isolobal concept in organometallic chemistry, 18e and 16e rule and their exceptions			CO2,CO6
	C	Organoberyllium, organomagnesium and organolithium compounds, synthesis and applications			CO2,CO6
	Unit 3	**Basics of Organometallic chemistry-II**			
	A	Synthesis, structure, bonding, reactivity of Ferrocene			CO3,CO6
	B	Synthesis, structure and bonding of Zeise's salt, pi-bonded organometallic complexes			CO3,CO6
	C	Applications of organometallic complexes			CO3,CO6
	Unit 4	**Bioinorganic Chemistry-I**			
	A	Importance of metal ions in biological systems, essential and trace metals			CO4,CO6
	B	Metal ion toxicity, deficiency and related diseases, chelating agents used in toxicity			CO4,CO6
	C	Hemoglobin and myoglobin, functions, CO poisoning			CO4, 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	CA	MSE	ESE	
		25%	25%	50%	

	Distribution			
	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.		

CO-PO & CO-PSO mapping

Pos / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT3102.1	2	1	1	1	1	1	1	2	1	1	1	1	1
CHT3102.2	2	1	1	1	1	1	1	2	1	1	1	2	1
CHT3102.3	2	1	1	1	2	1	1	2	1	1	1	1	1
CHT3102.4	2	1	1	2	1	1	1	2	1	1	2	2	2
CHT3102.5	2	1	1	1	1	1	1	2	1	1	1	1	1
CHT3102.6	1	1	1	2	1	1	1	2	1	1	1	1	1

Course Title: Basics of Spectral Techniques

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		**Semester-V**		
1	**Course Code**	**CHT3103**		
2	**Course Title**	**Basics of Spectral Techniques**		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
	Course Status	Compulsory	Major	Theory
5	**Course Objective**	Provide knowledge of interaction of electromagnetic spectrum with matter and to record the information in the form of signals Provide knowledge of various rules for electronic transition in a molecule upon irradiation with UV-Vis electromagnetic radiation in order to analyze the structure of unknown molecule Provide theoretical knowledge of various rules for molecular vibrations in a molecule upon irradiation with infra-red electromagnetic radiation in order to analyze the structure of unknown molecule Analyze the structure of molecule with help of various rules of fragmentation pattern in molecules through mass spectrum and NMR signals Elucidate the structure of any unknown simple molecules integrating the results of various spectroscopic techniques such as UV-Vis, IR, NMR and Mass. Provide detailed knowledge of solving the molecular structural problems by integrating various spectroscopic techniques		
6	**Course Outcomes**	CO1: Establish firm knowledge of various spectroscopic principle to elucidate the structure of analyte CO2: Theoretically calculate the absorption frequencies of molecule and predict the color, concentration and structure of polyenes and enone systems CO3: Correlate the various modes of vibration in a molecule based on absorption/		

		transmitted light to evaluate the presence of functional groups in a molecule; helpful to elucidate the structure CO4: Understand the various modes of fragmentation on high energy electron impact helpful to elucidate the structure of alkane, alkene, alcohol and ethers CO5: Understand the appearance of proton signal in a molecule depending on the environment helpful to elucidate the structure of molecule. CO6: Develops analytical skills to think, analyze and solve the molecular structural problems by integrating various spectroscopic techniques such as 1. Introduction to spectro-analytical methods 2. UV-Visible Spectroscopy 3. Infrared Spectroscopy 4. Mass spectroscopy 5.Nuclear Magnetic Resonance Spectroscopy	
7	**Course Description**	This course comprises of following analytical techniques as given below 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 radiations, interaction of radiation with matter	CO1, CO6
	B	Absorption, and emission of electromagnetic radiations	CO1, CO6
	C	Fourier transform spectroscopy	CO1, CO6
	Unit 2	**UV-Visible Spectroscopy**	
	A	Lambert's-Beer's law; Different type of electronic transitions; Chromophores; auxochromes	CO2, CO6
	B	Red shift; blue shift; Effect of conjugation; solvent effect; absorption in dyes	CO2, CO6
	C	Woodward's rule for conjugated cyclic and acyclic dienes; absorption in aromatic compounds	CO2, CO6
	Unit 3	**Infrared and Raman spectroscopy**	
	A	Introduction; Theory; electromagnetic range (functional group region and finger print region); frequency of vibrations of diatomic molecules	CO3, 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, 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, CO6
	Unit 4	**Mass spectroscopy**	
	A	Basic principle and Theory, Components of mass spectrometer, exact masses of nuclides	CO4, CO6
	B	Molecular ions; isotope ions; fragment ions, metastable ions, Mc-Lafferty rearrangement	CO4, CO6
	C	Factors affecting cleavage pattern, structural elucidation of alkane, alkene, alcohol and ethers.	CO4, 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: 25% / MSE: 25% / ESE: 50%	
	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.	

CO-PO & CO-PSO mapping

PO vs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT3103.01	3	2	1	2	3	2	1	1	1	2	3	3	3
CHT3103.02	3	3	1	2	2	1	1	1	1	1	3	3	3
CHT3103.03	3	3	2	3	3	2	1	1	2	2	3	3	3
CHT3103.04	3	3	2	3	3	2	1	1	2	2	3	3	3
CHT3103.05	3	3	2	3	3	2	1	1	2	2	3	3	3
CHT3103.06	3	3	3	3	3	2	2	2	2	3	3	3	3

Course Title: Physical Chemistry III

School: SSES		**Batch 2025-29**		
Programme:		**Academic year 2027-2028**		
Branch: Chemistry		**Semester-V**		
1	**Course Code**	CHT3104		
2	**Course Title**	Physical Chemistry III		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Major	Theory
6	**Course Objective**	To provide detailed concepts in Electrochemistry, theories for strong and weak electrolytes and to implant the concept of Ionic and electrolytic conductance. To inculcate the concept of equilibrium, equilibrium constant and to calculate free energy change from it. To inculcate the concept of conservation of energy. To inculcate the concepts related to laws of thermodynamics applicable in daily life. To make students understand the concept of chemical equation and thermochemical equation. 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.		
7	**Course Outcomes**	Students will be able to: CO1: Understand the application of electrochemical series in daily life and the theoretical basis of calculation of different thermodynamic parameters using EMF technique CO2: Differentiate between ionic and electrolytic conductance and learn the conductance of strong and weak electrolytes. CO3: Understand the concept of conservation of energy CO4: Explain the origin of the driving force of physical and chemical changes and evolution of the second law of thermodynamics and related concepts. CO5: Understand the role of thermodynamics in various thermochemical equations. CO6: Explain different concepts related to ionic, chemical equilibrium, kinetics of a reaction, colligative properties and how to identify crystal structure.		
8	**Course Description**	Students will develop detailed understanding to analyze basics of electrochemistry, thermodynamics and thermochemistry.		
9	**Outline Syllabus**			CO Mapping

	Unit 1	Electrolytic conductance	
	A	Conduction in electrolyte solutions, Arrhenius theory of electrolytic dissociation	CO1, CO6
	B	Conductivity, equivalent and molar conductivity, variation with dilution.	CO1, CO6
	C	Kohlrausch law. Debye-Hückel-Onsager equation, Walden's rules.	CO1, 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.	CO2, 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),	CO2, CO6
	C	Liquid junction potential, Application of concentration cells. Electrochemical corrosion and its mechanism in acid and neutral media.	CO2, 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, 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 equ.	CO3, 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, CO6
	Unit 4	**Thermodynamics II**	
	A	Discussion of experiential knowledge to account for the spontaneity in changes around us.: need for the Second law of thermodynamics, different statements of the law, Carnot cycle and its efficiency, Carnot theorem, Thermodynamic scale of temperature.	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.	CO4, 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.	CO4, CO6
	Unit 5	**Thermochemistry**	
	A	Standard state, standard enthalpy of formation. Hess's Law of heat summation and its applications.	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.	CO5, CO6
	C	Temperature dependence of enthalpy, Kirchhoff's equation.	CO5, CO6

	Mode of examination	Theory/Jury/Practical/Viva		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
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.		

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT3104.01	3	2	1	2	1	2	1	1	1	1	2	3	3
CHT3104.02	3	3	1	2	2	2	1	1	1	1	2	3	3
CHT3104.03	3	2	1	1	1	2	1	1	1	1	2	3	3
CHT3104.04	3	3	1	2	1	2	1	1	1	1	2	3	3
CHT3104.05	3	3	1	2	2	3	1	1	1	1	2	3	3
CHT3104.06	3	3	2	2	2	2	1	1	2	1	3	3	3

Course Title: Organic Chemistry Lab II

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		**Semester-V**		
1	**Course Code**	CHP3101		
2	**Course Title**	**Organic Chemistry Lab-II**		
3	**Credits**	2		
4	**Contact Hours (L-T-P)**	0-0-4		
5	**Course Type**	Compulsory	Major	Practical
6	**Course Objective**	1. An understanding of different biomolecules. 2. Skills to apply the theoretical knowledge of biomolecules into 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 into experiments. 6. The concept of good lab practices and finally the skills to apply the laboratory skills in research.		
7	**Course Outcomes**	Students will be able to 1. To introduce the concept of identifying carbohydrates and classifying them as reducing and non-reducing 2. To analyze the alpha amino acids and proteins 3. To understand the properties of oils, fats, lipids & buffers. 4. To have an understanding of isoelectric point of amino acids 5. To demonstrate the methods of synthesis of dyes. 6. To understand qualitative and quantitative estimations of carbohydrates, amino acids and fats/oils		
8	**Course Description**	This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids.		
9	**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, CO6
	B	To distinguish between aldoses (like glucose) and ketoses (like fructose). To distinguish between mono- , di- and poly saccharides.		CO1, CO6
	C	Estimation of glucose Estimation of sucrose		CO1, CO6

	Unit 2	**Qualitative & Quantitative tests for Amino acids**	
	A	To detect the presence of protein in the given solution using a. ninhydrin test. b. biuret test. c. Xanthoprotein test	CO2, CO6
	B	Sorenson's formol titration To determine the isoelectric point of glycine	CO2, CO6
	C	Paper chromatographic separation of a mixture containing 2/3 amino acids	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, CO6
	B	i) To determine the acid value of castor oil ii) To determine the iodine value of mahua oil	CO3, 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, CO6
	Unit 4	**Synthesis of Organic Compounds**	
	A	To prepare m-dinitrobenzene from nitrobenzene	CO4, CO6
	B	To perform the synthesis of dibenzalacetone (crossed aldol reaction) and report its yield and melting point	CO4, CO6
	C	Preparation of osazones	CO4, CO6
	Unit 5	**Practicals on Dyes & Pigments**	
	A	Synthesis of i) an Azo dye ii) p-Nitroacetanilide from Acetanilide	CO5, CO6
	B	Synthesis of i)Indigo dye ii)Orange-II	CO5, CO6
	C	Estimation of Primary amino group by diazotization	CO5, CO6
	Mode of examination	Theory/Jury/Practical/Viva	
	Weightage Distribution	CA: 60%	ESE: 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.

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP3101.1	3	2	3	3	3	2	2	1	1	2	2	1	2
CHP3101.2	3	2	3	3	3	2	2	1	1	2	2	1	2
CHP3101.3	3	2	3	3	3	1	2	1	1	2	2	1	2
CHP3101.4	3	3	3	3	3	2	2	1	1	2	2	1	2
CHP3101.5	3	3	3	3	3	1	2	1	1	2	2	2	3
CHP3101.6	3	3	3	3	3	2	2	1	1	1	2	2	3

Course Title: Inorganic Chemistry Lab-II

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		**Semester V**		
1	**Course Code**	**CHP3102**		
2	**Course Title**	**Inorganic Chemistry Lab-II**		
3	**Credits**	2		
4	**Contact Hours (L-T-P)**	0-0-4		
5	**Course Type**	Compulsory	Major I	Practical
6	**Course Objective**	1. To understand the analysis of industrial materials 2. To explain the manufacture and processing of industrial materials 3. To estimate and analyse the industrially important materials 4. To understand the process of determination of chemical properties of water samples. 5. To apply the spectrophotometric principles in estimation of materials. 6. To perform quantitative analysis of materials.		
7	**Course Outcomes**	1. To understand the analysis of industrial materials 2. To explain the manufacture and processing of industrial materials 3. To estimate and analyse the industrially important materials 4. To understand the process of determination of chemical properties of water samples. 5. To apply the spectrophotometric principles in estimation of materials. 6. To perform quantitative analysis of materials.		
8	**Course Description**	The course enables students to estimate the parameters of cement, fertilizers and petrochemicals. Physicochemical parameters are also discussed.		
9	**Outline Syllabus**			CO Mapping
	Unit 1	**Estimation of physicochemical parameters**		
	A	Estimation of copper and calcium in a mixture.		CO1, CO6
	B	Determination of initial and final setting time of cement.		CO1, CO6
	Unit 2	**Analysis of fertilizers**		

	A	Preparation of a sample of phosphate and sulphate fertilizers	CO2, CO6
	B	Estimation of nitrogen in fertilizer	CO2, CO6
	C	Determination of free acidity in ammonium sulphate fertilizer	CO2, CO6
	Unit 3	**Analysis of petrochemicals**	
	A	Determination of calorific value of a fuel by Bomb's Calorimeter	CO3, CO6
	B	Determination of flash point by Able's closed cup apparatus.	CO3, CO6
	Unit 4	**Titrimetric estimation of chemical parameters**	
	A	Analysis of alkalinity of water sample by acid-base titration.	CO4, CO6
	B	Estimation of available chlorine in bleaching powder iodometrically.	CO4, CO6
	Unit 5	**Analysis of physico-chemical parameters**	
	A	Preparation of Potash Alum.	CO5, CO6
	B	Estimation of chemical oxygen demand in a given water sample.	CO5, CO6
	Mode of examination	Practical	
	Weightage Distribution	CA	ETE
		60%	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.	

CO-PO & CO-PSO Mapping

COs \ POs & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP3102.01	3	2	2	2	2	3	2	1	1	1	2	3	3
CHP3102.02	3	2	3	2	2	3	2	2	2	2	2	3	3
CHP3102.03	3	3	3	3	2	3	1	2	2	2	3	3	3
CHP3102.04	3	2	2	3	2	3	1	1	1	1	2	3	3
CHP3102.05	3	3	2	3	3	2	1	1	1	1	3	3	3
CHP3102.06	3	3	3	3	3	2	1	2	2	2	3	3	3

Research-Based Learning-3 (RBL-3)

School: SSES		**Batch 2025-29**		
Programme: Bachelor of Science (Research) Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		Semester: V		
1	**Course Code**	CHR3101		
2	**Course Title**	Research-Based Learning- 3 (RBL-3)		
3	**Credits**	0		
4	**Contact Hours (L-T-P)**	**0-0-2**		
5	**Course Type**	Compulsory		Project
6	**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.		
7	**Course Outcomes**	**CO1**: Apply experimental methods to solve a given scientific task, **CO2**: Collect data for evaluation and for statistical treatment, if relevant, **CO3**: Show a professional attitude regarding time planning, collaboration, and the link between theoretical and practical knowledge, **CO4**: Reflect upon and discuss the relevance of the work in written and oral form **CO5**: Document results by writing a research report, **CO6:** Show independence, critical and creative thinking		
8	**Outline Syllabus**			CO Mapping
	Unit 1	**Identifying research problem** Selection of 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		CO5, CO6

		future remarks justifying the research problem, checking the similarity index, and submitting it to the competent authority		
	Mode of examination	Theory/Jury/Practical/Viva (Assessment will be made based on Rubrics)		
	Weightage Distribution	CA	MSE	ESE
		30%	30%	40%
	Text Book/s *	**Suggested Readings:** Research Methodology: Methods and Technique 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		

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CHR3101.1	3	2	2	2	2	1	1	1	2	1	2	2	2
CHR3101.2	1	2	3	3	2	2	3	1	2	1	2	2	2
CHR3101.3	2	2	3	3	2	2	2	1	2	1	2	2	2
CHR3101.4	2	2	2	2	2	2	1	1	2	1	2	2	3
CHR3101.5	2	2	2	2	2	2	2	1	2	1	2	2	3
CHR3101.6	2	2	2	2	2	2	1	2	2	1	2	2	3

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

SEMESTER -6

Course Title: Chemistry in Action

School: SSES		**Batch 2025-29**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		**Semester-VI**		
1	**Course Code**	CHT3105		
2	**Course Title**	Chemistry in Action		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Minor	Theory
6	**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 manufacturing process. 4.To increase the understanding of processes involved in the synthesis, effects, uses, 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 handling and storage of explosives. 6.To provide the knowledge and critical thinking about polymers, pesticides and insecticides, dyes, pigments and explosives.		
7	**Course Outcomes**	Students will be able to: CO1: Know the basics of polymer chemistry. CO2: Learn different types of dyes and pigments and their applications. CO3: Describe/recognize soaps and detergents and their mechanism of action. CO4: Understand the processes involved in the synthesis, effects, uses, consequences of insecticides and pesticides. CO5: Understand the classification, Oxygen balance, Properties, Chemical reactions, manufacture of important explosives like TNT, PETN, RDX and their storage. CO6: Develop critical thinking about polymers, dyes, pigments, pesticides and insecticides and explosives.		
8	**Course Description**	Chemistry in Action deals with polymers, dyes, pigments, pesticides, insecticide, and explosives. Polymers deals with introduction, vulcanization, biodegradable and conducting polymers. Pesticides and insecticides synthetic approach for DDT, Gammexene, Malathion, Parathion and anilides. Explosive encompasses oxygen balance, manufacture of high explosives,		

		blasting fuses and smokeless powders.			
9	**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 polymerisation			CO1, CO6
	B	Anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; thermosetting (phenol-formaldehyde, Polyurethanes), thermoplastics (PVC, polythene)			CO1, CO6
	C	Synthetic fibres (acrylic, polyamido, polyester) and Rubbers – natural and synthetic: Buna-S; Vulcanization; Biodegradable and conducting polymers with examples.			CO1, 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			CO2, CO6
	B	Classification of dyes based on a) chemical constitution with illustrative examples b) methods of application to fibre			CO2, CO6
	C	Synthesis of Pigment Yellow G, Benzidine orange, Pigments Orange VI			CO2, CO6
	Unit 3	**Soaps and Detergents**			
	A	Soaps: Raw material, chemical reaction, types and cleansing action. Surfactants-emulsion and emulsifying agents			CO3, CO6
	B	Wetting and non-wetting, CMC, hydrophobic and hydrophilic nature, amphipathic structures and types			CO3, CO6
	C	Detergents- raw materials, detergent builders, additives and cleansing action.			CO3, CO6
	Unit 4	**Pesticides & Insecticides**			
	A	General introduction to pesticides (natural and synthetic), benefits and adverse effects			CO4, CO6
	B	Synthesis and technical manufacture and uses of representative pesticides			CO4, CO6
	C	Inecticides in the following classes: Organochlorines (DDT, Gammexene); Organophosphates (Malathion, Parathion); Anilides (Alachlor and Butachlor).			CO4, CO6
	Unit 5	**Explosives**			
	A	Introduction, Classification, Oxygen balance, Properties, Chemical reactions			CO5, CO6
	B	Manufacture of important explosives: Trinitrotoluene (TNT), Nitroglycerine (NG), Pentaerythrial tetranitrate(PETN)			CO5, CO6
	C	Cyclomethylene trinitroamine (RDX) blasting fuses, smokeless powder, black powder, Precaution during storage of explosives			CO5, CO6
	Mode of examination	CA, MSE,ESE			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
		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)*.			

	Text Book/s *	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.

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT3105.1	3	2	3	3	3	2	2	1	1	2	2	1	2
CHT3105.2	3	2	3	3	3	2	2	1	1	2	2	1	2
CHT3105.3	3	2	3	3	3	1	2	1	1	2	2	1	2
CHT3105.4	3	3	3	3	3	2	2	1	1	2	2	1	2
CHT3105.5	3	3	3	3	3	1	2	1	1	2	2	2	3
CHT3105.6	3	3	3	3	3	2	2	1	1	1	2	2	3

Title: Chemical Energetics and Radiochemistry

School: SSES		**Batch 2024-28**		
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		**Semester-VI**		
1	**Course Code**	CHT3106		
2	**Course Title**	**Chemical Energetics and Radiochemistry**		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Major	Theory
6	**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.		
7	**Course Outcomes**	CO1: Apply the basics of thermodynamics to the lab-scale heat exchange processes CO2: Understand the types of non-conventional energy with special emphasis to fuel cells and solar energy CO3: Implement the solar energy resource for energy generation by using photovoltaic cells, principles and methods CO4: develop critical analytical thinking about Radiochemistry and its usefulness in energy systems CO5: apply the concepts of decay and emission in calculating the age of ancient items and buried materials CO6: Do the in-depth analysis of varioustypes of non-conventional energy resourcess and their working principles		
8	**Course Description**	This course takes in detail the energy consumption, demand, energy generation strategies, types of energy, basic principles of energy generation from solar power and fuels. Basics of radiochemistry, terminology and energy generation are also covered in this course		
9	**Outline Syllabus**			CO Mappi

			ng
	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, 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, CO6
	C	Exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear and hydroelectric power, impact of exponential rise in energy usage on global economy	CO1, 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.	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.	CO2, CO6
	C	Biofuel: Ethanol and Methanol production from Cellulose and wood Biomass, Biodiesel Production from Non-Edible Oil Seeds.	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, CO6
	B	Types of solar cells, First generation solar cells: design, fabrication, performance, and drawbacks, Second generation solar cells: design, performance and drawbacks	CO3, 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, CO6
	Unit 4	**Radiochemistry**	
	A	Natural and induced radioactivity; radioactive decay-α-decay, β-decay, γ-decay;	CO4, CO6

	B	neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half-life period	CO4, CO6
	C	Geiger-Muller relationship, Geiger-Nuttal rule, radioactive displacement law, readioactive series	CO4, CO6
	Unit 5	**Nuclear force and structures**	
	A	Two body problem - properties of deuteron and derivation of depth-range relationship, its applications in explaining nature of nuclear force	CO5, CO6
	B	Elementary particles; nuclear models - strong and weak interaction,	CO5, CO6
	C	Nuclear magnetic dipole moment and electric quadruple moment in terms of shell model, collective model, Fermi gas model.	CO5, CO6
	Mode of examination		
	Weightage Distribution	CA: 25% / MSE: 25% / ESE: 50%	
	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.	

CO-PO & CO-PSO mapping

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT3106.01	3	3	2	3	2	2	1	1	1	1	2	3	2
CHT3106.02	3	2	1	1	1	3	1	1	1	1	2	2	3
CHT3106.03	3	2	2	1	3	3	1	1	2	2	2	3	3
CHT3106.04	3	3	1	1	1	2	2	1	1	1	2	2	3
CHT3106.05	3	3	2	2	1	1	1	1	1	1	2	2	3
CHT3106.06	3	2	1	1	2	3	2	1	1	1	3	3	3

Course Title: Biological Chemistry

Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2027-2028**
Branch: Chemistry		**Semester: VI**
1	Course Code	CHT3209
2	Course Title	**Biological Chemistry**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
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 under goes 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	CO. 1. Learn the meaning of free energy change, how the release of free energy will make the biochemical reaction spontaneous and will be corelate the second and third law of thermodynamics in a living cell. CO. 2. Understand the creation of micro and mini voltage and current when an electron flows through the several electron carriers and the role of chemistry and physics in it. CO. 3. Recogonize the difference between the energy of activation for a catalyst and a biocatalyst and what causes such a huge difference that makes the enzyme work at a much faster rate than a chemical catalyst.

		CO. 4. To learn the anabolism and catabolism of several biological organic molecule like carbohydrate(Glucose, Maltose and Starch) , fat (Tri acyl glycerol) and nucleotides CO. 5. Understand the role of insulin in causing diabetes mellites and other chemistry behind the regulation of biochemical reaction.	
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;	CO 1,CO6
	C	High energy rich bio-organic compound; hydrolysis of phosphocreatine in muscle; exergonic and endergonic reaction	CO.1,CO6
	Unit 2	**Biological oxidation and reduction**	
	A	Redox reactions; reduction potentials; standard reduction potentials; Nernst equation;	CO.2,CO6
	B	Universal electron carriers (NAD+, NADP+ and FAD, flavoproteins); Mitochondrial electron carriers; Sequences of electron carriers;	CO.2,CO6
	C	ETC in mitochondria; Functions of ETC complex; Ubiquinone, cytochromes, Iron sulfur proteins	CO.2,CO6
	Unit 3	**Chemistry of a biocatalyst**	
	A	Enzyme and chemical catalyst; role of enzyme, activation energy lowering; transition state intermediate; enzyme-substrate complex	CO.3,CO6
	B	Enzyme specific chemical reaction: Oxidoreductase, transferase, hydrolase and isomerase	CO.3,CO6
	C	Mode of enzyme action: lock and key hypothesis, induced fit hypothesis, Acid base catalysis, covalent catalysis.	CO.3,CO6
	Unit 4	**Anabolism and Catabolism**	

	A	Principles of anabolism and catabolism. Biochemistry of Glycolysis			CO.4,CO6
	B	Kreb's cycle, β-oxidation, transamination reaction			CO.4,CO6
	C	urea cycle, pyrimidine and purine biosynthesis			CO.4,CO6
	Unit 5	**Hormone chemistry**			
	A	Chemical signaling of hormones -endocrine, paracrine, autocrine,			CO.5,CO6
	B	Neuroendocrine mechanisms. Classification of Hormones			CO. 5,CO6
	C	Structure of hormones , Steroid and non- steroid hormone			CO.5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		30%	20%	50%	
	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	5.Sadava, Hillis, Heller and Berenbam : Life the science of biology, 9th edition, W.H Freeman and Company. 6.Donald T Hynie : Biological thermodynamics,2nd edition, Cambridge University Press			

CO-PO & CO-PSO mapping

POs &PSOs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT3209.1	3	2	3	2	1	2	2	2	2	2	2	1	1
CHT3209.2	3	2	3	3	2	2	1	1	1	1	1	2	1
CHT3209.3	3	3	2	3	2	2	2	1	2	2	2	2	1
CHT3209.4	3	2	2	2	2	3	1	1	1	1	1	1	1
CHT3209.5	3	2	2	2	2	2	2	1	1	1	1	1	1
CHT3209.6	3	2	2	2	2	2	2	1	1	1	1	1	1

Course Title: Nanomaterials: Synthesis and Applications

School: SSES		**Batch 2025-29**		
Program: BSc		**Academic year 2027-2028**		
Branch: Chemistry/ chemistry		**Semester: VI**		
1	Course Code	CHT3107		
2	Course Title	Nanomaterials: Synthesis and Applications		
3	Credits	3		
4	Contact Hours (L-T-P)	3-0-0		
	Course Type		Interdisciplinary	Theory
5	Course Objective	To 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	Students will be able to CO1: Formulate the synthetic methods towards preparation of novel nanomaterials. CO2: Understand the diverse magnetic behavior of nanomaterials CO3: Prepare the mechanistic pathway towards facile synthesis of nanomaterials CO4: Apply the various electro-optical phenomenon of the materials and characterize the materials via spectroscopic and microscopic tools. CO5: Evaluate the diverse applications of nanomaterials CO6: Execute the advanced synthetic perspectives along with physical properties and the applications of nanomaterials		
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, CO6
	B	Size & Scale, Units Scaling, Atoms, Molecules,		CO1, CO6
	C	Clusters and Quantum dots		CO1, CO6
	Unit 2	**Properties of nanomaterials**		

	A	Properties and Size dependence of properties	CO2, CO6
	B	Chemical, Optical properties	CO2, CO6
	C	Magnetic Mechanical properties	CO2, CO6
	Unit 3	**Nanomaterial Synthesis**	
	A	Chemical synthesis of metal/metal oxide nanoparticle	CO3, CO6
	B	Bio inspired synthesis of metal/metal oxide nanoparticle	CO3, CO6
	C	Nanocomposite fabrication on polymer matrix	CO3, CO6
	Unit 4	**Nanomaterial characterization techniques**	
	A	Introduction to characterization techniques for nanomaterials	CO4, CO6
	B	Interpretation of SPR band by UV-Vis	CO4, CO6
	C	Functional group identification by FTIR spectrum of nanomaterials	CO4, CO6
	Unit 5	**Applications of nanomaterials**	
	A	Applications in bio-sensing	CO5, CO6
	B	Catalytic applications of nanomaterials	CO5, CO6
	C	Biological/bio-medical applications	CO5, CO6
	Mode of examination	Assignments, Quizzes & Viva	

	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: 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.

CO-PO & CO-PSO mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT3107.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHT3107.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHT3107.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHT3107.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHT3107.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHT3107.06	3	3	3	3	2	2	1	1	1	2	3	3	3

Course Title: Research-Based Learning - 4 (RBL-4)

School: SSES		**Batch 2025-29**		
Programme: Bachelor of Science (Research) Chemistry		**Academic year 2027-2028**		
Branch: Chemistry		Semester: VI		
1	**Course Code**	CHR3102		
2	**Course Title**	Research-Based Learning- 3 (RBL-4)		
3	**Credits**	0		
4	**Contact Hours (L-T-P)**	**0-0-2**		
5	**Course Type**	Compulsory		Project
6	**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.		
7	**Course Outcomes**	**CO1**: Apply experimental methods to solve a given scientific task, **CO2**: Collect data for evaluation and for statistical treatment, if relevant, **CO3**: Show a professional attitude regarding time planning, collaboration, and the link between theoretical and practical knowledge, **CO4**: Reflect upon and discuss the relevance of the work in written and oral form **CO5**: Document results by writing a research report, **CO6:** Show independence, critical and creative thinking		
8	**Outline Syllabus**			CO Mapping
	Unit 1	**Identifying research problem** Selection of 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		CO4, CO6

		forum and also in front of peer's students and friends			
	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	Theory/Jury/Practical/Viva (Assessment will be made based on Rubrics)			
	Weightage Distribution	CA	MSE	ESE	
		30%	30%	40%	
	Text Book/s *	**Suggested Readings:** Research Methodology: Methods and Technique 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			

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CHR3102.1	3	2	2	2	2	1	1	1	2	1	2	2	2
CHR3102.2	1	2	3	3	2	2	3	1	2	1	2	2	2
CHR3102.3	2	2	3	3	2	2	2	1	2	1	2	2	2
CHR3102.4	2	2	2	2	2	2	1	1	2	1	2	2	3
CHR3102.5	2	2	2	2	2	2	2	1	2	1	2	2	3
CHR3102.6	2	2	2	2	2	2	1	2	2	1	2	2	3

Course Title: Industry Connect

School: SSES		**Batch: 2025-29**	
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic Year: 2027-28**	
Branch: Chemistry		Semester: VI	
1	Course Code	INC001	
2	Course Title	Industry Connect	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	Compulsory	
5	Course Objective	This course will expose students to apply theories learned in the classroom and provides current technological developments relevant to the subject area of training. Students will be able to identify the career preferences and professional goals.	
6	Course Outcomes	Students will be able to: CO1: Get familiarize with industry principles and practices. CO2: Identify and analyze an appropriate problem. CO3: Develop teamwork and apply prior acquired knowledge in problem solving. CO4: Demonstrate effective verbal and written communication skills. CO5: Practice scientists' responsibilities, self-understanding, self-discipline and ethical standards. CO6: Identify the career preferences and professional goals.	
7	Course Description	The Internship aims to offer students the opportunity to apply their prior acquired knowledge in problem solving. Students will acquire skills important for time management, discipline, self-learning, and effective communication and so on.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	Define objectives and conditions for the internship, ensuring students that it is related to the study path carried out at the University	
	A, B, C		CO1,CO6
	Unit 2		
	A, B, C	Problem Definition and identification, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any.	CO2,CO6
	Unit 3		
	A, B, C	The internship work plan is drawn up by developing team work and applies prior acquired knowledge in problem solving.	CO3,CO6

	Unit 4				
	A, B, C	Demonstrate and execute Project with the team. Submission of evaluation form and final report completed by the intern.			CO4,CO6
	Unit 5				
	A, B, C	Final evaluation form completed by the supervisor at the Host Organization and final presentation before departmental committee.			CO5,CO6
	Mode of examination	Jury + Practical + Viva			
	Weightage Distribution	CA	MSE	ESE	
		30%	30%	40%	
	Text book/s*	Hygum, E., & Pedersen, P. M. (Eds.). (2010). *Early childhood education: Values and practices in Denmark*. Hans Reitzels Forlag. https://earlychildhoodeducation.digi.hansreitzel.dk/			
	Other References	Kesharwani, P. (Ed.). (2020). *Nanotechnology based approaches for tuberculosis treatment*. Academic Press. Torino, G. C., Rivera, D. P., Capodilupo, C. M., Nadal, K. L., & Sue, D. W. (Eds.). (2019). *Microaggression theory: Influence and implications*. John Wiley & Sons. https://doi.org/10.1002/9781119466642			

CO-PO & CO-PSO mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
INC001.1	3	2	1	2	3	1	1	2	3	1	1	1	1
INC001.2	3	1	1	1	3	1	1	2	3	1	1	1	1
INC001.3	3	2	1	2	3	1	1	2	3	1	1	1	1
INC001.4	3	2	1	2	3	1	1	2	3	1	1	1	1
INC001.5	3	2	1	2	3	1	1	2	3	1	1	1	1
INC001.6	3	1	1	1	3	1	1	1	3	1	1	2	2

Semester-7

Course Title: Advanced Inorganic Chemistry I

School: SSES		**Batch 2025-29**	
Programme: B.Sc. (Hons./Hons. with Research) in Chemistry		**Academic year 2028-2029**	
Branch: Chemistry		**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 bonding and structure of coordination compounds. 2.To explain the spectral and magnetic behaviour of coordination compounds. 3.To provide a thorough knowledge about the chemistry and application of inner transition metals. 4.To discuss about various spectroscopic methods for structure elucidation of inorganic compounds. 5.To explain the basics of radioactivity as well as various radio analytical techniques. 6.To impart knowledge about structure, bonding and application of inorganic compounds and radio chemistry.	
36	Course Outcome	CO1 : Explain the various theories of metal –ligand bonding CO2 : Explain the electronic spectra and magnetic properties of transition metal complexes. CO3 : Interpret the EPR and Mossbauer spectra CO4 : Illustrate the chemistry and uses of inner transition metals CO5 : Know about various radio-analytical techniques CO6 : Gain knowledge about of various aspects of modern inorganic chemistry	
7	Course Description	This course include 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-,	CO1,CO6

		5-and 6-coordinated complexes, d-orbitals splitting in 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, CO6
	B	charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information	CO2, CO6
	C	anomalous magnetic moments, magnetic exchange coupling, temperature independent paramagnetism (TIP) of complexes, spin cross over phenomenon. Effect of temperature on their magnetic properties	CO2, CO6
	Unit 3	Chemistry of Inner Transition Elements	
	A	General discussion on the properties of the f-block elements.	CO3, CO6
	B	Redox, Spectral and Magnetic properties.	CO3,CO6
	C	Use of Lanthanide compounds as shift reagents. Photophysical properties of Lanthanide complexes.	CO3,CO6
	Unit 4	Characterization Techniques	
	A	EPR spectroscopy-basic principle, hyperfine and superhyperfine lines, anisotropy, g values, application in selected inorganic compounds.	CO4,CO6
	B	Mossbauer Spectroscopy-Gamma ray emission and absorption by nuclei, Mossbauer effect — conditions, Doppler effect, instrumentation, chemical shift examples, quadrupole effect,	CO4,CO6
	C	Use of Mössbauer spectra in chemical analysis, typical spectra of iron and tin compounds.Optical rotatory dispersion (ORD) and circular dichroism (CD).	CO4,CO6
	Unit 5	Nuclear Chemistry	
	A	Nuclear structures and nuclear stability. Nuclear models ; radioactivity and nuclear reactions. Detection and measurement of radiation. Tracer techniques.	CO5,CO6
	B	Study of chemical reactions, isotope exchange reactions,	CO5,CO6

		kinetic isotope effect, nuclear activation analyses, Principle of nuclear detection, gas detector, ionization chamber, proportional and G. M. detector.			
	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.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	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.			

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT4101.01	2	2	3	1	1	2	1	2	1	1	2	2	3
CHT4101.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHT4101.03	1	2	3	2	1	1	1	1	1	1	2	3	2
CHT4101.04	1	3	1	3	3	1	1	1	1	1	1	1	1
CHT4101.05	1	3	3	1	1	3	1	1	1	1	1	3	3
CHT4101.06	2	3	3	3	2	2	1	1	1	2	3	1	3

Course Title: Advanced Organic Chemistry I

School: SSES		**Batch 2025-29**
Programme: B.Sc. (Hons./Hons. with Research) in Chemistry		**Academic year 2028-2029**
Branch: Chemistry		**Semester VII**
1	**Course No.**	**CHT4102**
2	**Course Title**	**Advanced Organic Chemistry 1**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**4-0-0**
	Course status	**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 dESErmine their effects on chemical reactivity. Also, evaluate stereochemical factors influencing nucleophilic additions, substitutions, and elimination reactions
6.	Course Outcomes	Upon successful completion of this course, students will be able to CO1: Explain and apply delocalized bonding concepts (resonance, hyperconjugation, and tautomerism) in organic molecules and dESErmine aromaticity in organic compounds using Huckel's rule and modern aromaticity principles. CO2: Predict the reaction mechanism of organic transformations based on kinetic and thermodynamic considerations. CO3: Identify and analyze key reaction intermediates (carbocations, carbanions, free radicals, carbenes, and benzynes) and their reactivity. CO4: Apply stereochemical principles to understand molecular chirality, stereoselectivity, and asymmetric synthesis strategies. CO5: Perform conformational analysis of cyclic systems and predict their

		impact on reaction outcomes, and evaluate the role of neighboring group participation in substitution and elimination reactions. CO6: Gaining expertise in bonding, reaction mechanisms, intermediates, and stereochemistry, enabling them to analyze structures, predict reactivity, and apply concepts in research and industry	
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, hESEroannulene, 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 dESErmination of reaction mechanism methods**: DESEction 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,	CO3, CO6

		Demjonove rearrangement, and Pinacol-pinacolone rearrangement	
	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, 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; dESErmination 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: 25% / MSE: 25% / ESE: 50%	
	Text Book	Organic Chemistry, R. T. Morrison and R. N. Boyd, (1992) 6th Edition, Prentice-Hall. Reaction Mechanism in Organic Chemistry, (1976) 1st Edition, S. M. Mukherji and S. P. Singh, Macmillan. Stereochemistry, P. S. Kalsi, (1994), 2nd Edition, New Age International.	
	Other references	Advanced Organic Chemistry Reactions: Mechanism and Structure, Jerry March, (1992) 4th Edition, John Wiley.	

		Stereochemistry of Organic Compounds by ELudwig Eleil, Samual H. Wilen, (1995) T.M.H Edition, Tata McGraw-Hill Publishing Company. Stereochemistry of Organic Compounds: Principles and Applications by D. Nasipuri, (1994) 2nd Edition, New Age International Publishers.

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT4102.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHT4102.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHT4102.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHT4102.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHT4102.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHT4102.06	3	3	3	3	2	2	1	1	1	2	3	3	3

CHT4103 Advanced Physical Chemistry I

School: SSES		**Batch: 2025-29**
Programme: B.Sc. (Hons./Hons. with Research) in Chemistry		**Academic year 2028-2029**
Branch: Chemistry		**Semester: VII**
1	**Course Code**	**CHT4103**
2	**Course Title**	**Advanced Physical Chemistry I**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**4-0-0**
	Course Status	**Core**
5	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
6	Course Outcomes	CO1: Understand the detailed concept of liquid and gaseous state and the structural features of solid state material by having complESE knowledge of X-ray diffraction and its analysis. CO2: Understand the application of second law of thermodynamics and the concept of third law of thermodynamics. CO3: Familiarize with the applications of partition function and statistics in understanding the thermodynamics of molecules. CO4: Understand the concept of electrical double layer at the electrode electrolyte interface by studying different proposed models of it. CO5: Understand the detailed concepts of kinetics and its applications, Influence of physical and chemical paramESErs on reaction rates in solutions

		CO6: Do the in-depth analysis of various phenomenon and laws of States of Matter, applications of Thermodynamics, Electrochemistry and Chemical Kinetics and different functions of statistical thermodynamics.	
7	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.	
8	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,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,	CO1,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.	CO1,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,	CO2,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, dESErmination of partial molar volume,	CO2,CO6
	C	thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), third law of thermodynamics, residual entropy, meaning and scope of irreversible thermodynamics.	CO2,CO6
	Unit 3	**Statistical Thermodynamics**	
	A	Concept of distribution, Thermodynamic probability and most probable distribution. Ensembles, Canonical, grand canonical and microcanonical ensembles.	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.	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 undESErmined 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,CO6
	Unit 5	**Chemical Kinetics**	
	A	Simple collision theory of reaction rates, Arrhenius equation and activated complex theory (ACT), thermodynamic treatment, chain reactions (hydrogen-halogen reactions) decomposition of N_2O_5	CO5,CO6
	B	Theory of unimolecular reactions: Lindemann – Hinshelwood mechanism of unimolecular reactions, RRKM and Slater treatment,	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: 25% / MSE: 25% / ESE: 50%	
	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	

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT4103.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHT4103.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHT4103.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHT4103.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHT4103.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHT4103.06	3	3	3	3	2	2	1	1	1	2	3	3	3

Course Title: CHT4104 Advanced Analytical Chemistry I

School: SSES		**Batch: 2025-29**
Programme: B.Sc. (Hons./Hons. with Research) in Chemistry		**Academic year 2028-2029**
Branch: Chemistry		**Semester: VII**
1	**Course Code**	**CHT4104**
2	**Course Title**	**Analytical Chemistry I**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**3-1-0**
	Course Status	**Core**
5	Course Objective	1.Provide and enrich the students to analytical techniques, various types of errors knowingly/ unknowingly introduced, accuracy and confidence limit in analytical process. 2.Provide detailed insight of chemical equilibrium and its effect in chemical analysis of analyte. 3.Provide detailed technical knowledge of various chromatogaraphic 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 temperature dependent decomposition process and structural elucidation of unknown analyte. CO6:Estimate the temperature dependent weight loss in compound and model and optimize suitable temperature condition for further chemical processing.
6	Course Outcomes	CO1: Apply the knowledge of analytical techniques to minimize the error and report the outcomes of analysis with high precision and accuracy, CO2: Understand the role of different analytical techniques used for the separation of compounds present in very small quantity, CO3:Understand the role of chemical equilibrium in chemical analysis, CO4: Segregate and select the suitable indicator for measurement of pH, CO5: Purify the various compounds for their further detailed structural elucidation and molecular mass analysis, CO6. To learn analytical tools involving Chromatographic methods and thermo-analytical instruments of a lab for the identification of equilibrium process.
7	Course	Analytical chemistry I emphasizes on various factors as - types of errors,

	Description	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 acid and weak base, 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 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 terphthalate, DSC curve for isothermal crystallization of polyethylene, DSC of phenacetein), thermometric titrations, Evolved gas analysis.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	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.			

CO-PO & CO-PSO Mapping

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT4104.01	3	3	2	3	2	2	1	1	1	1	2	3	2
CHT4104.02	3	2	1	1	1	3	1	1	1	1	2	2	3
CHT4104.03	3	2	2	1	3	3	1	1	2	2	2	3	3
CHT4104.04	3	3	1	1	1	2	2	1	1	1	2	2	3
CHT4104.05	3	3	2	2	1	1	1	1	1	1	2	2	3
CHT4104.06	3	2	1	1	2	3	2	1	1	1	3	3	3

Course Title: Advanced Inorganic Chemistry Lab I

School: SSES		**Batch: 2025-29**	
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2028-2029**	
Branch: Chemistry		**Semester: VII**	
1	**Course Code**	**CHP4101**	
2	**Course Title**	**Advanced Inorganic Chemistry Lab I**	
3	**Credits**	**1**	
4	**Contact Hours (L-T-P)**	**0-0-2**	
	Course Status	**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 separation of cations. • To learn the preparation of a given inorganic complex. • To analyze the prepared complexes with spectroscopic methods.	
6	Course Outcomes	After finishing the course the students will be able to CO1: Understand the technique of analysis of cations and anions in a given mixture. CO2: Identify and perform the confirmatory tests on the cations. CO3: Design the plan to identify the cations and anions in a given mixture. CO4: Able to estimate the elements in a given mixture by gravimetric / volumetric methods. CO5: Apply the techniques and theory behind gravimESEric and volumetric methods. CO6: Prepare and analyse the inorganic complexes by spectrophotometric techniques	
7	Course Description	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 gravimESEric, volumetric methods and will also learn to synthesize and analyse the inorganic complexes by spectrophotometric techniques.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on Quantitative analysis**	
	A **B** **C**	Quantitative analysis of anions : : Arsenide, Arsenate, Borate, Bromide, Carbonate Chloride, Chromate, Fluoride, Iodide, Nitrate, Oxalate, Phosphite, Phosphate, Sulphate	CO1, CO6

	Unit 2	**Practical related to Quantitative analysis gravimetrically**	
	A **B** **C**	Quantitative analysis of:Cation : Aluminium, Ammonium, Antimony,Arsenic,Barium, Bismuth, Cadmium,Calsium, Cadmium, Quantitative analysis of:Cation : Copper,Cobalt, Ferric,Ferrous,,LeadMagnisium,Manganese,Lead, Mercury,Nickel,Strontium,Tin,Zinc,Silver, Quantitative analysis of:Cation : Molybdenum, Vanadium, Chromium, Selenium, Telurium, Cerium,	CO2, CO6
	Unit 3	**Practical related to Quantitative analysis gravimetrically**	
	A B	Quantitative analysis of copper and Nickel gravimetrically Quantitative analysis of Copper and Zinc gravimetrically	CO3, CO6
	Unit 4	**Practical related to volumetric estimation**	
	A	Quantitative analysis of aluminium volumetrically	CO4, CO6
	Unit 5	**Practical related to Synthesis and characterization of Complexes**	
	A **B** **C**	Synthesis and characterization of $[Ni(NH_3)_6Cl_2]$ Synthesis and characterization of $K[Cr(C_2O_4)_2(H_2O)_2]$ Synthesis and characterization of $[Cr(en)_3]Cl_3$	CO5, CO6
	Mode of Examination	Practical/Viva	
	Weightage Distribution	CA: 60% / ESE: 40%	
	Text book/s*	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.	
	Other References	NA	

CO-PO & CO-PSO Mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CHP4101.1	3	2	2	2	2	1	1	1	2	1	2	2	2
CHP4101.2	1	2	3	3	2	2	3	1	2	1	2	2	2
CHP4101.3	2	2	3	3	2	2	2	1	2	1	2	2	2
CHP4101.4	2	2	2	2	2	2	1	1	2	1	2	2	3
CHP4101.5	2	2	2	2	2	2	2	1	2	1	2	2	3
CHP4101.6	2	2	2	2	2	2	1	2	2	1	2	2	3

Course Title: Advanced Organic Chemistry Lab I

School: SSES		**Batch: 2025-29**
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2028-2029**
Branch: Chemistry		**Semester: VII**
1	**Course Code**	**CHP4102**
2	**Course Title**	**Advanced Organic Chemistry Lab I**
3	**Credits**	**1**
4	**Contact Hours (L-T-P)**	**0-0-2**
	Course Status	**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	By the end of this course, students will be able to CO1: Analyze and identify organic compounds in binary mixtures using systematic qualitative methods. CO2: Measure and interpret the specific rotation of optically active compounds. CO3: Estimate and quantify organic compounds like aniline using suitable techniques. CO4: Synthesize, purify, and characterize organic molecules efficiently. CO5: Apply chromatographic methods for compound separation and analysis.
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 measurement of 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 Inversion of sucrose	CO2, CO6
	C	To determine the kinetics of Inversion of sucrose	CO2, CO6
	Unit 3	**Practical related to 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 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: 60%	ESE: 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.

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHR4101.01	2	2	3	1	1	2	1	2	1	1	2	2	3
CHR4101.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHR4101.03	1	2	3	2	1	1	1	1	1	1	2	3	2
CHR4101.04	1	3	1	3	3	1	1	1	1	1	1	1	1
CHR4101.05	1	3	3	1	1	3	1	1	1	1	1	3	3
CHR4101.06	2	3	3	3	2	2	1	1	1	2	3	1	3

Course Title: Advanced Physical Chemistry Lab I

School: SSES		**Batch:2025-29**	
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2028-2029**	
Branch: Chemistry		**Semester: VII**	
1	**Course number**	**CHP4103**	
2	**Course Title**	**Advanced Physical Chemistry Lab I**	
3	**Credits**	**1**	
4	**Contact Hours (L-T-P)**	**0-0-2**	
5	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.	
6	Course Outcomes	Students will be able to - 1. To imply various types of titrations for quantitative analysis. 2. Construct the phase change behaviour in graphical form. 3. To carry out conductometric and potentiometric titrations. 4. To find the acidity strength accurately. 5. Utilize computational tools for solving chemical problems. 6. To imply titrations, Calorimetry, computational and phase change phenomena towards appropriate quantitative and qualitative assessment of the physical process.	
7	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 NaOH and HCl mixture by Bomb Calorimetry.	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) pH meter and (b) 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 determine 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	ESE
		60%	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.	

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP4103.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHP4103.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHP4103.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHP4103.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHP4103.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHP4103.06	3	3	3	3	2	2	1	1	1	2	3	3	3

Course Title: Advanced Quantum Mechanics

School: SSES		**Batch:2025-29**		
Programme: B.Sc. (Hons./Hons. with Research) in Chemistry		**Academic year 2028-2029**		
Branch: Computational Chemistry		**Semester: VII**		
1	**Course Code**	CHT4301		
2	**Course Title**	**Advanced Quantum Mechanics**		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	4-0-0		
5	**Course Type**	Compulsory	Major	Theory
6	**Course Objective**	The objectives of the course are 1. To provide detailed knowledge of mathematical operations used in quantum chemistry. 2. To provide the concept of time-dependent Schrödinger equation 3. To elaborate the concept of quantum mechanical tunneling 4. To provide the concept of electronic spin and its salient features. 5. To introduce the concept of Laser spectroscopy. 6.To familiarize the important concepts of advance quantum mechanics.		
7	**Course Outcomes**	**Course Outcomes** The student will be able to CO1: Develop the knowledge of mathematical functions and operations in quantum chemistry. CO2: Know the detailed concept of the time-dependent Schrödinger equation. CO3: Understand the concept of Quantum Mechanical Tunneling. CO4: Get an idea about electronic spin and its related properties. CO5: Know the concept of Laser spectroscopy. CO6: Develop deep knowledge and application of advanced quantum mechanics		
8	**Course Description**	This is a specialization course for students of computational chemistry. The objective of this course is to make the students understand the advance quantum mechanics. Quantum mechanics is one of the base courses of computational chemistry programme. This course will review the various theories/approximations necessary to understand most popular framework of quantum mechanics.		
9	**Outline Syllabus**			CO Mapping
	Unit 1	**Mathematics for quantum chemistry**		
	A	Functions: Definition, Representation, Classification, Polynomials,		**CO1,**

		Implicit functions.			**CO6**
	B	Operators: Definition, Algebra of operators, Classification, Projection operators, properties of operators			**CO1, CO6**
	C	Vectors: Vector spaces, dimension, types of vector spaces			**CO1, CO6**
	Unit 2	**Time-dependent Schrödinger equation:**			
	A	Introduction, Time-dependent Schrödinger equation			**CO2, CO6**
	B	Hamiltonian operator, Ehrenfest theorem			**CO2, CO6**
	C	Schrödinger and Heisenberg pictures			**CO2, CO6**
	Unit 3	**Particles in Potential Wells and Tunneling**			
	A	Electrons in finite linear space, Schrödinger equation for deep rectangular well, Solution of Schrödinger equation inside well,			**CO3, CO6**
	B	Wave pattern inside rectangular well, finite potential well			**CO3, CO6**
	C	Tunneling through a potential barrier, Scanning tunneling microscope, quantum dot			**CO3, CO6**
	Unit 4	**Electronic Spin and Related Phenomena**			
	A	Introducing spin as intrinsic angular momentum, spin operators and Pauli spin matrices, spin orbit coupling			**CO4, CO6**
	B	Zeeman Effect, Relativistic energy and spin-orbit coupling effects			**CO4, CO6**
	C	singlet and triplet excitations, Clebsch-Gordan coefficients, angular momentum states of 2p electrons.			**CO4, CO6**
	Unit 5	**Lasers and Laser Spectroscopy**			
	A	Definition of Laser, Principles of laser action			**CO5, CO6**
	B	pulsed lasers, examples of lasers: He-Ne, Nd-YAG, dye lasers.			**CO5, CO6**
	C	Application of lasers			**CO5, C**
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	Text Book/s *	1. Jordan, T. F. (2007). *Quantum mechanics in simple matrix forms* (Illustrated ed.). Dover Publications.			
	Other References	Jackson, J. D. (1986). *Mathematics for quantum mechanics*. Dover Publications.			

		Jordan, T. F. (2007). *Linear operators for quantum mechanics* (Illustrated ed.). Dover Publications.

CO-PO & CO-PSO mapping

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHE4301.1	3	2	1	2	2	2	1	1	2	3	2	2	2
CHE4301.2	2	2	1	2	2	1	1	1	2	3	2	2	2
CHE4301.3	3	2	1	2	2	1	1	1	2	3	2	2	2
CHE4301.4	3	2	1	2	2	1	1	1	2	3	2	2	3
CHE4301.5	3	2	1	2	2	1	1	1	2	3	2	2	3
CHE4301.6	3	2	1	2	2	1	1	1	2	3	2	3	3

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

Semester-8

Course Title: Advanced Inorganic Chemistry II

School: SSES		**Batch: 2025-29**
Programme: B.Sc. (Hons./Hons. with Research) in Chemistry**.**		**Academic year 2028-2029**
Branch: Chemistry		**Semester: VIII**
1	**Course Code**	**CHT4105**
2	**Course Title**	**Advanced Inorganic Chemistry II**
3	**Credits**	**3**
4	**Contact Hours (L-T-P)**	**3-0-0**
	Course Status	**Core**
5	Course Objective	1.To introduce the basics concept of molecular symmetry and group theory 2.To demonstrate the various application of group theory in spectroscopy 3.To provide an introduction to basic concepts of organometallic chemistry 4.To explain to the student the various application of organometallic chemistry in industry 5.To provide information various industrially important organometallic compounds. 6.To provide structure, bonding and reactivity of transition metal carbonyls, nitrosyls and phosphin complexes.
6	Course Outcomes	CO1:Understand the various basics concept of molecular symmetry and group theory. CO2:Apply their knowledge of group theory to understand the principles of spectroscopy. CO3:Know the basic concepts of organometallic chemistry and its application in industry. CO4: Explain the structure and reactivity of transition metal alkyl, aryl, alkene, alkynes, allyls, dienyl and arene and carbine complexes. CO5: Gain insight about transition metal carbonyls, nitrosyls and phosphin complexes. CO6: Gain knowledge about advanced topics like 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 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 general rules, Derivation of matrices for rotation; reflection; rotation; reflection and inversion operations;	CO1,CO6
	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,CO6
	C	Defining properties of 'group'; Types of groups, Subgroups; reducible and irreducible representations	CO1,CO6
	Unit 2	Application of Group Theory	
	A	Construction of character table for C_{2v} and C_{3v} point group	CO2,CO6
	B	Optical activity and dipole moment	CO2,CO6
	C	Application of group theory to electronic and vibrational spectroscopy	CO2,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.	CO3,CO6
	B	Synthesis, structure and bonding of organolithium compounds	CO3,CO6
	C	Organometallic reagents in homogeneous catalytic reactions (Hydrogenation, hydroformylation, isomerisation, polymerisation).	CO3,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.	CO4,CO6
	B	Structure and bonding of metallocenes.	CO4,CO6
	C	Synthesis, structure and reactivity of metal carbene and carbynes	CO4,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.	CO5,CO6
	B	Ligand behavior of NO (NO^+, NO^- and bridging NO), preparation, structures, bonding of nitrosyls of Cr, Fe and Ru	CO5,CO6
	C	Preparation, structure, bonding and reactivity of metal	CO5,CO6

		phosphines. Comparison of phosphine and carbonyl ligands in terms of bonding.		
	Mode of examination	Theory		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	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.		

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT4105.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHT4105.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHT4105.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHT4105.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHT4105.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHT4104.06	3	3	3	3	2	2	1	1	1	2	3	3	3

Course Title: Advanced Organic Chemistry II

School: SSES		**Batch: 2025-29**
Programme B.Sc. (Hons./Hons. with Research) in Chemistry**.**		**Academic year 2028-2029**
Branch: Chemistry		**Semester: VIII**
1	**Course No.**	**CHT4106**
2	**Course Title**	**Advanced Organic Chemistry II**
3	**Credits**	**3**
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Core
5	Course Objective	This course aims to: 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. Develop the critical thinking to analyze the conditions required for C=C bond formation Introduce metal-catalyzed carbon- carbon bond formation techniques and their applications. Examine oxidation and reduction reactions, including stereochemical aspects and selectivity. Analyze key name reactions and molecular rearrangements in organic synthesis
6	Course Outcomes	By the end of the course, students will be able to: CO1. Utilize enolates, enamines, and organometallic reagents and metal-catalyzed coupling reactions for C- C bond formation. CO2. Differentiate between elimination strategies for double bond formation and apply them effectively. CO3. Implement oxidation techniques in organic synthesis with a focus on selectivity. CO4. Understand the functional mode of various reducing reagents. CO5. Understand and predict the mechanisms of key organic name reactions and rearrangements. CO6. Design synthetic routes using advanced organic transformations for target molecules
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, CO6
	C	**Metal-catalyzed C-C bond formations:** Negishi, Heck, Suzuki, and Sonogashira	CO1, CO6
	Unit 2	**Double bond (C=C) formations**	
	A	**Elimination reactions:** Hoffmann vs. Satyzev's rule, Cope elimination, Phospohorus, nitrogen and sulfur ylids, Wittig reaction, Wittig-Horner reaction	CO2, CO6
	B	Tebbe olefination, Julia olefination, Mannich reaction, Robinson annulation, PESErson olefination, McMurry reaction, Shapiro reaction, selenoxide elimination	CO2, CO6
	C	**Olefin metathesis:** Schrock and Grubb catalyst, ring closing metathesis, enyne metathesis, Thorpe reaction	CO2, 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, CO6
	Unit 4	**Reduction**	
	A	**Catalytic reduction** (Pt, Pd, Ni), Dissolving metal reductions (alkali metals in Liq. NH_3 and Zn, Sn),	CO4, CO6
	B	**Reduction by hydride transfer reagents** (Complex hydrides of Li and Na); Steroeselectivity 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	MSE	ESE	
		25%	25%	50%	
	Text Book/s*	Organic Reactions and Mechanisms, P.S. Kalsi, (2002) 2nd Edition, New Age International Publishers. Organic Chemistry, R. T. Morrison and R. N. Boyd, (1992) 6th Edition, Prentice-Hall. Reaction Mechanism in Organic Chemistry, (1976) 1st Edition, S. M. Mukherji and S. P. Singh, Macmillan.			
	Other references	Advanced Organic Chemistry Reactions: Mechanism and Structure, Jerry March, (1992) 4th Edition, John Wiley. Organic Chemistry, Francis A. Carey, (1996) 3rd Edition, The McGraw-Hill Companies, Inc. Modern Methods of Organic Synthesis South Asia Edition W. Carruthers, Iain Coldham, (2004) 4th Edition, Cambridge University Press Principles of Organic Synthesis, R.O.C. Norman, (1978) 2nd Edition, Chapman and Hall			

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT4106.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHT4106.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHT4106.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHT4106.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHT4106.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHT4106.06	3	3	3	3	2	2	1	1	1	2	3	3	3

Course Title: Advanced Physical Chemistry II

School: SSES		**Batch: 2025-29**
Programme: B.Sc. (Hons./Hons. with Research) in Chemistry**.**		**Academic year 2028-2029**
Branch: Chemistry		**Semester: VIII**
1	**Course Code**	**CHT4107**
2	**Course Title**	**Advanced Physical Chemistry II**
3	**Credits**	**3**
4	**Contact Hours (L-T-P)**	**3-0-0**
	Course Status	**Core**
5	Course Objective	1. To familiarise students with theoretical and mathematical aspects of quantised energy levels of particle in box, 2. To introduce the theoretical concept of Hydrogen atom and hydrogen molecule and 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 phenomenon's 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:The concepts of quantum mechanics and its mathematical interpretation for atoms and molecules possessing single electron. CO2:The results and their analysis obtained on the basis of MOT and VBT for hydrogen atom, molecule and ion. CO3:The nomenclature of particles on the basis of particle size and different theories and results related to stability of colloids. CO4:The concept of surface tension, micellization and solubilisation. CO5: The concept of existence of different phases with change in different variables by visualizing the phase diagrams CO6: The concept of quantum mechanics, their application to MOT and VBT, how to draw phase diagrams and importance of colloids and surface chemistry in daily life, their concepts, phenomenon and mathematical equations.
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,CO6
	B	The wave equation, Particle in one dimensional box, particle in three-dimensional box, Degeneracy.	CO1,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.	CO1,CO6
	Unit 2	Chemical Bonding	
	A	Born Oppenheimer Approximation, The variation method, Ground state energy of the hydrogen atom,	CO2,CO6
	B	Huckel molecular orbital theory of conjugated systems, Secular equations, delocalisation energy,	CO2,CO6
	C	MOT and Valence bond theory- Hydrogen molecule.	CO2,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,CO6
	C	DLVO theory and stability of colloids. Smoluchowski theory of kinetics of coagulation and distribution of colloids aggregates.	CO3,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,CO6
	C	Micelles-Surface active agents, micellization, hydrophobic interaction, critical micellar concentration (cmc), factors affecting cmc of surfactants, micro emulsions, reverse micelles.	CO4,CO6
	Unit 5	Phase Equilibria	
	A	Statement and meaning of the terms in Gibbs phase rule; phase equilibria of water, Helium and Carbon systems;	CO5,CO6
	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	MSE	ESE
		25%	25%	50%
	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.		

CO-PO & CO-PSO Mapping

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT4107.01	3	3	2	3	2	2	1	1	1	1	2	3	2
CHT4107.02	3	2	1	1	1	3	1	1	1	1	2	2	3
CHT4107.03	3	2	2	1	3	3	1	1	2	2	2	3	3
CHT4107.04	3	3	1	1	1	2	2	1	1	1	2	2	3
CHT4107.05	3	3	2	2	1	1	1	1	1	1	2	2	3
CHT4107.06	3	2	1	1	2	3	2	1	1	1	3	3	3

Course Title: CHP4105 Advanced Inorganic Chemistry Lab II

School: SSES		**Batch:2025-29**	
Programme: Bachelor of Science (Research) Chemistry		**Academic year 2028-2029**	
Branch: Chemistry		**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	Compulsory	
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	After doing this course the student should be able to CO1: Prepare solutions of different strength and standardize them CO2: Estimate elements gravimetrically CO3: Analyse various elements using redox titrations CO4: Estimate one metal ion in a mixture CO5: Understand the Job's method CO6: Analyse given compound spectrochemically and using different volumetric methods.	
7	Course Description	The course aims to appraise the students to learn basic methods of titration and characterization of given material. It will enable students to analyse various materials like steel and alloys.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on gravimetric analysis**	
	A B C	Ba as $BaSO_4$ Fe as Fe_2O_3 Al as Al_2O_3	CO1, CO2, CO6
	Unit 2	**Practical related to redox titration**	
	A B C	Estimation of antimony in tatrtar-emetic iodometrically. Estimation of arsenite in tatrtar-emetic iodometrically Estimation of copper as CuSCN.	CO3, CO6
	Unit 3	**Practical related to masking in solution phase**	
		Determination of Cr and Fe in a mixture	CO4, CO6
	Unit 4	**Practical related to Applications of jobs method**	

		Calculate the composition of a metal complex using Job's method	CO5, CO6
	Unit 5	**Practical based to synthesis and characterization of metal complexes.**	
	A **B** **C**	Synthesis and characterization of $[Cu(I)(PPh_3)_3(NO_3)]$ Synthesis and characterization of $Mn(acac)_3$ Synthesis and characterization of Linkage isomers: $[Co(NH_3)_5(NO_2)]^{2+}$ and $[Co(NH_3)_5(ONO)]^{2+}$	CO6 CO6 CO6
	Mode of examination	Practical/Viva	
	Weightage Distribution	CA: 60%	ESE: 40%
	Text book/s*	1. O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co. 2. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Ahluwalia, V.K., Aggarwal, R**.** (2004), University Press 3. Practical Inorganic Chemistry: Volume–I, Pasricha, S., Chaudhary, A. (2021), I K International Publishing house Pvt. Ltd, New Delhi	
	Other References	Practical Inorganic Chemistry, Mann, F.G., Saunders, B.C. (2009), Pearson Education.	

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP4105.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHP4105.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHP4105.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHP4105.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHP4105.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHP4104.06	3	3	3	3	2	2	1	1	1	2	3	3	3

Course Title: Advanced Organic Chemistry Lab II

School: SSES		**Batch: 2025-2029**
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry		**Academic year 2028-2029**
Branch: Chemistry		**Semester: VIII**
1	**Course Code**	**CHP4106**
2	**Course Title**	**Advanced Organic Chemistry Lab II**
3	**Credits**	**1**
4	**Contact Hours (L-T-P)**	**0-0-2**
	Course Status	**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	Upon completing this course, students will be able to CO1: Understand the methods of separation of solid organic compounds on the basis of their solubility difference. CO2: Systematically analyze and identify components in binary organic mixtures. CO3: Synthesize specific organic compounds using standard laboratory procedures. CO4: Utilize spectroscopic methods (UV, IR) for the characterization of synthesized compounds. CO5: Apply chromatographic techniques for the separation and purification of organic compounds. CO6: Develop proficiency in handling laboratory equipment and maintaining scientific documentation.
7	Course	This course provides an in-depth exploration of qualitative and synthetic

	Description	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, 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	**Qualitative analysis of organic compounds-II**	
	A	To analyze the mixture of two components (Mixture 4)	CO2, CO6
	B	To analyze the mixture of two components. (Mixture 5)	CO2, CO6
	C	To analyze the mixture of two components. (Mixture 6)	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 orange using aniline. 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: 60%	ESE: 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.

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP4106.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHP4106.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHP4106.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHP4106.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHP4106.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHP4106.06	3	3	3	3	2	2	1	1	1	2	3	3	3

Course Title: Advanced Physical Chemistry Lab II

School: SSES		**Batch: 2025-29**
Programme: B.Sc. (Hons. /Hons. with Research) in Chemistry**.**		**Academic year 2028-2029**
Branch: Chemistry		**Semester: VIII**
1	**Course Code**	**CHP4107**
2	**Course Title**	**Physical Chemistry Lab II**
3	**Credits**	**1**
4	**Contact Hours (L-T-P)**	**0-0-2**
	Course Status	**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 **Physical Chemistry II Lab** 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	1. Students will be able to understand the phenomenon of adsorption and how to determine the concentration of a solution after adsorption. 2. The student will learn to use instruments like conductometers, potentiometers, UV/V spectrophotometers, and Polarimeters to determine the composition, strength, and dissociation constants of different chemicals/solutions. 3. Students will understand the concept of thermometric titrations. 4. Students will be able to determine atomic parameters using computational studies. 5. Students will be able to understand solubility, solubility product, and CMC and how to determine them practically. 6. The student will be able to understand the practical difference between the double alkali method and the salt line method.
7	Course Description	The **M.Sc. Physical Chemistry II Lab** provides hands-on training in essential analytical instruments, including **spectrophotometers, conductometer's, polarimeter's, 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 parameter's**. 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 Conductometers and Potentiometers**			
	A& B	To estimate the normality of oxalic acid in given solutions conductometrically (a) Solution of pure oxalic acid (b) Solution having HCl and oxalic acid The solution having acetic acid and oxalic acid			**CO2**
	C	To find out the composition of Zinc ferrocyanide precipitate on adding $ZnSO_4$ potentiometrically.			**CO2**
	Unit 2	**Practical based on Adsorption and Thermometric Titration**			
	A& B	To verify the Freundlich and Langmuir adsorption isotherms by studying the adsorption of oxalic acid/acetic acid on activated charcoal.			**CO1**
	C	To determine the concentration of strong acid by thermometric titration and use it to calculate the enthalpy of neutralization.			**CO3**
	Unit 3	**Practical based on Solubility product and CMC**			
	A & B	Find the solubility and solubility product of the sparingly soluble salt in water.			**CO5**
	C	Find the CMC of a given surfactant and, hence, calculate Δt Gmix of the surfactant.			**CO5**
	Unit 4	**Practical based on Polarimeters and Spectrophotometers**			
	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.			**CO2**
	B & C	To determine the concentration of $KMnO_4$ solution after adsorption using UV/Visible spectrophotometers.			**CO2**
	Unit 5	**Computational Modeling, Salt line and Double Alkali Method**			
	A	To calculate the atomic parameter's using density function calculations and molecular simulations.			**CO4**
	B & C	Titrate using conductometers a moderately strong acid (salicylic/mandelic acid) by the (a) salt-line method (b) double alkali method.			**CO6**
	Mode of examination	Practical and/or Viva			
	Weightage Distribution	CA	CE	ESE	
		25%	25%	50%	

	Text book/s			
	Other References	Practical Physical Chemistry by B. D. Khosla, R. Chand and Co., New Delhi		

CO-PO & CO-PSO Mapping

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHP4107.01	3	2	3	1	1	1	1	1	1	1	2	3	3
CHP4107.02	3	3	1	1	1	1	1	1	1	1	1	2	3
CHP4107.03	3	2	3	2	1	1	1	1	1	1	1	3	3
CHP4107.04	3	3	1	3	3	1	1	1	1	1	1	3	3
CHP4107.05	2	3	3	1	1	3	1	1	1	1	1	3	3
CHP4107.06	3	3	3	3	2	2	1	1	1	2	3	3	3

Course Title: Science and Technology of Nanomaterials

School:SSES		**Batch:2025-29**
Programme: B.Sc. (Hons./Hons. with Research) in Chemistry		
Branch:Chemistry		**Semester: VIII**
1	**Course Code**	**CHT4109**
2	**Course Title**	**Science and Technology of Nanomaterials**
3	Credits	4
4	Contact Hours (L-T-P)	3-1-0
	Course Status	Elective
5	Course Objective	1.Teach the advanced methods towards the synthesis of functional materials. 2.Teach the advanced methods towards the synthesis of high-quality thin films. 3.Teach the mechanical and magnetic behaviour of functional materials.

		4.Teach the basics and phenomenon associated with the electrical and optical behavior. 5.Teach modern spectroscopic and microscopic methods towards the characterization of functional materials. 6. To understand the novel materials from synthetic, analysis and application perspectives.	
6	Course Outcomes	CO1:Formulate the synthetic methods towards preparation of novel materials. CO2:Prepare the mechanistic pathway towards facile synthesis of thin films. CO3:Understand the diverse magnetic behaviour of materials CO4:Understand the various electro-optical phenomenon of the materials. CO5:Characterize the materials via spectroscopic and microscopic tools. CO6:Understand the advanced synthetic perspectives along with physical properties and the concept of Auger and X-ray Photoelectron Spectroscopy.	
7	Course Description	The elective course on Chemistry of Materials aims to teach the modern and advanced methods of synthesis, characterization and properties of novel materials.	
8	Outline syllabus		CO Mapping
	Unit 1	**Synthesis Methods: Physicochemical Techniques**	
	A	Preparation of materials by Ball milling, Attrition and Vibration milling, Cluster compounds, Preparation of nano particles, Preparation of nanostructured polymers/Conducting polymers, composites.	CO1,CO6
	B	Chemical precipitation and co-precipitation, Wet chemical methods, Metal crystals by reduction, Sol-gel synthesis	CO1,CO6
	C	Microemulsions or reverse micelles, Hydrothermal & Solvothermal synthesis, Thermolysis routes, Microwave heating synthesis, Electrochemical synthesis.	CO1,CO6
	Unit 2	**Synthesis Methods: Deposition Techniques**	
	A	Physical Vapor Deposition; mass evaporation rate; evaporators, e-beam, reactive evaporation, ion beam assisted deposition, Sputtering techniques	CO2,CO6
	B	Chemical Vapor Deposition - reaction chemistry and thermodynamics of CVD	CO2,CO6
	C	Thermal CVD, laser & plasma enhanced CVD, Pyrolytic synthesis.	CO2,CO6
	Unit 3	**Unit 3: Properties: Mechanical and Magnetic**	
	A	**S**tress Strain diagram for different engineering materials, Ductile and brittle material, Tensile strength, Hardness, Impact strength	CO3,CO6
	B	Fracture (Types and Ductile to brittle transition), Fatigue,	CO3,CO6

		Creep, Factors affecting mechanical properties			
	C	Classification of magnetic materials, Diamagnetism, Paramagnetism, Langevin theory of dia- and paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Structure of Ferrite.			CO3,CO6
	Unit 4	**Properties: Electrical and Optical**			
	A	Dielectric Materials: Basic concepts: complex permittivity, dielectric loss factor, polarization, mechanism of polarization, classification of dielectrics-frequency dependence of dielectric constant			CO4,CO6
	B	Ferroelectricity, Piezoelectricity, pyro-electric states, transition temperature, polarization catastrophe, antiferroelectricity, ferro electric domains.			CO4,CO6
	C	Optical Properties: Refractive index and dispersion, Transmission, Reflection and absorption of light, Optical material for UV and IR, Optical anisotropic, Non-linear optical crystals, Photoluminescence			CO4,CO6
	Unit 5	**Structural Analysis**			
	A	UV-visible, FT-IR, Raman and Atomic absorption spectroscopy; X-ray diffraction			CO5,CO6
	B	Glancing angle and wide angle, Debye-Scherer formula, Dislocation density, Micro strain			CO5,CO6
	C	AUGER Spectroscopy and X-ray photoelectron spectroscopy (XPS)			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	Text book/s*	1.Characterization of materials (Vol. 1 and 2) by E.N. Kaufmann, John Wiley and Sons. 2.Structure and Properties of Materials', Volume III,by R. M., Rose Shepard L. A., Wulff J.,4th Edition, John Wiley, 1984			
	Other References	1.Pradeep T., "NANO the Essential, understanding Nanoscience and Nanotechnology". TataMcGraw-Hill Publishing Company Limited, 2007. 2.Charles P. Poole Jr. "Introduction to Nanotechnology", John Willey & Sons, 2003			

CO-PO & CO-PSO Mapping

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CHT4109.01	3	3	2	3	2	2	1	1	1	1	2	3	2
CHT4109.02	3	2	1	1	1	3	1	1	1	1	2	2	3
CHT4109.03	3	2	2	1	3	3	1	1	2	2	2	3	3
CHT4109.04	3	3	1	1	1	2	2	1	1	1	2	2	3
CHT4109.05	3	3	2	2	1	1	1	1	1	1	2	2	3
CHT4109.06	3	2	1	1	2	3	2	1	1	1	3	3	3

Course Title: Medical Lab Techniques

SSES		**Batch: 2025-29**		
Programme: Programme B.Sc. (Hons./Hons. with Research) in Chemistry		**Academic year 2028-2029**		
Branch: Biochemistry		**Semester: VIII**		
1	**Course Code**	**VOB 151**		
2	**Course Title**	**Medical Lab Techniques**		
3	**Credits**	4		
4	**Contact Hours(L-T-P)**	0-0-8		
5	**Course Type**	Compulsory	Vocational	Practical
6	**Course Objective**	1. To undergo training in all fields of laboratory medicine (Biochemistry, Microbiology, Pathology and Blood bank departments respectively) 2. To know how to collect and prepare the sample. 3. To handle medical lab instruments and fully automated analysers. 4. To understand and perform special stains and smears. 5. To understand and perform basic cytology and haematology procedures.		
7	**Course Outcomes**	Student will able to: CO1: Understand basic lab cytological techniques. CO2: Examine various staining and microscopic examination techniques. CO3: Analyze various blood/ urine/body fluid examinations. CO4: Understand and perform qualitative and quantitative estimations of biomolecules. CO5: Analyze testing compounds for antimicrobial activity. CO6: Execute skills in various laboratory related to pathological diagnosis inbiological fluids.		
8	**Course Description**	This course will provide knowledge, skills and opportunities to students towork in various pathological, medical and forensic science labs.		
9	**Outline Syllabus**			**CO Mapping**
	Unit 1	**Cytological techniques**		
	A	Preparation of cytological fixatives		CO1,CO6
	B	Preparation of smear and Giemsa staining on fluid sample		CO1,CO6
	C	Preparation ,Mounting and preservation of slides.		CO1,CO6
	Unit 2	**Blood examination**		

	A	RBC, WBC, Platelets count	CO2,CO6
	B	Determination of Heamoglobin by various methods.	CO2, CO6
	C	Blood banking techniques	CO2, CO6
	Unit 3	**Quantitative estimation of biomolecules in biological fluids**	
	A	Bile salt, Bile pigments and Urobilinogen determination	CO3,CO6
	B	Determination of G-6-PD	CO3,CO6
	C	Estimation of bicarbonate	CO3,CO6
	Unit 4	**Urine examination**	
	A	Microscopic examination of urine	CO4,CO6
	B	Determination of Ketone bodies in urine	CO4,CO6
	C	Determination of various parameters of urine by uristik method	CO4, CO6
	Unit 5	**Antimicrobial sensitivity testing**	
	A	Antimicrobial test of organic/inorganic compound	CO5, CO6
	B	Antibiotic sensitivity test	CO5,CO6
	C	Drug sensitivity test	CO 5,CO6
	Mode of examination	Practical	
	Weightage Distribution	CA	ESE
		60%	40%
	Text Book/s *	1. Teitz,(2007), Fundamentals of Clinical Chemistry,6th edition, Elsevier Publications 2. Henry's Clinical Diagnosis and Management by Laboratory Methods,(2011),22nd edition,Elsevier	
	Other references	3. Lehninger,(2013),Principles of Biochemistry,6th edition, W H Freeman 4. Wilson & Walker, Practical Biochemistry,2nd edition	

CO-PO & CO-PSO mapping

CO/ PO/ PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
VOB151.1	2	2	1	2	2	1	2	-	1	3	3	2	3
VOB151.2	2	2	1	2	2	1	-	-	-	2	3	2	2
VOB151.3	1	2	2	2	2	1	-	-	-	2	3	2	2
VOB151.4	2	2	2	2	1	1	1	-	-	2	3	3	3
VOB151.5	1	1	2	1	1	1	1	-	-	3	3	3	2
VOB151.6	2	3	2	2	2	2	1	1	2	3	3	3	3