Sharda School of Engineering & Science

Department of Chemistry & Biochemistry

Programme Structure
Batch : 2025-27
AY: 2025-26

MSc. in Chemistry
(Specialization : Inorganic/Organic/Physical)

Programme Code: SBR0101

Vision of the University

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

Mission of the University

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

Core Values

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

Vision of the School

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

Mission of the School

- **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.**

1.3 Vision and Mission of Department of Chemistry & Biochemistry

Vision 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 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.**

1.3 Programme Educational Objectives (PEO)

PEO 1: To deliver advanced concepts in Chemistry covering topics in Analytical, Inorganic, Organic and Physical Chemistry, while also reinforcing the fundamental concepts.

PEO2: To make students proficient in advanced laboratory techniques, enabling them to independently plan and conduct experiments as well as to work as a team.

PEO 3: To expose the students to a range of analytical methods using modern instrumentation, enabling them to analyse results at a higher level.

PEO 4: To provide significant opportunities to make their future career in research and to get employment in academia and industries by advancing their theoretical and practical knowledge.

PEO5: To develop critical thinking and skills like effective scientific communication, time management, and multi-tasking aptitude.

1.3.2 Map PEOs with Mission Statements:

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

Correlation levels 1, 2, or 3 as defined below:

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

1.3.3 Programme Outcomes (PO's)

PO1: Attain sound knowledge about the fundamentals and applications of chemical and scientific theories

PO2: Gain knowledge and understanding of reaction mechanisms, complex chemical structures, instrumental method of chemical analysis, molecular rearrangements and separation techniques.

PO3: Acquire general, technical, and professional skills to accomplish tasks in research, industry or academia.

PO4: Apply of knowledge and skills in addressing social economic and environmental problems.

PO5: Execute constitutional, humanistic, ethical, and moral values in scientific practice.

PO6: Imbibe employability, job-readiness and entrepreneurship skills in the interdisciplinary and multidisciplinary areas of chemical sciences.

PSO1 : Apply modern research techniques to investigate complex chemical phenomena and solve practical problems.

PSO2 : Acquire skills to prepare for doctoral studies, competitive exams and demonstrate competence in quality assurance and quality control practices essential for industry.

1.3.4 Mapping of Programme Outcome Vs Programme Educational Objectives

	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	2	2	2
PO2	1	3	3	1	1
PO3	2	3	2	3	3
PO4	3	3	3	2	2
PO5	2	2	2	3	3
PO6	3	3	2	2	2
PSO1	3	3	3	2	2
PSO2	3	2	2	2	2

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

1.3.5 Programme Outcome Vs Courses Mapping Table:

1.3.5.1 COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT4101	2	1	1	1	3	2	2	3
CHT4102	2	1	1	1	2	3	2	2
CHT4103	2	1	1	1	3	2	3	2
CHT4104	2	1	1	1	2	2	2	2
CHT4105	2	3	1	3	2	3	2	3
CHT4106	2	3	1	3	2	3	1	3
CHT4107	2	3	1	3	2	2	3	3
CHT4108	3	1	1	1	3	2	2	2
OPEXXX	2	2	1	1	2	2	3	2
CHT5101	2	1	1	1	2	2	3	3
CHT5102	2	1	1	1	2	3	2	2
CHT5103	2	3	1	3	2	3	2	3
CHT5104	2	3	1	3	2	3	2	3
CHT5105	2	3	1	3	2	3	3	3
CHT5106	3	2	2	3	3	2	2	3
CHT5107	3	1	1	2	3	2	2	2
CHT5108	3	1	1	2	3	2	2	2
CHT5109	3	2	1	1	3	2	3	2
CHT5110	3	1	1	1	3	2	2	3
CHT5111	3	1	1	1	3	2	3	2
CHT5112	3	2	1	1	3	2	2	2
CHT5113	3	3	1	3	3	3	2	3
CHT5114	3	3	1	3	3	3	3	3
CHT5115	3	3	1	3	3	3	2	3
CHT5116	3	2	2	2	3	2	2	2

CHT5117	3	1	1	1	3	3	2	2
CHP4101	3	1	1	1	3	3	2	2
CHP4102	3	1	1	1	3	2	1	2
CHP4103	3	2	1	2	3	2	2	2
CHP4104	3	1	1	1	3	2	3	2
CC	3	1	1	1	3	2	3	3
PHT1151	3	2	1	3	3	2	2	3
PHP1153	2	3	1	3	2	3	2	3
CHP4105	2	3	1	3	2	3	2	3
CHP4106	2	3	1	3	2	3	3	3
CHP4107	3	2	2	3	3	2	2	3
CHR4101	3	1	1	2	3	2	2	2
CHP5101	2	3	1	3	2	3	2	3
CHP5102	2	3	1	3	2	3	2	3
CHP5103	2	3	1	3	2	3	3	3
CHP5104	3	2	2	3	3	2	2	3
CHP5105	3	1	1	2	3	2	2	2
CHP5106	3	1	1	2	3	2	2	2
CHP5107	3	2	1	1	3	2	3	2
CHP5108	3	1	1	1	3	2	2	3
CHP5109	3	1	1	1	3	2	3	2
CHR5101	3	2	1	1	3	2	2	2
CHR5102	3	3	1	3	3	3	2	3
CHR5103	3	3	1	3	3	3	3	3
CHR5104	3	3	1	3	3	3	2	3
CHR5105	3	2	2	2	3	2	2	2
CHR5106	2	3	1	3	2	3	2	3

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

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: I - PG Diploma after exit from 1st Year (Entry & Exit Option) TYPE I(Course Level = 400)

S. No.	Subject Code	Subjects	Teaching Load			Credits	Pre-Requisite/Co Requisite
			L	T	P		
THEORY SUBJECTS							
1.	CHT4101	Advanced Inorganic Chemistry I	4	-	-	4	Core
2.	CHT4102	Advanced Organic Chemistry I	4	-	-	4	Core
3.	CHT4103	Advanced Physical Chemistry I	4	-	-	4	Core
4.	CHT4104	Advanced Analytical Chemistry I	3	1	-	4	Core
PRACTICAL SUBJECTS							
5.	CHP4101	Advanced Inorganic Chemistry Lab I	-	-	2	1	Core
6.	CHP4102	Advanced Organic Chemistry Lab I	-	-	2	1	Core
7.	CHP4103	Advanced Physical Chemistry Lab I	-	-	2	1	Core
8.	CHP4104	Basic Chemistry Softwares	-	-	2	1	Core
9.	CCP4001	Community Connect	-	-	2	0	SEC
TOTAL CREDITS						**20**	

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: I - PG Diploma after exit from 1st Year (Entry & Exit Option) TYPE II(Course Level = 400)

S. No.	Subject Code	Subjects	Teaching Load			Credits	Pre-Requisite/Co Requisite
			L	T	P		
THEORY SUBJECTS							
1.	CHT4101	Advanced Inorganic Chemistry I	4	-	-	4	Core
2.	CHT4102	Advanced Organic Chemistry I	4	-	-	4	Core
3.	CHT4103	Advanced Physical Chemistry I	4	-	-	4	Core
4.	CHT4104	Advanced Analytical Chemistry I	3	1	-	4	Core
5.	PHT1151	Artificial Intelligence and Machine Learning	2	-	-	2	SEC
PRACTICAL SUBJECTS							
6.	CHP4101	Advanced Inorganic Chemistry Lab I	-	-	2	1	Core
7.	CHP4102	Advanced Inorganic Chemistry Lab I	-	-	2	1	Core
8.	CHP4103	Advanced Physical Chemistry Lab I	-	-	2	1	Core
9.	CHP4104	Basic Chemistry Softwares	-	-	2	1	Core
10.	PHP1153	Data Analysis Using Python	-	-	4	2	SEC
11.	CCP4001	Community Connect	-	-	2	0	SEC
TOTAL CREDITS						**24**	

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: II PG Diploma after exit from 1st Year (Entry & Exit Option) TYPE I(Course Level = 400)

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	CHT4105	Advanced Inorganic Chemistry II	3	-	-	3	Core
2.	CHT4106	Advanced Organic Chemistry II	3	-	-	3	Core
3.	CHT4107	Advanced Physical Chemistry II	3	-	-	3	Core
4.	CHT4108	Basic Principles of Computational Chemistry/MOOC	2	-	-	2	DSE
5.	OPEXXX	Open Elective	2	-	-	2	DSE
PRACTICAL SUBJECTS							
6.	CHP4105	Advanced Inorganic Chemistry Lab II	-	-	2	1	Core
7.	CHP4106	Advanced Organic Chemistry Lab II	-	-	2	1	Core
8.	CHP4107	Advanced Physical Chemistry Lab II	-	-	2	1	Core
9.	CHR4101	Project*	-	-	8	4	Dissertation
10.	NVXXXX	Value added Course I	-	-	2	0	Qualifying
TOTAL CREDITS						20	

Courses shall be Research based / Lab based training / Hands on training evaluation will be made as per Rubrics made by the Department/School and duly approved by DAA/Committee constituted for the purpose.

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: II PG Diploma after exit from 1st Year (Entry & Exit Option) TYPE II(Course Level = 500)

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	CHT4105	Advanced Inorganic Chemistry II	3	-	-	3	Core
2.	CHT4106	Advanced Organic Chemistry II	3	-	-	3	Core
3.	CHT4107	Advanced Physical Chemistry II	3	-	-	3	Core
4.	CHT4108	Basic Principles of Computational Chemistry	2	-	-	2	SEC
5.	OPEXXX	Open Elective	2	-	-	2	SEC**
	PRACTICAL SUBJECTS						
6.	CHP4105	Advanced Inorganic Chemistry Lab II	-	-	2	1	Core
7.	CHP4106	Advanced Organic Chemistry Lab II	-	-	2	1	Core
8.	CHP4107	Advanced Physical Chemistry Lab II	-	-	2	1	Core
9.	NVXXXX	Value added Course I	-	-	2	0	Qualifying
TOTAL CREDITS						**16**	

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: III - 1 Year PG degree by CW+RW Type I(Course Level = 500)

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	CHT5101	Advanced Molecular Spectroscopy*	3	-	-	3	DSE
2.	CHT5102/CHT5103/ CHT5104	Advanced Inorganic Chemistry III/ Advanced Physical Chemistry III/ Advanced Organic Chemistry III	4	-	-	4	Core
3.	CHT5105/CHT5106/ CHT5107	Advanced Inorganic Chemistry IV/ Advanced Physical Chemistry IV/ Advanced Organic Chemistry IV	4	-	-	4	Core
4.	CHT5108	Research methodology & Intellectual Property Rights	2	-	-	1	SEC
Practical							
5.	CHP5101/ CHP5102/CHP5103	Advanced Organic Chemistry Lab III/ Advanced Physical Chemistry Lab III/ Advanced Inorganic Chemistry Lab III	-	-	4	2	Core
6.	CHR5101	Dissertation I(RBL-1)*	-	-	12	6	Dissertation
7.	NVXXXX	Value added Course II	-	-	2	0	Qualifying
TOTAL CREDITS						**20**	

**** Courses shall be Research based / Lab based training / Hands on training evaluation will be made as per Rubrics made by the Department/School and duly approved by DAA/Committee constituted for the purpose.***

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: III - 1 Year PG degree by CW Type II(Course Level = 500)

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	CHT5101	Advanced Molecular Spectroscopy	3	-	-	3	DSE
2.	CHT5102/CHT5103/CHT5104	Advanced Inorganic Chemistry III/ Advanced Physical Chemistry III/ Advanced Organic Chemistry III	4	-	-	4	Core
3.	CHT5105/CHT5106/CHT5107	Advanced Inorganic Chemistry IV/ Advanced Physical Chemistry IV/ Advanced Organic Chemistry-IV	4	-	-	4	Core
4.	CHT5108	Research methodology & Intellectual Property Rights	2	-	-	1	SEC
Practical							
5.	CHP5101/ CHP5102/CHP5103	Advanced Organic Chemistry Lab III/ Advanced Physical Chemistry Lab III/ Advanced Inorganic Chemistry Lab III	-	-	4	2	Core
6.	CHP5104	Instrumental Methods of Analysis Lab	-	-	4	2	DSE
7.	CHP5105	Computations Based on Density Functional Theory*/MOOC*	-	-	4	2	SEC
8.	CHR5102	Dissertation I(RBL-1)*	-	-	4	2	Dissertation
9.	NVXXXX	Value added Course II	-	-	2	0	Qualifying
TOTAL CREDITS						**20**	

**** Courses shall be Research based / Lab based training / Hands on training evaluation will be made as per Rubrics made by the Department/School an duly approved by DAA/Committee constituted for the purpose.***

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: III - 1 Year PG degree by RW(*Research Based Applied Courses) Type III

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	CHT5101	Advanced Molecular Spectroscopy	3	-	-	3	DSE
2.	CHT5108	Research methodology & Intellectual Property Rights	2	-	-	1	SEC
Practical							
3.	CHR5103	Dissertation I(RBL-1)*	-	-	32	16	Dissertation
4.	NVXXXX	Value added Course II	-	-	2	0	Qualifying
TOTAL CREDITS						**20**	

**** Courses shall be Research based / Lab based training / Hands on training evaluation will be made as per Rubrics made by the Department/School and duly approved by DAA/Committee constituted for the purpose.***

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: IV - 1 Year PG degree by CW+RW Type I(Course Level = 500)

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	CHT5109/ CHT5110/ CHT5111	Advanced Inorganic Chemistry V/ Advanced Physical Chemistry V/ Advanced Organic Chemistry V	3	-	-	3	Core
2.	CHT5112/ CHT5113/ CHT5114	Advanced Inorganic Chemistry VI/ Advanced Physical Chemistry VI/ Advanced Organic Chemistry VI	3	-	-	3	Core
Practical							
3.	CHR5104	Dissertation II(RBL-2)*	-	-	28	14	Dissertation
TOTAL CREDITS						**20**	

**** Courses shall be Research based / Lab based training / Hands on training evaluation will be made as per Rubrics made by the Department/School and duly approved by DAA/Committee constituted for the purpose.***

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: IV 1 Year PG degree by CW Type II(Course Level = 500)

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	CHT5109/ CHT5110/ CHT5111	Advanced Inorganic Chemistry V/ Advanced Physical Chemistry V/Advanced Organic Chemistry-V	3	-	-	3	Core
2.	CHT5112/ CHT5113/ CHT5114	Advanced Inorganic Chemistry VI/ Advanced Physical Chemistry VI/ Advanced Organic Chemistry VI	3	_	_	3	Core
3.	CHT5115	Fundamentals of Medicinal Chemistry	3	-	-	3	Core
4.	CHT5116/CHT5117	Advanced Analytical Chemistry II/Introduction to Environmental Chemistry	3	1	-	4	DSE
Practical							
5.	CHP5106/ CHP5107/ CHP5108	Advanced Organic Chemistry Lab IV/ Advanced Inorganic Chemistry Lab IV/ Advanced Physical Chemistry Lab IV	-	-	4	2	Core
6.	CHP5109	Environmental Chemistry Lab	-	-	4	2	Core
7.	CHR5105	Minor project/Term paper(Dissertation II or RBL-2)*	-	-	6	3	Dissertation
TOTAL CREDITS						**20**	

**** Courses shall be Research based / Lab based training / Hands on training evaluation will be made as per Rubrics made by the Department/School and duly approved by DAA/Committee constituted for the purpose.***

Programme Structure
Sharda School of Engineering & Sciences
M. Sc. Chemistry
Batch: 2025-27
TERM: IV 1 Year PG degree by RW* Research Based Applied Courses Type III

S. No.	Course Code	Course	Teaching Load			Credits	Core/Elective
			L	T	P		
THEORY SUBJECTS							
1.	CHT5116	Advanced Analytical Chemistry II*	3	1	-	4	DSE
Practical							
2.	CHR5106	Dissertation II(RBL-2)*	-	-	32	16	Dissertation
TOTAL CREDITS						**20**	

Courses shall be Research based / Lab based training / Hands on training evaluation will be made as per Rubrics made by the Department/School and duly approved by DAA/Committee constituted for the purpose.

Course modules

CHT4101 Advanced Inorganic Chemistry I

School: SSES		**Batch 2025-27**	
Programme: M.Sc.		**Current Academic Year : 2025-26**	
Branch: Chemistry		**Semester I**	
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-, 5-and 6-coordinated complexes, d-orbitals splitting in linear, trigonal, octahedral, square planar, tetrahedral, square pyramidal, trigonal-bipyramidal and cubic complexes	CO1,CO6
	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, kinetic isotope effect, nuclear activation analyses, Principle of nuclear detection, gas detector, ionization chamber, proportional and G. M. detector.	CO5,CO6
	C	*Radioactive Techniques:* Detection and measurement of radiation- GM ionization and proportional counters.	CO5,CO6

		Radiometric analysis: Isotope dilution analysis, age determination, neutron activation analysis (NAA) and their applications. Radiation hazards and safety measures.			
	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.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT4101.1	3	1	1	1	1	2	3	3
CHT4101.2	3	1	2	2	2	1	3	3
CHT4101.3	3	2	2	2	2	1	3	3
CHT4101.4	3	2	1	2	1	2	3	3
CHT4101.5	3	1	1	1	1	2	3	3
CHT4101.6	3	1	2	1	2	2	3	3

CHT4102 Advanced Organic Chemistry I

School: SSES		**Batch 2025-27**
Programme: M.Sc.		**Current Academic Year: 2025-26**
Branch: Chemistry		**Semester I**
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, heteroannulene, fullerenes, C-60, cryptates, azulenes.	CO1, CO6
	C	**Current concepts of aromaticity:** Anti-aromatic, non-aromatic and homoaromatic compounds, Effect of tautomerism and hyperconjugation on aromaticity.	CO1, CO6
	Unit 2	**Reaction Mechanism - Structure and Reactivity**	
	A	**Types of reaction mechanisms:** substitutions, eliminations, additions, rearrangements, thermodynamic and kinetic requirements	CO2, CO6
	B	Hammond postulate, Curtin-Hammett principle, transition states and intermediates, **catalysis:** electrophilic catalysis, acid and base catalysis	CO2, CO6
	C	**Methods of 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, Demjonove rearrangement, and Pinacol-pinacolone rearrangement	CO3, CO6
	B	**Carbanions:** formation, stability and their reactions. HSAB principle and its applications	CO3, CO6
	C	**Free radicals:** formation, stability and reactions, cage effects, radical cations and radical anions;	CO3, CO6

		Carbene: Synthesis, structure and reactions of singlet and triplet carbene, nitrenes, Benzyne.	
	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; deterrmination 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	1. Organic Chemistry, R. T. Morrison and R. N. Boyd, (1992) 6th Edition, Prentice-Hall. 2. Reaction Mechanism in Organic Chemistry, (1976) 1st Edition, S. M. Mukherji and S. P. Singh, Macmillan. 3. Stereochemistry, P. S. Kalsi, (1994), 2nd Edition, New Age International.	
	Other references	1. Advanced Organic Chemistry Reactions: Mechanism and Structure, Jerry March, (1992) 4th Edition, John Wiley. 2. Stereochemistry of Organic Compounds by ELudwig Eleil, Samual H. Wilen, (1995) T.M.H Edition, Tata McGraw-Hill Publishing Company. 3. Stereochemistry of Organic Compounds: Principles and Applications by D. Nasipuri, (1994) 2nd Edition, New Age International Publishers.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT4102.1	3	1	1	2	3	1	1	1
CHT4102.2	3	1	1	1	3	1	1	1
CHT4102.3	3	1	1	1	3	1	1	1
CHT4102.4	3	1	1	2	3	1	1	1
CHT4102.5	3	1	1	2	3	1	1	1
CHT4102.6	3	1	1	1	3	1	1	1

CHT4103 Advanced Physical Chemistry I

School: SSES		**Batch : 2025-27**
Programme:M.Sc.		**Current Academic Year: 2025-26**
Branch:Chemistry		**Semester:I**
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 complete 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 parameters 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, deterrmination 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 undeterrmined multipliers.	CO3,CO6
	Unit 4	**Electrochemistry**	

	A	Debye-Huckel theory of ion- ion interactions, Debye-Huckel limiting law of activity coefficients and its limitations,	CO4,CO6
	B	Debye - Huckel -Onsager treatment for aqueous solutions and its limitations, Wein effect, Debye – Falkenhagen effect.	CO4,CO6
	C	The electrode-electrolyte interface: The electrical double layer -The Helmholtz-Perrin parallel plate model, the Gouy-Chapman diffuse-charge model and the Stern model, excess function	CO4,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	

Mapping of CO vs. PO & PSO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT4103.1	3	3	3	1	1	3	2	3
CHT4103.2	3	3	3	1	1	3	3	3
CHT4103.3	3	2	3	2	1	3	2	3
CHT4103.4	3	2	3	2	1	3	3	3
CHT4103.5	3	2	3	2	1	3	3	3
CHT4103.6	3	3	3	1	1	3	3	3

CHT4104 Advanced Analytical Chemistry I

School: SSES		**Batch : 2025-27**
Programme: M.Sc		**Current Academic Year: 2025-27**
Branch: Chemistry		**Semester: I**
1	**Course Code**	**CHT4104**
2	**Course Title**	**Analytical Chemistry I**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**4-0-0**
	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 Description	Analytical chemistry I emphasizes on various factors as - types of errors, accuracy and precision in chemical analysis, concepts of chemical equilibrium and its effects on qualitative and quantitative estimation, Chromatographic separation and Thermal analysis.

8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Analytical Chemistry**	
	A	Scope & objectives of Analytical chemistry and chemical analysis, Classification of analytical methods. Errors in chemical analyses- Accuracy and precision	CO1,CO6
	B	Types of error-determinant, indeterminate and gross. Nature of random errors, statistical treatment of random errors, standard deviation of calculated results, reporting of calculated data	CO1,CO6
	C	ways of expressing accuracy and precision. variance and confidence limit. Comparison of mean with true values, regression analysis (least-square method for linear plots)	CO1,CO6
	Unit 2	**Concept of Equilibrium**	
	A	General treatment of equilibria in aqueous medium involving monoprotic weak 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 terephthalate, DSC curve for isothermal crystallization of polyethylene, DSC of phenacetin), thermometric titrations, Evolved gas analysis.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		15%	10%	75%	
	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.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO1
CHT4104.1	3	2	1	2	3	1	1	1
CHT4104.2	3	2	1	3	3	1	1	1
CHT4104.3	3	2	1	1	3	1	1	1
CHT4104.4	3	3	1	3	3	1	1	1
CHT4104.5	3	3	1	3	3	1	1	1
CHT4104.6	3	3	1	3	3	1	1	1

CHT4105 Advanced Inorganic Chemistry II

School: SSES		**Batch : 2025-27**	
Programme: M.Sc.		**Current Academic Year: 2025-26**	
Branch:Chemistry		**Semester: II**	
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 phosphine 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	CO1,CO6

		general rules, Derivation of matrices for rotation; reflection; rotation; reflection and inversion operations;	
	B	Symmetry operations of all the molecular point groups (C_n, D_n, C_{nh}, D_{nb},C_{nv}, D_{nd}, S_n, T, T_d and T_h ; Determination of the classes of operations by similarity transform method (only C_{2v}, C_{2h}, C_{3v}) and general rules	CO1,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 phosphines. Comparison of phosphine and carbonyl ligands in terms of bonding.	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. 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.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT4105.1	3	2	1	1	1	2	3	3
CHT4105.2	3	1	2	1	2	1	3	3
CHT4105.3	3	2	1	2	2	1	3	3
CHT4105.4	3	1	1	2	2	2	3	3
CHT4105.5	3	1	2	1	1	2	3	3
CHT4105.6	3	1	1	1	2	2	3	3

CHT4106 Advanced Organic Chemistry II

School: SSES		**Batch: 2025-27**
Programme: M.Sc.		**Current Academic Year: 2025-26**
Branch: Chemistry		**Semester: II**
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: 1. Develop an in-depth understanding of single bond (C- C) formation strategies and explore the role of enolates, enamines, and organometallic reagents in organic synthesis. 2. Develop the critical thinking to analyze the conditions required for C=C bond formation 3. Introduce metal-catalyzed carbon- carbon bond formation techniques and their applications. 4. Examine oxidation and reduction reactions, including stereochemical aspects and selectivity. 5. Analyze key name reactions and molecular rearrangements in organic synthesis
6	Course Outcomes	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. Saytzev'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, Peterson 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*	1. Organic Reactions and Mechanisms, P.S. Kalsi, (2002) 2nd Edition, New Age International Publishers. 2. Organic Chemistry, R. T. Morrison and R. N. Boyd, (1992) 6th Edition, Prentice-Hall. 3. Reaction Mechanism in Organic Chemistry, (1976) 1st Edition, S. M. Mukherji and S. P. Singh, Macmillan.			
	Other references	1. Advanced Organic Chemistry Reactions: Mechanism and Structure, Jerry March, (1992) 4th Edition, John Wiley. 2. Organic Chemistry, Francis A. Carey, (1996) 3rd Edition, The McGraw-Hill Companies, Inc. 3. Modern Methods of Organic Synthesis South Asia Edition W. Carruthers, Iain Coldham, (2004) 4th Edition, Cambridge University Press 4. Principles of Organic Synthesis, R.O.C. Norman, (1978) 2nd Edition, Chapman and Hall			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT4106.1	3	2	1	2	3	1	1	2
CHT4106.2	3	1	1	1	3	1	1	2
CHT4106.3	3	2	1	2	3	1	1	2
CHT4106.4	3	2	1	2	3	1	1	2
CHT4106.5	3	2	1	2	3	1	1	2
CHT4106.6	3	1	1	1	3	1	1	1

CHT4107 Advanced Physical Chemistry II

School: SSES		**Batch : 2025-27**	
Programme:M.Sc.		**Current Academic Year: 2025-26**	
Branch:Chemistry		**Semester:II**	
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,	CO1,CO6

		Commutation of operators, Eigen value and Eigen function. Angular momentum operator, Ladder operator.			
	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			
		CA	MSE	ESE	

	Weightage Distribution	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.		

Mapping of CO vs. PO & PSO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT4107.1	3	1	3	3	1	3	2	3
CHT4107.2	3	3	3	1	1	3	3	3
CHT4107.3	3	2	3	2	1	3	2	3
CHT4107.4	3	2	3	2	1	3	3	3
CHT4107.5	3	2	3	2	1	3	3	3
CHT4107.6	3	1	3	1	1	3	3	3

CHT4108 Basic Principles of Computational Chemistry

School: SSES		**Batch 2025-27**	
Programme: M.Sc.			
Branch : Chemistry		**Semester II**	
1	**Course Code**	**CHT4108**	
2	**Course Title**	**Basic Principles of Computational Chemistry**	
3	**Credits**	**2**	
4	**Contact hours**	**2-0-0**	
	Course Status	**DSE**	
5	Course Objectives	The objectives of the course are to 1.To provide basic knowledge of quantum mechanics. 2. To learn MO theory in the perspective of quantum chemistry. 3. To understand Hartree-Fock theory of quantum chemical calculations. 4. To teach the concept of ab initio theory in quantum chemistry calculations. 5. To introduce the implementation of DFT to solve quantum mechanical problems. 6.To provide knowledge of various electronic structure theory to solve problems theoretically.	
6	Course Outcome	After successful completion of the course, the students will be able to: CO1:Develop the knowledge of quantum mechanics in the context of chemical systems. CO2: Master fundamental concept of MO theory of quantum chemistry. CO3: Understand the essential features of Hartree Fock theory. CO4: Apply the concepts of ab initio theory in computational chemistry. CO5: Able to understand the role of DFT to solve quantum mechanical problems. CO6: Develop deep knowledge and application of electronic structure theory to solve quantum mechanical problems.	
7	Course Description	The goal of this course is to provide basic concepts of Quantum Chemistry and its applications in the field of Chemical Sciences. This course will review the various theories/approximations necessary to understand most popular framework of Theoretical and Computational Chemistry and its applications.	
8	Outline Syllabus		CO mapping
	Unit 1	**Quantum Mechanics**	
	A	Introduction of Quantum mechanics, Schrodinger equation,	CO1, CO6

	B	Position and momentum, Operators, Hamiltonian operator,	CO1, CO6
	C	Quantum oscillator, Oscillator Eigen value problems, Quantum numbers	CO1, CO6
	Unit 2	**Huckels MO theory**	
	A	Huckel's MO theory,	CO2, CO6
	B	approximate and exact solution of Schrodinger equation,	CO2, CO6
	C	exception values of energy, Computational techniques exception values of energy. Computational techniques	CO2, CO6
	Unit 3	**SCF theory and Hartree-Fock equation**	
	A	Self consistent field theory, Elements of secular matrix,	CO3, CO6
	B	Vibrational calculations, Semi empirical methods,	CO3, CO6
	C	Slater determinants, Hartree equation, Fock equation.	CO3, CO6
	Unit 4	**Ab initio theory**	
	A	Ab-initio calculations,	CO4, CO6
	B	Gaussian implementations	CO4, CO6
	C	Koopman's theorem,	CO4, CO6
	Unit 5	**Density Functional Theory**	
	A	Concept of Density Functional Theory	CO5, CO6
	B	DFT for larger molecules.	CO5, CO6
	C	DFT applications	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MSE: 25% / ESE: 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. Young, D. (2004). *Computational chemistry: a practical guide for applying techniques to real world problems*. John Wiley & Sons.	
	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. Jensen, F. (2017). *Introduction to computational chemistry*. John wiley & sons. 4. Leach, A. R. (2001). *Molecular modelling: principles and applications*. Pearson education.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT4108.1	3	1	3	1	1	3	3	3
CHT4108.2	3	1	3	1	1	3	3	3
CHT4108.3	3	1	3	1	1	3	3	3
CHT4108.4	3	2	3	1	1	3	3	3
CHT4108.5	3	2	3	1	1	3	3	3
CHT4108.6	3	2	3	1	1	3	3	3

CHT5101 Advanced Molecular Spectroscopy

School: SSES		**Batch : 2025-27**	
Programme:M.Sc.			
Branch:Chemistry		**Semester:III**	
1	**Course No.**	**CHT5101**	
2	**Course Title**	**Advanced Molecular Spectroscopy**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To know the principle and applications of molecular spectroscopy. 2. To understand the theories of UV, FT-IR, Raman, NMR, and Mass spectroscopic techniques. 3. Analyze and identify simple organic molecules by using UV, IR, Mass, ^{1}H NMR and ^{13}C NMR data. 4. To evaluate the application of NMR and Mass spectroscopic techniques to different molecules. 5. To know the principle and instrumentation of different spectrophotometric techniques. 6. To impart the knowledge of electronic, rotation, vibration. NMR, FTIR, ESR, spectroscopy and their applications.	
6	Course Outcomes	CO1:Explain the general principles and theory of spectroscopy, distinguish the specialities and applications of various types of spectroscopic methods. CO2:Describe the concept and instrumentation of atomic uv-visible absorption, infrared NMR and Mass spectrometers. CO3:Apply Woodward Fieser Rules. CO4:Understand first and second order ^{1}HNMR spectra. CO5:Solve analytical science problems involving uv-visible absorption, infrared ^{1}H, ^{13}C and mass techniques. CO6:Predict UV, IR, Proton chemical shift, spin-spin coupling, coupling constants and apply ^{13}C resonance spectroscopy and mass spectroscopy to chemical structures.	
7	Course Description	The course is framed to give fundamental concepts of UV-Visible, IR, ^{1}HNMR, ^{13}CNMR and Mass spectroscopy. Applications of these spectroscopic techniques to organic/inorganic systems will be discussed.	
8	Outline syllabus		CO mapping
	Unit 1	**UV-Visible Spectroscopy**	
	A	Electronic spectra, Frank-Condon Principle, predissociation spectra, Fortrat diagram	CO1,CO6
	B	conjugated polyene and enone systems, and different types of charge transfer transitions and their basis	CO1,CO6

	C	Charge transfer spectra in organic and inorganic systems	CO1,CO6
	Unit 2	**Infrared Spectroscopy**	
	A	Basic principle and sample handling. Modes of stretching and bending, bond properties and absorption trends,	CO2,CO6
	B	Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance.	CO2,CO6
	C	Application of IR spectroscopy for determination of inorganic structures, bond strength, frequency shift reactions.	CO2,CO6
	Unit 3	**Nuclear Magnetic Resonance Spectroscopy-I**	
	A	^{1}H NMR - Effect of magnetic field strength on sensitivity and resolution, chemical shift δ, inductive and anisotropic effects on δ, chemical structure correlations of δ, chemical and magnetic equivalence of spins, spin-spin coupling, structural correlation to coupling constant J	CO3,CO6
	B	first order and second order spectra, examples of AB, AX, ABX, AMX and AA′BB′ systems, simplification of second order spectrum, selective decoupling, double resonance; classification of splitting pattern; spin; de coupling; chemical exchange; effect of deuteration	CO3,CO6
	C	Structural elucidation of organic and inorganic compounds using ^{1}H, ^{11}B, ^{15}N, ^{19}F, ^{31}P, ^{195}Pt etc.	CO3,CO6
	Unit 4	**Nuclear Magnetic Resonance Spectroscopy-II**	
	A	^{13}C NMR- Introduction, interpretation of ^{13}C NMR spectra, Chemical shifts and its calculation,	CO4,CO6
	B	proton coupled and decoupled spin-spin splitting; Application of DEPT technique to the analysis of CH multiplicities in ^{13}C NMR spectroscopy. Correlation spectroscopy - Illustration of practical applications of ^{1}H-^{1}H COSY, ^{1}H-^{13}C COSY.	CO4,CO6
	C	Nuclear overhauser enhancement (NOE).Basic concept of Heternonuclear (F, P, Si) NMR.	CO4,CO6
	Unit 5	**Mass Spectrometry**	
	A	Measurement technique (El; FAB); Resolution; exact masses of nucleides; molecular ions; isotope ions; fragment ions of odd and even electron types; rearrangement ions	CO5,CO6
	B	factors affecting cleavage patterns; simple cleavage; cleavage at a hetero atom; multi centre fragmentation	CO5,CO6
	C	Structure elucidation of organic and inorganic compounds employing mass spectroscopy.	CO5,CO6

		resolution MS.		
	Mode of examination	Theory		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	Text Book/s*	1. Spectroscopy of Organic Compounds – P.S.Kalsi, 6th edition, 2004. 2. Molecular Spectroscopy – Banwell, 5th Edition, 2013		
	Other References	1. Applications of Absorption Spectroscopy of Organic Compounds – Dyer, 1st Edition, 2009. 2. Spectroscopic Methods in Organic Chemistry by D.H. Williams and I. Fleming, 4th edition, Tata McGraw-Hill Publishing company Ltd., New Delhi. 3. Spectrometric Identification of Organic Compounds- R. M. Silverstein, F. X. Webster, D. Kiemle, 7th Edition, 2005. 4. Physical Methods in Inorganic Chemistry by R. S. Drago, Affiliated East-West Press, 1st Edition. 5. Spectroscopic identification of organic compounds by Kiemle Webster Silverstein, 7 2nd Edition, 2005		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5101.1	3	1	1	1	1	2	3	1
CHT5101.2	3	2	1	1	2	2	3	2
CHT5101.3	3	1	1	3	1	2	3	1
CHT5101.4	3	1	2	3	2	2	3	1
CHT5101.5	3	1	2	3	2	1	3	1
CHT5101.6	3	1	1	3	2	2	3	1

CHT5102 Advanced Inorganic Chemistry III

School: SSES		**Batch 2025-27**	
Programme: M.Sc.			
Branch: Chemistry		**Semester III**	
1	**Course No**	**CHT5102**	
2	**Course Title**	**Advanced Inorganic Chemistry III**	
3	**Credits**	**4**	
4	**Contact hours(L-T-P)**	**4-0-0**	
	Course Status	**Core**	
5	Course Objectives	1. To explain the reaction mechanism of an inorganic reaction. 2. To discuss factors affecting stability of complexes. 3. To explain the route of addition of molecules in a reaction. 4. To have an overview of chemistry of CO complexes. 5. To explain the concept of stereoisomerism in inorganic complexes. 6. To demonstrate mechanisms of substitution reaction and compare it with associative reaction.	
6	Course Outcome	CO1: Explain the trends of rate constants and its dESErmination with different methods. CO2: Provide explanation for substitution in octahedral and square planar complexes. CO3: Explain ligand replacement reactions under different conditions. CO4: Distinguish between oxidative addition and reductive elimination mechanisms. CO5: Analyze the chemistry of carbonyl compounds and metal hydrides. CO6: Gain knowledge about various aspects of inorganic reaction mechanism	
7	Course Description	The course gives a detailed view of reaction mechanism, electron transfer mechanisms, oxidative addition and insertion reactions of transition metal complexes.	
	Unit 1	**Reaction Mechanism of Transition metal complexes-I**	
	A	Rate Law, Steady state, Activated complex theory. Stepwise and overall formation constants, their interaction	CO1,CO6
	B	deterrmination of formation constant by pHmeter, Job's method and spectrophotometry. Trends in stepwise constants	CO1,CO6
	C	factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Chelate effect and its thermodynamic origin	CO1,CO6
	Unit 2	**Reaction Mechanism of Transition metal complexes-II**	

	A	Inert and labile complexes, mechanisms of substitution	CO2,CO6

		reactions (dissociative, associative interchange mechanism), the conjugate mechanism,	
	B	direct and indirect evidence in favour of conjugate mechanism, substitution in cis and trans complexes, isomerism of chelate rings, *trans* effects, explanation for *trans* effect	CO2,CO6
	C	Ligand replacement reactions of square planar and octahedral complexes: their factors and mechanism of substitution, Anation reactions.	CO2,CO6
	Unit 3	**Electron Transfer Mechanisms**	
	A	Inner sphere and outer sphere reactions and their mechanisms	CO3,CO6
	B	Racemization and Isomerization, Effect of ligand field on reaction rates	CO3,CO6
	C	Mixed valence complexes, Marcus-Husch theory, Thermal and optical electron transfer reactions.	CO3,CO6
	Unit 4	**Oxidative-Addition and Migration (Insertion Reactions)**	
	A	Introduction: Acid base behaviour of metal atoms in complexes, Protonation and Lewis Base behaviour, acceptor properties of Lewis acidity of complexes	CO4,CO6
	B	oxidative addition and reductive elimination, addition of specific molecules, Hydrogen addition, HX additions, Organic halides addition of some other molecules productive elimination, migration (Insertion) reaction	CO4,CO6
	C	promotion of alkyl migration, insertion of CO into M-H bonds, other aspects of CO insertion reactions, Insertion of alkenes and C-C unsaturated compounds, Cleavage of C-H bonds; alkane activation, Cyclometallation reactions.	CO4,CO6
	Unit 5	**Metal Hydride Complexes**	
	A	Synthesis, structure and reactions of hydrido complexes, characterization of complexes, molecular hydrogen compounds-synthesis and reactions	CO5,CO6
	B	Mononuclear polyhydrides, homoleptic polyhydride anions; carbonyl hydrides and anion	CO5,CO6
	C	MH interactions; synthetic applications of metal hydrides	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MSE: 25% / ESE: 50%	
	Text book/s*	1.J.E.Huheey. Inorganic Chemistry: Principles of Structure and Reactivity. Harper Inter science.	

	Other References	1.William L. Jolly, Modern Inorganic Chemistry, 2nd Edn, Tata McGraw Hill.
		2.E. A. V. Ebsworth, D. W. H. Rankin and S. J. Cradock. Structural methods in Inorganic Chemistry, Blackwell Scientific Oxford. 3.I. P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver and Atkins. Inorganic Chemistry, Oxford University Press. 4.T. Moeller. Inorganic Chemistry: A Modern approach, John Wiley. 5.F. Basalo and R.G.Pearson, Mechanism of Inorganic reactions,2nd Edn ,Wiley Eastern Ltd., New Delhi

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5102.1	3	1	1	1	1	2	3	3
CHT5102.2	3	1	2	1	2	1	3	3
CHT5102.3	3	2	2	2	2	1	3	3
CHT5102.4	3	1	1	1	2	2	3	3
CHT5102.5	3	1	2	1	1	2	3	3
CHT5102.6	3	1	1	1	2	2	3	3

School: SSES		**Batch 2025-27**	
Programme: M.Sc.			
Branch : Chemistry		**Semester III**	
1	**Course Code**	**CHT5103**	
2	**Course Title**	**Advanced Physical Chemistry III**	
3	**Credits**	**4**	
4	**Contact hours**	**4-0-0**	
	Course Status	**Core**	
5	Course Objectives	The main objectives of this program is to: 1: To provide deep knowledge on advanced quantum chemistry. 2: To provide a thorough proficiency in approximate methods in quantum chemistry. 3: To enable students to interpret many electron systems quantum mechanically. 4: To impart knowledge on kinetics of complex reactions. 5: To make the student understand the kinetics of reaction in solution . 6: Apply the knowledge about quantum chemistry and kinetics to solve real life problems .	
6	Course Outcome	After successful completion of the course, the students will be able to: CO1: understand different polynomials and their application. CO2. apply the knowledge of time dependent perturbation theory and variational method for quantum mechanical problems. CO3 apply the quantum chemistry knowledge to analyse the behaviour of multi electron systems. CO4. explain the kinetics of various types of complex reactions CO5. Apply the knowledge of kinetics of reactions in solution to solve kinetics problems. CO7.Apply knowledge quantum chemistry to solve real life problems and kinetics to understand mechanism of reactions.	
7	Course Description	The course provides in-depth knowledge about advanced quantum chemistry and kinetics of complex reactions.	
8	Outline Syllabus		CO mapping
	Unit 1	Advanced Quantum chemistry: Prerequisite	
	A	Legendre, associated Legendre polynomials; Hermite polynomials; Lagurre and associated Lagurre polynomials; polynomials as orthonormal functions, their properties; step-up and step-down operators, application to single electron and multi-electron atom,	CO1, CO6
	B	eigen-ket-ladder and formulation of spherical harmonics from angular momentum rules, finite rotation operation	CO1, CO6

		vs. angular momentum operators, spin angular momentum, Pauli spin matrices — spin eigenfunctions and their properties.	
	C	coupling of angular momentum for many electron system, spin-orbit coupling, Molecular term symbols. Quantum tunnel effect. Fermi and Bose gases.	CO1, CO6
	Unit 2	Approximate methods	
	A	Time dependent perturbation theory, semi classical treatment of radiation-matter interaction, transition probability and rates, Einstein's A and B coefficients, selection rules; Oscillator strength,	CO2, CO6
	B	Variation theorem and variational methods: principles of linear and non-linear variation methods,	CO2, CO6
	C	stationary perturbation theory for non-degenerate and degenerate states - applications to rotator, Stark effect.	CO2, CO6
	Unit 3	Many electron systems	
	A	Antisymmetry of many electron wave function, spin and spatial orbitals, Slater dESErminant; closed-shell and open-shell electron configurations; multi-electron pure-spin state wave functions - examples with 2- and 3-electron systems,	CO3, CO6
	B	formulation of a multi-electron closed-shell electron configuration energy, introduction of core, Coulomb and exchange integrals with their properties - example of He atom, independent particle model, multi-electron atomic Hartree Hamiltonian and related SCF equations solution,	CO3, CO6
	C	Roothaan-Hartree-Fock method vertical ionization potential and Koopman's theorem; Problems with open-shell systems. Restricted and unrestricted HF methods (elementary idea).discussion of electron correlation.	CO3, CO6
	Unit 4	Kinetics of complex reactions	
	A	Application of statistical mechanics to transition state theory, comparison of transition state theory with experimental results, Kinetics of complex reactions (reversible, simultaneous and consecutive),	CO4, CO6
	B	chain reactions; branched and non-branched kinetic rate equations, population explosion, upper and lower ignition/explosion limits; thermal ignition and ignition temperature; chemical oscillation: conditions for oscillation, chemistry of BZ reaction (Brusselator model); autocatalysis,	CO4, CO6
	C	Fast reactions, experimental techniques for fast reactions (stopped-flow, temperature- jump and flash photolysis	CO4, CO6
	Unit 5	Reactions in solution	

	A	Reaction between ions, effect of solvent (single & double sphere models), interpretation of frequency factor and entropy of activation, influence of ionic strength, salt effect, reactions involving dipoles,			CO5, CO6
	B	influence of pressure and volume on reaction rates in solution. Intermolecular potential and centrifugal barrier, impact paramESEr, collision cross section and rate, energy threshold, opacity function and reaction cross section			CO5, CO6
	C	Discussion of physicochemical techniques for kinetic study.			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. Laidler, K. J. (2013). *Reaction kinetics: homogeneous gas reactions* (Vol. 1). Elsevier.			
	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. Alberty, R. A. (1960). The foundations of chemical kinetics (benson, sidney W.).			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5103.1	3	1	3	1	1	3	3	3
CHT5103.2	3	1	3	1	1	3	3	3
CHT5103.3	3	1	3	1	1	3	3	3
CHT5103.4	3	2	3	1	1	3	3	3
CHT5103.5	3	2	3	1	1	3	3	3
CHT5103.6	3	2	3	1	1	3	3	3

CHT5104 Advanced Organic Chemistry III

School: SSES		**Batch 2025-27**	
Programme: M.Sc.			
Branch : Chemistry		**Semester III**	
1	**Course No.**	**CHT5104**	
2	**Course Title**	**Advanced Organic Chemistry III**	
3	**Credits**	**4**	
4	**Contact Hours (L-T-P)**	**4-0-0**	
	Course Status	**Core**	
5	Course Objective	1.Oxidation and reduction reagents and their application for functional group conversion in organic synthesis. 2.Explain retro-synthesis of aromatic, alicyclic and aliphatic compounds and synthons. 3.The ability to recognize reagents for functional group transformations. 4.Retrosynthetic simplification of target molecules and to provide forward synthetic proposals. 5.Designing a retrosynthetic approach for the synthesis of a target molecule.	
6	Course Outcomes	CO1:Role of various reagents used in organic chemistry. CO2:Have a thorough grounding in protection and deprotection chemistry. CO3:Identify the components of retrosynthesis. CO4:Understand the synthesis and properties of metallocenes, non-benzenoids and polycyclic aromatics. CO5: Design a green synthesis using principles of prevention of waste/by-products/toxic products, atom economy. CO6: Gain in-depth knowledge in synthetic organic chemistry.	
7	Course Description	The aim of this organic chemistry course is to provide an in-depth overview of retrosynthetic analysis and the disconnection approach. These are fundamental concepts used by organic chemists in designing the synthesis of target molecules in sectors such as pharmaceuticals, agrochemicals and fine chemicals.	
8	Outline syllabus		CO mapping
	Unit 1	**Reagents in Organic Synthesis**	
	A	Use of the following reagents in organic synthesis and functional group transformations; Gilman's reagent, lithium diisopropylamide (LDA), dicyclohexylcarbodiimide(DCC)	CO1,CO6
	B	1,3-dithiane (reactivity Umpoloung), trimethylsilyl iodide, tri-n-butyltin hydride, DDQ,	CO1,CO6

	C	Phase transfer catalysts, crown ethers and Merrifield resin, Wilkinson's catalyst, Baker yeast.			CO1,CO6
	Unit 2	**Protection and Deprotection of Functional Groups**			
	A	Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy groups			CO2,CO6
	B	Protection and deprotection of amino groups and carbon-carbon multiple bonds			CO2,CO6
	C	chemo- and regioselective protection and deprotection, illustration of protection and deprotection in multi-step synthesis			CO2,CO6
	Unit 3	**Retrosynthetic Analysis**			
	A	Basic principles and terminology of retrosynthesis, guidelines, synthesis of aromatic compounds			CO3,CO6
	B	one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis			CO3,CO6
	C	important strategies of retrosynthesis, functional group transposition, important functional group interconversions, reversal of polarity (umpolung)			CO3,CO6
	Unit 4	**Metallocenes, Non-benzenoid Aromatics and Polycyclic Aromatic compounds**			
	A	General considerations, synthesis and reactions of some representative compounds - tropone, tropolone, azulene,			CO4,CO6
	B	General considerations, synthesis and reactions of some representative compounds - ferrocene, fluorene,			CO4,CO6
	C	General considerations, synthesis and reactions of some representative compounds - phenanthrene and indene.			CO4,CO6
	Unit 5	**Green Chemistry**			
	A	Principles of Green Chemistry, Concept of atom economy, Tools of Green Chemistry: Alternative feedstocks/starting materials, Reagents, Solvents, Product/target molecules, Catalysis and process analytical chemistry.			CO5,CO6
	B	Evaluation of chemical product or process for its effect on human health and environment, Evaluation of reaction types and methods to design safer chemicals. Evaluating the effects of Chemistry:			CO5,CO6
	C	Toxicity to humans, Toxicity to wildlife, Effects on local environment, Global environmental effects. Planning a green synthesis.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	

	Text Book/s*	1.Organic reactions and their mechanisms, P.S. Kalsi, New Age International. 2.Reagents for Organic Synthesis, L.F. Fieser and M. Fieser. 3.Organic Synthesis: The Disconnection Approach, Stuart Warren, Paul Wyatt. 4. Organic Chemistry, I.L. Finar Volumes I & II.
	Other references	1. Anastas, P., and Williamson, T. C., Green Chemistry Frontiers in Benign Chemical Synthesis and Processes, Oxford University Press (1999). 2.Ahluwalia, V. K., and Kidwai, M., New Trends in Green Chemistry, Anamaya Publishers (2004). 3.Protective Groups in Organic Synthesis, Peter G. M. Wuts, T.W. Greene. 4.Sheldon, R.A., Arends, I., and Hannefed, U., Green Chemistry and Catalysis, Wiley-VCH Verlag GmbH and Co. (2007).

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CHT5104.1	3	2	1	2	3	1	1	2
CHT5104.2	3	2	1	2	3	1	1	2
CHT5104.3	3	2	1	2	3	1	1	2
CHT5104.4	3	1	1	1	3	1	1	2
CHT5104.5	3	2	1	2	3	1	1	3
CHT5104.6	3	2	1	2	3	1	1	2

CHT5105 Advanced Inorganic Chemistry-IV

School: SSES		**Batch 2025-27**	
Programme: M.Sc.			
Branch:Chemistry		**Semester:III**	
Course Code		**CHT5105**	
Course Title		**Advanced Inorganic Chemistry IV**	
1	**Credits**	**4**	
2	**Contact Hour**	**4-0-0**	
	Course Status	**Core**	
5	Course Objective	1.To describe about the structure, properties and uses of inorganic chains. 2. To provide information about inorganic ring compounds. 3. To introduce the basic concepts about cluster structure and their reactivity. 4.To illustrate the basic concepts of inorganic photochemistry. 5.To describe the various photochemistry of various inorganic metal complexes. 6. To know about the application of photochemistry.	
6	Course Outcome	CO1: Explain the structure, properties and uses of inorganic cages and chains. CO2: Describe the structure and properties of inorganic rings. CO3: Predict the structure of inorganic clusters using Wade's rule. CO4: Understand photochemical reactions of various coordination compounds. CO5: Apply the knowledge of photochemistry in real life problems. CO6: Gain knowledge about advanced topics like inorganic photochemistry and inorganic clusters	
7	Course Description	The course is designed to appraise the chemistry of inorganic chains, cages, rings, clusters. The photochemistry of inorganic compounds is also covered in detail.	
8	Outline syllabus		CO mapping
	Unit 1	**Chains and Cages**	
	A	Structural aspects of silicate minerals and silicones, Zeolites-Structure, applications and synthesis, Intercalation Chemistry, One dimensional conductors, (SN)x chains.	CO1,CO6
	B	Cages: Electron deficient bonding in higher boranes and its derivatives, Types of heteroboranes with special reference to carboranes, structure, bonding and IUPAC nomenclature.	CO1,CO6

	C	Metallaboranes, metal σ and μ bonded borane/carborane clusters. Resemblance of Metallaboranes with ferrocene and related compounds. Applications of Metallaboranes.	CO1,CO6
	Unit 2	**Rings and Clusters**	
	A	Rings : Synthesis, structure and chemical application of borazine, Phosphazene, phosphazene polymers, Metal-Metal bonds. Concept of quadrupolar bond and its comparison with a C-C bond.	CO2,CO6
	B	Clusters: Types of metal clusters and multiplicity of M-M bonds. Simple and condensed metal carbonyl clusters-types, calculation of number of M-M bonds using 18/16 electron rule in low and high nuclearity metal clusters, capping rule.	CO2,CO6
	C	Application of Wade's rule over metral carbonyl clusters. Metal halide and metal chalcogenide clusters.	CO2,CO6
	Unit 3	**Photo Inorganic Chemistry-I**	
	A	Introduction, Absorption, excitation, photochemical laws, quantum yield, electronically excited states, Photochemical laws; Jablonski Diagram	CO3,CO6
	B	radiative and non-radiative processes, Franck-Condon principle, photochemical stages-primary and secondary processes, Kasha's rule, Thexi state	CO3,CO6
	C	Types of photochemical reactions in transition metal complexes–substitution, decomposition, fragmentation, rearrangement and redox reactions.	CO3,CO6
	Unit 4	**Photo Inorganic Chemistry-II**	
	A	Photo substitution reactions of Cr(III)- ammine complexes : Adamson's rules,	CO4,CO6
	B	Photochemistry of Co(III) and Rh(III) Ammine Complexes,	CO4,CO6
	C	Photochemistry of Ru- Polypyridyl complexes, comparison of Fe(II) and Ru(II) complexes. Ligand photoreactions, photoredox reactions	CO4,CO6
	Unit 5	**Applications of Photochemistry**	
	A	Solar Cells, semiconductor supported metal oxide systems, water photolysis.	CO5,CO6
	B	Applications of quenching and sensitization techniques in the identification of reactive state in coordination complexes. Photoreactions and solar energy conversions.	CO5,CO6
	C	Photochromism, Photocalorimetry, application of photochemistry in lasers.	CO5,CO6
	Mode of Examination	Theory	

	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	Text Book/s*	1.J.E.Huheey. Inorganic Chemistry: Principles of Structure and Reactivity. Harper Inter science. 2.F. A. Cotton and G. Wilkinson. Advanced Inorganic Chemistry, Wiley InterScience. 3.Concepts of Inorganic Photochemistry, A. W. Adamson and P. D. Fleischauer, Wiley. 4. Advanced Inorganic Chemistry Vol-1 & 2, Gurdeep Raj, Krishna Prakashan.		
	Other References	1.G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd edition, Pearson Education.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5105.1	3	1	1	1	1	2	3	3
CHT5105.2	3	1	2	1	1	1	3	3
CHT5105.3	3	2	2	2	2	1	3	3
CHT5105.4	3	2	1	1	2	2	3	3
CHT5105.5	3	2	2	2	1	2	3	3
CHT5105.6	3	1	1	1	2	2	3	3

CHT5106 Advanced Physical Chemistry IV

School: SSES		**Batch 2025-27**	
Programme: M.Sc.			
Branch : Chemistry		**Semester III**	
1	**Course Code**	**CHT5106**	
1	**Course Title**	**Advanced Physical Chemistry IV**	
3	**Credits**	**4**	
4	**Contact hours**	**4-0-0**	
	Course Status	**Core**	
5	Course Objectives	The main objectives of this course is to: 1: To provide the details of advanced topics of spectroscopy. 2. To provide the detailed understanding of Rotational spectroscopy. 3. To provide the structure elucidation methods using IR spectroscopy. 4. To provide the detailed knowledge of the electric structure of molecules. 5. To provide the knowledge of the phenomenon associated with photoelectron spectroscopy. 6. To enrich the student level of understanding of molecular spectroscopy.	
6	Course Outcome	After successful completion of the course, the students will be able to: CO1: Analyse the essential paramESErs from absorption and emission spectrum. CO2: Analyse the microwave spectrum of a molecule. CO3: Analyse the IR spectrum and obtain the bond strength paramESErs. CO4: Analyse the ground and excited state Absorption and emission spectrum of the molecules. CO5: Investigate the photoelectron spectrum of the molecules. CO6: Correctly predict the molecular structure and associated properties using various spectroscopic techniques.	
7	Course Description		
8	Outline Syllabus		CO mapping
	Unit 1	**Principles of Spectroscopy**	
	A	Electromagnetic radiation, Born-Oppenheimer approximation, Heisenberg's Uncertainty Principle,	CO1, CO6
	B	Jablonski Diagram, Fourier Transform, Time dependent perturbation, Einstein coefficients. Lambert-Beer's law, Integrated absorption coefficients, Transition dipole moments and general selection rules based on symmetry ideas,	CO1, CO6
	C	Transition probability, oscillator strength, the integrated absorption coefficient.	CO1, CO6

	Unit 2	**Introduction to Rotational Spectroscopy**:	
	A	Rotational spectroscopy of diatomic molecules based on rigid rotator approximation, Deterrmination of bond lengths and/or atomic masses from microwave data,	CO2, CO6
	B	Effect of isotopic substitution, Non-rigid rotator, Classification of polyatomic molecule	CO2, CO6
	C	Energy levels and spectra of symmetric top molecules and asymmetric top molecules, First order Stark effect, FC principle.	CO2, CO6
	Unit 3	**Vibrational Spectroscopy:**	
	A	Force constant and amplitudes, zero potential energy, Morse Potential, Normal coordinates analysis of homonuclear and heteronuclear diatomic molecules, Extension to polyatomic linear molecules,	CO3, CO6
	B	Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation. Anharmonic oscillator, Overtones and combination bands, Dissociation energies from Vibrational data, Vibration-rotation spectra, P, Q and R branches, Breakdown of the Born-Oppenheimer approximation.	CO3, CO6
	C	**Raman Spectroscopy:** Classical and quantum theories, Stokes and anti-Stokes lines, Polarizability ellipsoids, Rotational and Vibrational Raman spectroscopy, pure rotational Raman Spectrum of a linear molecules. Selection rules-Mutually Exclusion Principle, Polarization of Raman lines.	CO3, CO6
	Unit 4	**UV-Visible Absorption and Emission Spectroscopy:**	
	A	Basic principle, Instrumentation and application of absorption and emission spectroscopy, Electronic spectra, Frank-Condon Principle, predissociation spectra, conjugated polyene and enone systems, different types of charge transfer transitions and their basis, Charge transfer spectra in organic and inorganic systems, solvent effects.	CO4, CO6
	B	Steady-state fluorescence spectroscopy, Mirror-image symmetry and its violation, Radiative and radiationless deactivation, Fluorescence Quenching (static and	CO4, CO6

		Dynamics), Room Temperature Phosphorescence, Time-resolved (Time correlated single photon counting-TCSPC) fluorescence spectroscopy, Fluorescence lifetime measurement,	
	C	Introduction to Single molecule fluorescence and fluorescence imaging, Photometric titration, comparison of Luminescence and UV Absorption Methods, Limitation of absorption and emission measurement.	CO4, CO6
	Unit 5	**Photoelectron Spectroscopy:**	
	A	The photoionization processes, Auger and autoionization processes, de-excitaion by fluorescence,	CO5, CO6
	B	outlines of UPS, XPS and Auger techniques and their applications in interpretation of valence and core shell spectra of atoms and molecules,	CO5, CO6
	C	Laser Spectroscopy.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MSE: 25% / ESE: 50%	
	Text book/s*	□ Banwell, C.N., 2018. *Fundamentals of Molecular Spectroscopy*. 3rd ed. New York: McGraw-Hill. □ Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R., 2014. *Introduction to Spectroscopy*. Boston: Cengage Learning. □ Barrow, G.M., 1962. *Introduction to Molecular Spectroscopy*. New York: McGraw-Hill. □ Hollas, J.M., 2004. *Modern Spectroscopy*. 4th ed. Chichester: John Wiley & Sons. □ Chang, R., 1970. *Basic Principles of Spectroscopy*. New York: McGraw-Hill.	
	Other References	-	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2
CHT5106.1	3	2	3	2	3	2	1	1	2	1	3	2
CHT5106.2	3	2	3	2	3	2	1	1	2	1	3	2
CHT5106.3	3	2	3	2	3	2	1	1	2	1	3	2
CHT5106.4	3	2	3	2	3	2	1	1	2	1	3	2
CHT5106.5	3	2	3	2	3	2	1	1	2	1	3	2
CHT5106.6	3	2	3	2	3	3	1	1	2	1	3	3

CHT5107 Advanced Organic Chemistry IV

School: SSES		**Batch: 2025-27**
Programme: M.Sc.		
Branch: Chemistry		**Semester: III**
1	**Course No.**	**CHT5107**
2	**Course Title**	**Advanced Organic Chemistry IV**
3	**Credits**	**4**
4	**Contact Hours (L-T-P)**	**4-0-0**
	Course status	**Core**
5	Course Objective	This course aims to 1. Understand the fundamental principles of photochemistry, including primary photophysical processes and energy transfer mechanisms. 2. Explore the photochemical reactions of olefins and ketones with applications in organic synthesis. 3. Scrutinize the photochemical reactions of aromatic compounds with applications in organic synthesis. 4. Analyze pericyclic reactions using molecular orbital theory, including electrocyclic, cycloaddition, and sigmatropic rearrangements. 5. Apply theoretical models such as the Woodward-Hoffmann rules and frontier molecular orbital (FMO) theory to predict reaction outcomes
6	Course Outcomes	Upon successful completion of this course, students will be able to CO1: Explain the fundamental concepts of photochemistry, including Jablonski diagrams, spin rules, and photophysical processes. CO2: Identify and describe photochemical reactions of olefins and ketones such as Norish type I and Norish type II, distinguish inter & intra molecular cyclo addition, and photodissociation reaction. CO3: Learn photorearrangement reactions and compare them between types of singlet oxygen reactions. CO4: Analyze pericyclic reactions using orbital symmetry concepts and apply selection rules to predict the stereochemistry and feasibility of pericyclic reactions CO5: Identify various theories/rules governing electrocyclic reaction, cycloaddition, and sigmatropic shifts and analyze which type of pericyclic mechanism is operative in a reaction. CO6: Understand the concepts involved in organic photochemical reactions, their mechanisms, and their applications in organic synthesis.
7	Course Description	This course provides an in-depth study of photochemistry and pericyclic reactions, emphasizing fundamental principles, reaction mechanisms, and applications in organic synthesis. It covers key photochemical processes such as energy transfer, quenching, and photochemical transformations of olefins, ketones, and aromatic compounds. Additionally, it explores pericyclic reactions using molecular orbital theory, including electrocyclic reactions, cycloadditions, and sigmatropic rearrangements. The course

		equips students with theoretical and practical knowledge applicable to research and industrial chemical processes.	
8	Outline syllabus		CO mapping
	Unit 1	**Introduction to Photochemistry**	
	A	**Introduction:** Primary photophysical process of atoms and diatomic molecules (absorption and emission), spectroscopic notations, importance of electronic excitation and spin configurations – Jabolanski diagram, Wigner's spin rule, Frank Condon principle and its applications, Kasha's rule, quantum efficiency/quantum yield, potential surfaces	CO1, CO6
	B	Fate of excited state, radiationless transition and predissociation, energy transfer processes, quenching of excited states species, rates of absorption and emission	CO1, CO6
	C	**Organic photochemistry:** Introduction, definitions, Energy transfer and electron transfer processes, primary and secondary photochemical reactions	CO1, CO6
	Unit 2	**Photochemistry of alkenes and ketones**	
	A	**Photochemistry of Olefins:** Cis-trans isomerism, cycloaddition, rearrangements. Reaction of conjugated olefins; di-π-methane rearrangements (including oxa- and aza-).	CO2, CO6
	B	**Photochemistry of Ketones:** Excited state of C=O, Norrish type-I and type-II cleavages.	CO2, CO6
	C	Paterno-Buchi reaction, α,β-unsaturated ketones, Rearrangement of cyclohexadienones.	CO2, CO6
	Unit 3	**Photochemistry of aromatic compounds**	
	A	**Photochemistry of Aromatic compounds:** Isomerization of aromatic compounds, photochemical addition, rearrangement and substitution reactions	CO3, CO6
	B	photo-Fries reaction, photo-Fries reactions of anilides, photochemistry of diazocompounds, Photochemistry of p-Benzoquinones, Barton reaction,	CO3, CO6
	C	**Photo-oxidation and reduction:** Cycloaddition of singlet molecular oxygen, Oxidative coupling of aromatic compounds, photoreduction by hydrogen abstraction	CO3, CO6
	Unit 4	**Pericyclic Reactions I**	
	A	Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system.	CO4, CO6
	B	Classification of pericyclic reactions. Woodward – Hoffmann correlation diagrams. FMO and PMO approach, transition state (ATS) theory, generalized orbital symmetry (GOS) rule.	CO4, CO6

	C	Electrocyclic reactions – conrotatory and disrotatory motions, [4n], [4n+2] and allyl systems, torquoselectivity.			CO4, CO6
	Unit 5	**Pericyclic Reactions II**			
	A	Cycloadditions – antarafacial and suprafacial additions, 4n and 4n+2 systems. Regio, enantio and Endo selectivities in Diels-Alder reactions.			CO5, CO6
	B	HESEro Diels-Alder reaction, 2+2 addition of ketenes, Dipolar cycloadditions, retrocycloadditions.			CO5, CO6
	C	Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties. [i, j] - sigmatropic rearrangements (including Walk, Claisen, Cope, oxy and aza-Cope rearrangements).			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	Text book/s*	1. Photochemistry and Pericyclic Reaction, J. Singh. Editor, J. Singh, (2006) 3rd Edition, New Age Science. 2. Fundamentals of Photochemistry, K. K. Rohatgi-Mukherjee, (2022), 4th Edition, New Age International.			
	Other References	1. Organic Photochemistry, J.M. Coxon and B. Halton, (1979) Cambridge University press. 2. Aspects of Organic Photochemistry, W.M. Horspool, (1976) Academic Press. 3. Organic Reactions and Orbital symmetry, T.L. Gilchrist and R.C. Storr, (1972) Cambridge Press.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5107.1	3	1	1	1	3	1	2	2
CHT5107.2	3	1	1	1	3	1	1	2
CHT5107.3	3	2	1	2	3	1	1	2
CHT5107.4	3	2	1	2	3	1	1	2
CHT5107.5	3	2	1	2	3	1	1	2
CHT5107.6	3	1	1	1	3	1	1	2

CHT5109 Advanced Inorganic Chemistry V

School: SSES		**Batch : 2025-27**	
Programme: M.Sc.			
Branch:Chemistry		**Semester: IV**	
1	**Course Code**	**CHT5109**	
2	**Course Title**	**Advanced Inorganic Chemistry V**	
3	**Credits**	**3**	
4	**Contact Hours (L-T-P)**	**3-0-0**	
	Course Status	**Core**	
5	Course Objective	1. To describe about basic principles and importance of various metals in natural systems. 2. To describe various ion transport through biological membrane. 3.To explain the importance of Iron and Copper containing metallo-biomolecule. 4.To illustrate the chemistry of bio molecules like DNA and RNA. 5.To describe the bioinorganic chemistry of Molybdenum, Tungsten and Zinc containing Enzymes. 6. To describe the bioinorganic chemistry of Vitamin $B_{12.}$	
6	Course Outcomes	CO1:Explain the transport of ions through membrane CO2: Predict the structure and mechanism of Fe and Cu containing metalloproteins. CO3: Learn about structure and chemistry of DNA and RNA. CO4:Understand the importance of Molybdenum, Tungsten and Zinc containing Enzymes. CO5:Illustrate biologically important processes like photosynthesis CO6: Understand the role and importance of metal ions in biology.	
7	Course Description	This course includes details discussion about various bio molecules and metal containing enzymes with special reference to iron, copper, zinc, tungsten and molybdenum.	
8	Outline syllabus		CO Mapping
	Unit 1	Bioinorganic Chemistry of Metals	
	A	Essential and trace elements in biological systems,	CO1,CO6
	B	structure and functions of biological membranes; mechanism of ion transport across membranes; sodium pump, Role of calcium in blood clotting	CO1,CO6
	C	Structure and functions of amino acids, proteins, peptides	CO1,CO6
	Unit 2	Bioinorganic Chemistry of Iron and Copper	
	A	Iron-sulphur proteins: rubredoxin and ferredoxins;	CO2,CO6

	B	Heme proteins: hemoglobin, myoglobin. Cytochrome P-450, Cytochrome c-oxidase and cytochrome c;			CO2,CO6
	C	Synthetic oxygen carrier and model systems. Non-heme proteins: hemerythrin and hemocyanin.			CO2,CO6
	Unit 3	Bioinorganic Chemistry in Biological Systems			
	A	Metal complexes of polynucleotides, nucleosides and nucleic acids (DNA and RNA).			CO3,CO6
	B	Stability of DNA and melting temperature.			CO3,CO6
	C	Role of metal ions in replication and transcription process of nucleic acids.			CO3,CO6
	Unit 4	Molybdenum, Tungsten and Zinc containing Enzymes			
	A	Enzymes and their classification; Importance of Zn in nature, carbonic anhydrase, carboxypeptidase, alcohol dehydrogenase.			CO4,CO6
	B	Biological nitrogen fixation (Nitrogenase) and abiological nitrogen fixation			CO4,CO6
	C	tungsten containing formate dehydrogenase and tungsten bearing hyperthermophilic enzymes.			CO4,CO6
	Unit 5	Biologically Important Processes			
	A	Photosynthetic electron transport chain, chlorophyll, PS-I and PS-II,			CO5,CO6
	B	Vitamin B 12 coenzyme, its function			CO5,CO6
	C	Availability of iron and iron toxicity.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	Text book/s*	1. S. J. Lippard & J. M. Berg. Principles of Bioorganic Chemistry; Panima Publ. Corpn. (2005). 2. E. -I. Ochiai. Bioinorganic Chemistry; An Introduction; Allyn and Bacon Inc. (1977).			
	Other References	1.M. N. Hughes. The Inorganic Chemistry of Biological Processes; Wiley (1981). 2.R. P. Hanzlik. Inorganic Aspects of Biological and Organic Chemistry; Academic Press (1976). 3.H. Kraatz & N. Metzler-Nolte (Eds.). Concepts and Models in Bioinorganic Chemistry; Wiley (2006). 4.Bertini; H. B. Gray; S. J. Dippard & J. S. Valentine; Bioinorganic Chemistry; Viva Books Pvt. Ltd. (2004). 5.A. W. Addison; W.R. Cullen; D. Dolphin & B.R. James (eds.). Biological Aspects of Inorganic Chemistry; John Wiley (1977).			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5109.1	3	1	1	1	1	2	3	3
CHT5109.2	3	1	2	1	2	1	3	3
CHT5109.3	3	2	1	2	2	1	3	3
CHT5109.4	3	2	2	1	2	2	3	3
CHT5109.5	3	2	2	2	1	2	3	3
CHT5109.6	3	1	1	1	2	2	3	3

CHT5110Advanced Physical Chemistry V

School: SSBSR		**Batch : 2025-2027**	
Programme: M. Sc			
Branch: Chemistry		**Semester:IV**	
1	Course Code	CHT5110	
2	Course Title	**Advanced Physical Chemistry V**	
3	Credits	3.0.0	
4	Contact Hours (L-T-P)	(3 0 0)	
	Course Status	Compulsory	
5	Course Objective	1. To provide the understanding of Quantum mechanical aspect of Band gap and Band theory in semi conductors. 2. To understand the various techniques for the preparation of nanomaterial and properties of nanomaterials. 3. To extend the concept of X-Ray diffraction, their generation and different experiments to study X-Ray diffraction. 4. To provide the understanding of physical aspects in Biological phenomenon. 5. To provide the indepth concept of polymers and their properties.	
6	Course Outcomes	CO1: Direct and indirect band gap in semiconductors, types and analysis of p-n junctions. CO2: Students will be able to prepare nanomaterials and will be able to characterize their optical, electronic and structural properties. CO3:Students will be able to understand the generation of X-rays and diffraction patterns and will be able to refine the X-ray patterns. CO4: Students will be able to understand the energy Transformation and Thermodynamic principles and their applications in biological system. CO5: Student will be able to calculate the molecular weights of polymers using different techniques and will able to identify different physical and rheological properties of polymers. CO6: In depth knowledge of semiconductors, nanomaterials and polymers with application of X-rays, their generation and refinement of structure, application of physical phenomenons in biological system.	
7	Course Description	Course emphasizing on the application part of Solid state chemistry and analysis of structure using X-Ray diffraction, materials chemistry, Biophysical aspects and applications and properties of polymers.	
8	Outline syllabus		CO Mapping
	Unit 1	**Solid State Chemistry**	
	A	Free Electron Theory of Metals, Quantum Mechanical Treatment Explaining the Origin of Band Gaps (Essential for understanding semiconductor physics), Density of States, Band Theory	CO1,CO6

	B	Direct and Indirect Band Gap Semiconductors, Hole Concept, Free Carrier Concentration in Intrinsic and Extrinsic Semiconductors, Temperature Dependence of Mobility and Electrical Conductivity	CO1,CO6
	C	Generation and Recombination of Carriers in Semiconductors, Fundamental for understanding semiconductor behavior. Analysis of p-n Junction, Including I-V Characteristics	CO1,CO6
	Unit 2	**Materials Chemistry**	
	A	Definition of Nanomaterials, Fundamental for introducing the subject. Various Techniques for the Preparation of Nanomaterials, Important for practical applications. Thin Films	CO2,CO6
	B	Langmuir-Blodgett Films – Preparation Techniques – Fundamental for understanding LB films, Evaporation/Sputtering – Key physical vapor deposition (PVD) methods for thin film preparation, Chemical Processes (MOCVD, Sol-Gel)	CO2,CO6
	C	Photolithography, Electronic Structure and Properties of Nanomaterials, Optical, Electrical, and Magnetic Properties of Nanomaterials, Applications of Nanomaterials	CO2,CO6
	Unit 3	**X-Ray Diffraction and Crystal Structure**	
	A	Generation of X-rays, Fundamental for understanding X-ray-based material characterization, Diffraction of X-rays by Crystals	CO3,CO6
	B	X-ray Diffraction Experiments – The Powder Method, Bragg Condition, Bragg Method and Single Crystal Method	CO3,CO6
	C	Patterson Synthesis, R-Factor, Important for evaluating the quality of crystallographic models.	CO3,CO6
	Unit 4	**Biophysical Chemistry**	
	A	Energy Transformation and Distribution of Energy, Thermodynamic Principles in Biological Systems, Osmotic Pressure	CO4,CO6
	B	Cell Membrane and Transport of Ions, Structure and Functions of the Cell Membrane, Muscular Contraction and Energy Generation in Mechanochemical Systems	CO4,CO6
	C	Active Transport Across Cell Membrane, Irreversible Thermodynamics Treatment of Membrane Transport	CO4,CO6
	Unit 5	**Polymers**	
	A	Introduction, Classification of polymers, Concept of Mass and Number average molecular weights	CO5,CO6

	B	Physical Properties of Polymers, Glass Transition Temperature (Tg) – Crucial for understanding polymer behavior. Crystalline Melting Point (Tm)		CO5,CO6
	C	Biodegradable and Biomedical Polymers, Rheological Properties		CO5,CO6
	Mode of examination	Theory		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	Text book/s*	1. Billmeyer, F.W., *Polymer Chemistry*. New York: Wiley. 2. Gowarikar, V.R., *Polymer Chemistry*. New Delhi: New Age International. 3. Haynie, D.T., 2001. *Biological Thermodynamics*. Cambridge: Cambridge University Press. 4. Cantor, C.R. and Schimmel, P.R., 1980. *Biophysical Chemistry*, Vols. 1-3. San Francisco: W.H. Freeman. 5. Upadhyay, A., 2009. *Biophysical Chemistry: Principles and Techniques*. Mumbai: Himalaya Publishing House. 6. Martin, R.B., 1964. *Introduction to Biophysical Chemistry*. New York: McGraw-Hill. 7. West, A.R., 1984. *Solid State Chemistry and Its Applications*. Singapore: John Wiley & Sons. 8. Azaroff, L.V., 1977. *Introduction to Solids*. New Delhi: Tata McGraw-Hill. 9. Smart, L. and Moore, E., 1992. *Solid State Chemistry*. Madras: Chapman & Hall. 10. Keer, H.V., 1993. *Principles of Solid State*. New Delhi: Wiley Eastern. 11. Braun, R.D., *Instrumental Methods of Chemical Analysis*. New York: McGraw-Hill.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5110.1	3	3	2	1	1	1	3	2
CHT5110.2	3	3	3	2	1	2	3	3
CHT5110.3	3	3	2	1	1	1	3	2
CHT5110.4	3	3	2	3	1	1	2	2
CHT5110.5	3	3	2	1	1	2	2	3
CHT5110.6	3	3	3	2	2	3	3	3

CHT5111 Advanced Organic Chemistry V

School: SSES		**Batch : 2025-27**	
Program: M.Sc.		**Current Academic Year: 2026-27**	
Branch:Chemistry		**Semester: IV**	
1	**Course No.**	**CHT5111**	
2	**Course Title**	**Advanced Organic Chemistry V**	
3	**Credits**	**3**	
4	**Contact Hours (L-T-P)**	**3-0-0**	
	Course Status	**Core**	
5	Course Objective	1.To impart knowledge on synthesis of five and six- member heterocyclic compounds with two or more hetero atoms. 2.To familiarize with the synthesis of larger ring heterocyclic compounds. 3.To impart knowledge on synthesis of natural products. 4.To familiarize with structure determination of terpenoids and carotenoids. 5.To understand the structure and significance of alkaloids. 6. To provide basic knowledge of natural product chemistry and understand the importance heterocycles in biological systems and in pharmaceuticals.	
6.	Course Outcomes	After completing the course students will be able to: CO1: interpret the structure, properties, synthesis, reactions and applications of five-member heterocyclic compounds with one and more hetero atoms. CO2: explain the structure, properties, synthesis and reactions of five/six-member heterocyclic compounds with one and more hetero atoms. CO3: describe the methods of extraction, structure and synthesis of terpenes and terpenoids. CO4: elucidate the structure and synthesis of terpenoids and carotenoids. CO5: analyze the structure of alkaloids. CO6: demonstrate the knowledge of natural product chemistry and importance heterocycles in biological systems and in pharmaceuticals.	
7	Course Description	This course will provide a concise introduction to heterocyclic chemistry. Emphasis will be given on the most important heterocyclic systems particularly five, and six-membered heterocyclic systems with 2- or 3-heteroatoms as well as fused heterocyclic systems. Chemical synthesis, properties, characteristics and applications of these systems will be discussed in detail. The course provides a basic knowledge of natural products chemistry with emphasis on terpenoids, carotenoids and alkaloids.	
8	Outline syllabus		CO Mapping
	Unit 1	**Heterocycles I**	

	A	Introduction**,** synthetic approaches, reactions and important applications of five membered heterocyclic compounds with two or three hetero atoms - imidazole, oxazoles			CO1, CO6
	B	synthetic approaches, reactions and important applications of - thiazoles, oxadiazoles,			CO1, CO6
	C	synthetic approaches, reactions and important applications of - thiadiazoles			CO1, CO6
	Unit 2	**Heterocycles II**			
	A	Introduction**,** synthetic approaches, reactions and important applications of condensed five and six membered heterocycles with one/two hetero atom – indole			CO2, CO6
	B	synthetic approaches, reactions and important applications of – benzofuran			CO2, CO6
	C	Synthetic approaches, reactions and important applications of – quinoline, isoquinoline and pyrazine			CO2, CO6
	Unit 3	**Terpenoids I**			
	A	Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule			CO3, CO6
	B	Monoterpenoids - Citral, geraniol (acyclic)			CO3, CO6
	C	Structure determination and synthesis of the following representative molecules: α-terpeneol, menthol (monocyclic).			CO3, CO6
	Unit 3	**Terpenoids II and Carotenoids**			
	A	Structure deterrmination and synthesis of the following representative molecules: Sesquiterpenoids - Farnesol (acyclic), zingiberene (monocyclic),			CO4, CO6
	B	Structure determination and synthesis of the following representative molecules: santonin (bicyclic), Diterpenoids - Phytol			CO4, CO6
	C	Structure deterrmination and synthesis of the following representative molecules: β- carotene and vitamin A.			CO4, CO6
	Unit 5	**Alkaloids**			
	A	Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants.			CO5, CO6
	B	Occurence, synthesis and structure elucidation of alkaloids – Reserpine			CO5, CO6
	C	Occurence, synthesis and structure elucidation of alkaloids –morphine			CO5, CO6
	Mode of examination	Theory/Jury/Practical/Viva			
		CA	MSE	ESE	

	Weightage Distribution	25%	25%	50%	
9	Text Book/s*	1. Gilchrist, T. L. (2010). Heterocyclic chemistry, Wiley. 2. Finar, I. L. (2002). *Organic Chemistry, Volume 2: Stereochemistry And The Chemistry Natural Products, 5/E*. Pearson Education India.			
10	References	Joule, J. A., & Mills, K. (2012). HESErocyclic chemistry at a glance. John Wiley & Sons.			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5111.1	3	3	2	2	1	2	1	1
CHT5111.2	3	3	2	2	1	1	1	3
CHT5111.3	3	3	2	2	1	2	1	3
CHT5111.4	3	3	2	2	1	2	1	3
CHT5111.5	3	3	2	2	1	2	1	3
CHT5111.6	3	3	2	2	1	2	1	3

School: SSES		**Batch : 2025-27**	
Programme:M.Sc.			
Branch:Chemistry		**Semester:IV**	
1	**Course Code**	**CHT5112**	
2	**Course Title**	**Advanced Inorganic Chemistry VI**	
3	**Credits**	**3**	
4	**Contact hours**	**3-0-0**	
	Course Status	**Core**	
5	Course Objectives	1. Understand the importance of superconductors in engineering applications. 2. Relate the supramolecular role in ion dESEctions. 3. Understand the chemistry of glasses and ceramics and their application in daily routine. 4. Understand the role of superconductors in catalysis. 5. Describe the technique used in applications of nanomaterials. 6. Understand the importance of nanomaterial based device in daily. routine.	
6	Course Outcome	CO1:Understand the concept of molecular recognition in the application of supramolecules. CO2:Relate the applications of glass and ceramics on the basis of their structure. CO3:Explain the concept of superconductivity. CO4:Synthesis of nanomaterials. CO5:Identify the properties of nanomaterials and their applications in electronic applications. CO6:Gain knowledge about various advanced inorganic materials.	
7	Course Description	The course is framed to give broad view of supramolecular, smart inorganic materials, superconductors and nanomaterials. Physicochemical properties and applications of nanomaterials have been covered in this paper.	
8	Outline syllabus		CO Mapping
	Unit 1	**Supramolecular Chemistry**	
	A	Concepts of Molecular recognition: Molecular receptors for different types of molecules including anionic substrates, design and synthesis of co-receptor molecules and multiple recognition	CO1,CO6
	B	Catenanes, Rotaxanes, Dendrimers and Supramolecular gels, Supramolecular reactivity in catalysis	CO1,CO6
	C	Transport processes and carrier design. Supramolecular devices. Some example of self-assembly in supramolecular chemistry	CO1,CO6
	Unit 2	**Inorganic Smart Materials**	
	A	Structure of Glass and Ceramics: Ceramics crystal structures, density computations, silicate ceramics	CO2,CO6

	B	Glass ceramics.Refractories with reference to preparation, Properties and applications.	CO2,CO6
	C	fibre reinforced Composites, microscopic composites, preparation procedure, special properties and applications	CO2,CO6
	Unit 3	**Superconductors**	
	A	Inorganic semiconductors, Electrical, magnetic, thermal and optical properties of superconductors,.	CO3,CO6
	B	Metallic bonds High temperature superconductors Structural features of cuprate superconductors:1-2-3 and 2-1-4 cuprates.	CO3,CO6
	C	Electrical and magnetic properties of superconductors	CO3,CO6
	Unit 4	**Nanomaterials**	
	A	Definition of nanomaterials, fullerenes**,** carbon nanotubes, graphene. Discovery of C60, Superconductivity in C60, Alkali doped C60.	CO4,CO6
	B	Carbon nanotubes - Synthesis of Single walled carbon nanotubes. Synthesis methods - Arc discharge, Laser Abalation, Low temperature method, Chemical vapour deposition. Growth mechanisms on CNT.	CO4,CO6
	C	Structure and characterization techniques. Surface area measurement, determination of size and textural studies of nanotubes.	CO4,CO6
	Unit 5	**Physiochemical Properties and Applications of Nanomaterials**	
	A	Reactivity, effect of size and shape on nanocrystal reactivity, agglomeration and sintering, dispersibility and chemical stability in solution, surface modification of metallic and semiconductor nanoparticles, nanofabrication and nanomanipulation.	CO5,CO6
	B	Magnetism in nanomaterials, Doping, functionalizing nanotube.	CO5,CO6
	C	Applications of Graphene, CNTs and Fullerenes – sensing, organic transistor, odour sensor, electronics and optoelectronics and photovoltaics.	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MSE: 25% / ESE: 50%	
9	Textbook/s*	1. Timp.G. , Ed.Nanotechnology, Springer-Verlag, N. Y 2. Supramolecular Chemistry by Jonathan W Steed; Jerry L. Atwood.	
10	Other References	1. Keer, H.V. Principles of the Solid State, Wiley Eastern Ltd., New Delhi.	

		2. West, A. R., Solid State Chemistry and its applications, John Wiley and Sons. 3. Supramolecular Chemistry: Concept and Perspective by Jean Marie Lehn 4. Mitchell, B. S. – An introduction to material engineering and Science.Wiley interscience.

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5112.1	3	1	1	1	1	2	3	2
CHT5112.2	3	1	1	1	2	2	3	2
CHT5112.3	3	2	1	1	2	1	3	3
CHT5112.4	3	1	1	2	2	2	3	1
CHT5112.5	3	1	1	1	2	2	3	2
CHT5112.6	3	1	1	1	2	2	3	2

CHT5113 Advanced Physical Chemistry VI

School: SSES		**Batch : 2025-2027**	
Programme: M. Sc			
Branch:Chemistry		**Semester: 04**	
1	**Course Code**	**CHT5113**	
2	**Course Title**	**Advanced Physical Chemistry VI**	
3	**Credits**	**3**	
4	**Contact Hours (L-T-P)**	**(3 0 0)**	
	Course Status	**Core**	
5	Course Objective	6. To provide the understanding of photophysical and photochemical processes of atoms and diatomic molecules. 7. To understand various nonradiative relaxation processes. 8. To get familiar with high energy radiation with matter, radiation dosimetry and flash photolysis. 9. To understand the meaning, scope, laws of irreversible thermodynamics. 10. To provide information about various laws, paramESErs, and equations related to transport phenomenon. 11. To provide the conceptual knowledge of molecular and advanced photochemistry; radiation chemistry, dosimetry, and photolysis; irreversible thermodynamics and transport phenomenon.	
6	Course Outcomes	CO1: To understand various photophysical and photochemical processes of atoms and diatomic molecules upon irradiation. CO2: To study the various radiationless relaxation pathways. CO3: To learn about mechanism of interaction of high energy radiation with matter; radiation dosimetry and principle and application of flash photolysis. CO4: To understand the fundamental meaning, scope, and laws of irreversible thermodynamics. CO5: To get familiarize with different parameters and laws related to transport phenomenon. CO6: To study molecular and advanced photochemistry; radiation chemistry, dosimetry, and photolysis; irreversible thermodynamics and transport phenomenon.	
7	Course Description	Course emphasize on the basic concepts of molecular and advanced photochemistry; radiation chemistry, dosimetry, and photolysis; irreversible thermodynamics and transport phenomenon.	
8	Outline syllabus		CO Mapping
	Unit 1	**Molecular photochemistry**	
	A	Introduction-primary photophysical process of atoms and diatomic molecules, the absorption and emission of light - spectroscopic notations, spin-orbit coupling and spin forbidden radiative transitions,	CO1,CO6

	B	Franck-Condon principle, selection rules, laws of photochemical equivalence. Radiative transitions-classical model of radiative transitions.	CO1,CO6
	C	Jablonski diagram, Fluorescence, phosphorescence, photosensitization, and chemiluminescence.	CO1,CO6
	Unit 2	**Advanced photochemistry**	
	A	Fluorescence quenching: collisional quenching, Stern-Volmer equation, concentration quenching, quenching by excimer and exciplex emission	CO2,CO6
	B	Energy transfer: Theory of radiationless energy transfer and energy transfer by electron exchange. Fluorescence resonance energy transfer between photoexcited donor and acceptor systems and dexter energy transfer.	CO2,CO6
	C	Triplet-triplet, triplet-singlet, singlet triplet energy transfer. Multiphoton energy transfer processes, reversible energy transfer.	CO2,CO6
	Unit 3	**Radiation Chemistry, Dosimetry and Photolysis: An overview**	
	A	G-value. The mechanism of interaction of high energy radiation with matter, Photoelectric effect, Compton effect, Pair production, total absorption co-efficient, excitation and ionization, Stopping power and linear energy transfer.	CO3,CO6
	B	Radiation dosimetry: Radiation dose and its measurement, standard free air chamber method, chemical dosimeter (Frick's Dosimeter).	CO3,CO6
	C	Flash photolysis: Principle and its applications. Radiolysis of water and aqueous solutions.	CO3,CO6
	Unit 4	**Irreversible thermodynamics**	
	A	Meaning and scope of irreversible thermodynamics, Thermodynamic criteria for non-equilibrium states, Phenomenological laws- Linear laws, Gibbs equation,	CO4,CO6
	B	Onsager's reciprocal relations, Entropy production-specific examples of entropy production, Non-equilibrium stationary states,	CO4,CO6
	C	Prigogine's principle of maximum entropy production, Coupled phenomena. Some important applications.	CO4,CO6
	Unit 5	**Transport phenomena**	
	A	Diffusion coefficients, Fick's first and second laws, relation between flux and viscosity,	CO5,CO6
	B	relation between diffusion coefficient and mean free path, relation between thermal conductivity/viscosity and mean free path of a perfect gas, Einstein relation,	CO5,CO6
	C	Nernst-Einstein equation, Stokes-Einstein equation, Einstein-Smoluchowski equation.	CO5,CO6

	Mode of examination	Theory		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	Text book/s*	1. Turro, N. J. (1991). *Modern molecular photochemistry*. University science books. 2. Sood, D. D., Reddy, A. V. R., & Ramamoorthy, N. (2010). Fundamentals of radiochemistry. 4. 3. Lakowicz, J. R. (Ed.). (2006). *Principles of fluorescence spectroscopy*. Boston, MA: springer US. 4. Friedlander, G., Kennedy, J. W., Macias, E. S., & Miller, J. M. (1981). *Nuclear and radiochemistry*. John Wiley & Sons.		
	Other References	1. Rohatgi-Mukherjee, K. K. (1978). *Fundamentals of photochemistry*. New Age International. 2. Gilbert, A., & Baggot, J. (1991). Essentials of Molecular Photochemistry Blackwell Scientific. *Publications: Oxford*, 265-267. (1990). 3. Prigogine, I. (1955). *Thermodynamics of irreversible processes*. Thomas. 4. Richter, H. W., Wishart, J. F., & Nocera, D. G. (1998). Photochemistry and Radiation Chemistry. *Adv. Chem. Series*, 5.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5113.1	3	2	3	2	1	3	3	2
CHT5113.2	3	1	3	2	1	3	3	2
CHT5113.3	3	1	3	2	1	3	3	2
CHT5113.4	3	1	3	1	1	3	3	2
CHT5113.5	3	1	3	1	1	3	3	2
CHT5113.6	3	2	3	2	1	3	3	2

CHT5114 Organic Chemistry VI

School: SSES		**Batch 2025-27**	
Programme: M.Sc.			
Branch : Chemistry		**Semester IV**	
1	**Course No.**	**CHT5114**	
2	**Course Title**	**Advanced Organic Chemistry VI**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course status	Core	
5	Course Objective	1.To provide a comprehensive introduction to biochemistry. 2.To learn the chemistry of enzymes, structures of nucleic acids, proteins and carbohydrates. 3.To know the chemistry of selected steroids, cholesterol and hormones. 4.To familiarize the chemistry and structure of oxytocin. 5.To know the kinetics of enzymes. 6.To understand the chemistry of antibiotics.	
6	Course Outcomes	CO1:To introduce structure and functions of carbohydrates and their derivatives. CO2:Understand the structure, function, and folding of proteins. CO3:Analyze the double helical structure of DNA and its replication, RNA and transcription. CO4:Learn kinetics of enzyme catalyzed reactions and enzyme inhibition. CO5:Convert cholesterol to progesterone, estrone and testosterone and structure elucidation of cholesterol. CO6:Acquire knowledge of molecular structure and interactions present in proteins, nucleic acids and carbohydrates and enzymes, the organization and working principles of various components present in living cell.	
7	Course Description	The course is designed to give provide an ability to assess the significance of fundamental chemical properties on biomolecular structure, understanding of the connection between biomolecular structure and function, acquire knowledge of chemical synthesis of biomolecules and the chemical reactions of biomolecules.	
8	Outline Syllabus		CO Mapping
	Unit 1	**Carbohydrates**	
	A	Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars.	CO1,CO6
	B	N-acetylneuraminic acid, sialic acid disaccharides and polysaccharides. Structural 82polysaccharides - cellulose and chitin. Storage polysaccharides- starch and glycogen.	CO1,CO6
	C	Structure and biological functions of glucosaminoglycans or mucopolysaccharides.	CO1,CO6

	Unit 2	**Amino acids and Proteins**			
	A	Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of protein, forces responsible for holding of secondary structures. A-helix, β-sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein- folding and domain structure. Quaternary structure			CO2,CO6
	B	Amino acid metabolism- degradation and biosynthesis of amino acids,			CO2,CO6
	C	sequence determination: chemical/ enzymatic/ mass spectral, racemization/ detection			CO2,CO6
	Unit 3	**Nucleic Acids**			
	A	Introduction, chemical and enzymatic hydrolysis of nucleic acids, Structure physical and chemical properties of the heterocyclic bases – Adenine, Guanine. Cytosine, Uracil and Thiamine.			CO3,CO6
	B	Structure and synthesis of mono and poly – nucleosides and nucleotides. Deoxyribose nucleic acid (DNA): Primary, secondary, tertiary structure of DNA.			CO3,CO6
	C	Structure of RNA. Types of RNA – mRNA, rRNA and tRNA.			CO3,CO6
	Unit 4	**Enzymes**			
	A	Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation.			CO4,CO6
	B	Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors			CO4,CO6
	C	Enzyme kinetics, Michaelis–Menten and Lineweaver Burk plots, reversible and irreversible inhibition, mechanism of enzyme action			CO4,CO6
	Unit 5	**Steroids and Hormones**			
	A	Occurrence, nomenclature, Diel's hydrocarbon and stereochemistry.			CO5,CO6
	B	Isolation, structure determination and synthesis of Cholesterol, bile acids			CO5,CO6
	C	Androsterone, testosterone, estrone, progesterone, vitamin D			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	Text Book/s*	1.A.L. Lehninger, Principles of Biochemistry, CBS Publishers, Delhi. 2.I.L. Finar Volume II.			

	Other references	1.D. Voet, J.G. Voet & CW Pratt, Fundamentals of Biochemistry, John Wiley & Sons, New York. 2.H.R. Mahler and E.H. Cordes, Biological Chemistry, 2nd Edition, Harper and Row Pub., New York. 3.T.C. Bruice and S. Bentkovic, Bioorganic Mechanisms, Vol. I & II, W. A. Benjamin, New York.

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5114.1	3	1	1	1	3	1	2	2
CHT5114.2	3	1	1	1	3	1	2	2
CHT5114.3	3	1	1	1	3	1	2	2
CHT5114.4	3	1	1	1	3	1	1	2
CHT5114.5	3	1	1	1	3	1	2	2
CHT5114.6	3	1	1	1	3	1	1	2

CHT5116 Advanced Analytical Chemistry II

School: SSES		**Batch : 2025-27**	
Programme: M.Sc.		**Current Academic Year: 2025-26**	
Branch: Chemistry		**Semester: II**	
1	**Course Code**	**CHT5116**	
2	**Course Title**	**Advanced Analytical Chemistry II**	
3	**Credits**	**4**	
4	**Contact Hours (L-T-P)**	**4-0-0**	
	Course Status	**DSE**	
5	Course Objective	1. Understand the theories and principles of qualitative and quantitative analysis through optical and spectroscopic technique. 2.Analyse the textural information of bulk materials and particle dimension. 3.Carry out qualitative and quantitative analysis employing descriptive knowledge of electrochemistry and electrochemical titration. 4.Separate and estimate macromolecule (proteins, enzymes, blood and natural products) electroanalytically. 5.Effectively use various sensors for estimation and gain idea about developing technologically potent sensor materials. 6. To learn the advance spectroscopic and microscopic methods for the analysis of molecular materials.	
6	Course Outcomes	CO1: Understand various optical and spectroscopic methods for qualitative and quantitative analysis of metals and non metal to trace level. CO2: Evaluate the properties of materials such as porosity, density and microstructure of materials. CO3: Develop new synthetic routes involving electrochemical redox process. CO4: Understand principles of Cyclic Voltammetry and Electrophoresis. CO5: Develop quick, sensitive and selective sensory materials for qualitative and quantitative estimation of analyte. CO6: Investigate the molecular materials using advanced spectroscopic and microscopic techniques.	
7	Course Description	Analytical chemistry II emphasizes on various parts of analytical methods as - Atomic Spectroscopy comprises of AAS, AES and ICPMS, Electron Microscopic techniques comprises of SEM, TEM and FESEM, Polarography and amperometry, Cyclic voltammetry and electrophoresis Chemical sensors	
8	Outline syllabus		CO Mapping
	Unit 1	**Atomic Spectroscopy**	
	A	Theory, sources, burners, atomic emission spectra, atomic absorption spectra, effect of temperature on emission and	CO1,CO6

		absorption, Instrumentation for AES and AAS, standard addition and internal standard method of analysis	
	B	Comparison of atomic absorption and emission methods, Applications of AAS and AES Features of atomic mass spectroscopy, Atomic weight in mass spectroscopy, mass to charge ratio	CO1,CO6
	C	Types of atomic mass spectroscopy, quadruple mass analyzer, time of flight mass analyzer, Inductively coupled mass spectroscopy (ICPMS), Instrumentation for ICPMS, Applications of ICPMS	CO1,CO6
	Unit 2	**Electron Microscopic Techniques**	
	A	Basic principle, instrumentation and application of Transmission Electron Microscope (TEM) and HRTEM	CO2,CO6
	B	Basic principle, instrumentation and application of Scanning Electron Microscope (SEM)	CO2,CO6
	C	Basic principle, instrumentation and application of FESEM	CO2,CO6
	Unit 3	**Electroanalytical Technique I**	
	A	**Polarography** Introduction, Instrumentation, Ilkovic equation and its verification	CO3,CO6
	B	Derivation of wave equation, Determination of half wave potential, qualitative and quantitative applications	CO3,CO6
	C	**Amperometry:** Basic principles, instrumentation, nature of titration curves and analytical principles	CO3,CO6
	Unit 4	**Electroanalytical Technique II**	
	A	**Cyclic Voltammetry** Cell design, instrumentation, current-potential relation for linear sweep voltammetry (LSV), cyclic voltammetry, interpretation of voltammograms.	CO4,CO6
	B	**Electrophoresis:** Separation by adsorption-Affinity techniques, affinity elution from ion exchangers and other adsorbents	CO4,CO6
	C	Pseudo affinity adsorbents, polyacrylamide get electrophoresis, isoelecrictric focusing, isotachophoresis	CO4,CO6
	Unit 5	**Chemical Sensors**	
	A	Principles, types of chemical sensors based on the modes of transductions, Types of chemical sensor based on the chemically sensitive materials	CO5,CO6
	B	solid electrolyte, gas, semiconductor, Humidity sensors, Biosensors sensors	CO5,CO6
	C	Electrochemical sensors (Potentiometric sensors, Ion-selective electrodes, Membrane electrodes, Amperometric sensors)	CO5,CO6

	Mode of examination	Theory		
	Weightage Distribution	CA	MSE	ESE
		25%	25%	50%
	Text book/s*	Principles of Instrumental Analysis, Skkog, Holler, Nieman, (Sixth Ed.)		
	Other References	1) Introduction to Instrumental Analysis by R. D. Broun, Mc Graw Hill (1987) 2) Instrumental methods of chemical analysis by H. willard, L.Merrit, J.A. Dean and F.A. settle. Sixth edition CBS (1986) 3) Fundamentals of Analytical Chemistry, 6th edition, D.A. Skoog, D.M. West and F.J. Holler, Saunders college publishing. 4) Principles of Instrumental Analysis, Skkog, Holler, Nieman, (Sixth Ed.) 5) Introduction to instrumental analysis by R. D. Braun, MC. Graw Hill-International edition. 6) Analytical Chemistry, Ed. by Kellner, Mermet, otto, Valcarcel, Widmer, Second Ed. Wiley –VCH 7) Electron microscopy in the study of material, P. J Grundy and G. A Jones, Edward Arnold.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
C5116.1	3	2	1	2	3	1	1	2
C5116.2	3	2	1	2	3	1	1	2
C5116.3	3	2	1	2	3	1	1	2
C5116.4	3	2	1	2	3	1	1	2
C5116.5	3	2	1	2	3	1	1	2
C5116.6	3	2	1	2	3	1	1	2

CHT5117 Introduction to Environmental Chemistry

School: SSES		**Batch : 2025-27**	
Programme: M.Sc.			
Branch:Chemistry		**Semester: IV**	
1	**Course Code**	**CHT5117**	
2	**Course Title**	**Introduction to Environmental Chemistry**	
3	**Credits**	**4**	
4	**Contact Hours (L-T-P)**	**4-0-0**	
	Course Status	**DSE**	
5	Course Objective	1.To introduce the basics knowledge of chemistry of environment. 2.To describe the chemistry of hydrosphere. 3.To provide an introduction to chemistry of soil. 4.To explain to the student the causes of industrial pollution. 5.To provide information environmental toxicology. 6.To illustrate the infamous cases of environment related disasters.	
6	Course Outcomes	CO1:Understand the chemistry of atmosphere. CO2:Understand the chemistry of hydrosphere. CO3:Explain the chemistry of soil. CO4: Know about adverse effect of industrialization and possible prevention method CO5:Know about environmental toxicology and a few example of environmental disaster. CO6: Gain knowledge about the chemistry of atmosphere, factors affecting it and possible prevention methods	
7	Course Description	This course describes the chemistry of earth atmosphere, soil and water bodies. It also describes the adverse effect of industrial pollution and its possible prevention method.	
8	Outline syllabus		CO Mapping
	Unit 1	**Earth's Atmosphere**	
	A	Introduction, composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere	CO1,CO6
	B	Bio-distribution of elements. Reactions in atmosphere, Stratospheric chemistry. Chemistry of photochemical smog, Precipitation, Acid rain, Production and removal of nitric acid, Sulphuric acid	CO1,CO6
	C	Atmospheric aerosols-Sources, Concentrations, Control. Chemistry of global climate. Air sampling techniques, Sources, effects and monitoring of air pollutants by Instrumental methods, Control of air pollution	CO1,CO6

	Unit 2	**Hydrosphere**			
	A	Chemical composition of water bodies – lakes, streams, rivers and wetlands etc Hydrological cycle. Aquatic pollution-inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills and oil pollutants			CO2,CO6
	B	water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms, water quality standards, Analytical methods for measuring BOD, DO, COD, F, OILS, METALS (As, Cd, Cr, Hg, Pb, Se), Residual chloride and chlorine demand, purification and treatment of water.			CO2,CO6
	C	Distribution of species in aquatic systems: Single variable diagrams, Two variable diagrams, Method of calculating pE^o			CO2,CO6
	Unit 3	**Soils**			
	A	Chemical composition of the soil, micro and macronutrients, the exploitation of the mineral resources and abuse of the earth			CO3,CO6
	B	soil pollution due to natural and artificial agencies and its effects, remedial measures to check the pollution. pollution-fertilizers, pesticides, plastics and metals, waste treatment.			CO3,CO6
	C	Humic material–Formation, Composition, Structure determination using spectroscopy, Properties. Radioactive pollution, disposal of radioactive waste			CO3,CO6
	Unit 4	**Industrial Pollution**			
	A	Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy, polymers, drugs etc			CO4,CO6
	B	radionuclide analysis, disposal of wastes and their management. Waste Water, Treatment of Industrial Waste Water,			CO4,CO6
	C	Environmental Impact Assessment process in India.			CO4,CO6
	Unit 5	**Environmental Toxicology**			
	A	Chemical solutions to environmental problems, biodegradability,			CO5,CO6
	B	principles of decomposition, better industrial processes. Bhopal Gas Tragedy, Chernobyl Disaster, Three Mile Island, Sewozo and Minamata disasters**.**			CO5,CO6
	C	Occupational safety Hazard Assessment, MSDS			CO5,CO6
	Mode of examination	Theory			
		CA	MSE	ESE	

	Weightage Distribution	25%	25%	50%
	Text book/s*	1.Environmental Chemistry, A.K.Das. 2.Environmental Chemistry, Samir K. Banerji. 3.Environmental Chemistry H. Kaur, 6th Edn, Pragathi Prakashan, Meerut, 2011. 4.Environmental Pollution Analysis, S. M. Khopkar, New Age International (P) Ltd, 1993.		
	Other References	1.Analysis of Industrial Waste Water, K.H.Mancy and W,.J.Weber Jr. Wiley, Interescience New York, 1971. 2.Environmental Chemistry, L.W. Moore and E. A. Moore, McGraw Hill Publication, New York 3.Environmental Chemistry, Colid Baird. W. H. Freemand and Company, 1995.		

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO1	PO2	PSO1	PSO2
CHT5117.1	3	2	1	2	3	2	2	3
CHT5117.2	3	1	1	2	3	2	2	3
CHT5117.3	3	2	1	3	3	2	2	3
CHT5117.4	3	1	1	2	3	2	2	3
CHT5117.5	3	2	1	1	3	2	1	3
CHT5117.6	3	2	1	1	3	2	1	3

CHP4102 Advanced Organic Chemistry Lab I

School: SSES		**Batch: 2025-27**
Programme: M.Sc.		**Current Academic Year: 2025-26**
Branch: Chemistry		**Semester: I**
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 deterrmine 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 dESErmine 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	ESE
		60%	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.

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHP4102.1	3	1	1	2	3	1	1	1
CHP4102.2	3	1	1	1	3	1	1	1
CHP4102.3	3	1	1	1	3	1	1	1
CHP4102.4	3	1	1	2	3	1	1	1
CHP4102.5	3	1	1	2	3	1	1	1
CHP4102.6	3	1	1	1	3	1	1	1

CHP4103 Advanced Physical Chemistry Lab I

School: SSES		**Batch:2025-27**	
Programme: M.Sc		**Current Academic Year: 2025-26**	
Branch: Chemistry		**Semester:I**	
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 Calorimeter.	CO1,CO6
	C	To study precipitation titration between KCl and $AgNO_3$ conductometrically and deterrmine the strength of the given solution of $AgNO_3$	CO1,CO6
	Unit 2	**Quantitative Analysis - II**	
	A	To deterrmine 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 deterrmine the strength of H_3PO_4 by titration with standard NaOH using pH meter	CO2,CO6
	Unit 3	**Quantitative/Qualitative Assessment - I**	
	A & B	To determine the strength of strong acid and weak acid conductometrically by titrating against standard NaOH solution	CO3,CO6
	C	To estimate the amount of ferrous ions in a given solution potentiometrically.	CO3,CO6
	Unit 4	**Quantitative/Qualitative Assessment -II**	
	A	To study the separation of dyes by thin layer chromatography (TLC)	CO3,CO4,CO6
	B	To determine the amount of $BaCl_2$ in a given solution by conductometric titrations	CO3,CO4,CO6
	C	Study the conductometric titration of hydrochloric acid with sodium carbonate	CO3,CO4,CO6
	Unit 5	**Data Handling**	
	A & B	To calculate Mean, Median, Mode, Standard deviation, Variance, Range by using Microsoft Excel	CO5,CO6
	C	To calculate and draw the first and second derivative of given data on excel sheet.	CO5,CO6
	Mode of examination	Practical/Viva	
	Weightage Distribution	CA	ESE
		60%	0%
	Text book	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.	
	Other References	Vogel's "Textbook of quantitative Analysis", Pearson.	

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CHP4103.1	3	1	1	2	3	1	1	1
CHP4103.2	3	2	1	1	3	1	1	1
CHP4103.3	3	1	1	1	3	1	1	1
CHP4103.4	3	1	1	1	3	1	1	1
CHP4103.5	3	2	1	1	3	1	1	1
CHP4103.6	3	1	1	1	3	1	1	1

School: SSES		**Batch:2025-27**	
Programme: M.Sc		**Current Academic Year: 2025-26**	
Branch: Chemistry		**Semester:II**	
1	**Course Code**	**CHP4105**	
2	**Course Title**	**Advanced Inorganic Chemistry Lab II**	
3	**Credits**	**1**	
4	**Contact Hours (L-T-P)**	**0-0-2**	
	Course Status	**Core**	
5	Course Objective	To learn about types of titration and estimation of elements of alloys, and learn the techniques of jobs method and characterization of metal complexes	
6	Course Outcomes	After doing this course the student should be able to CO1: Prepare solutions of different strength and standardize them CO2: Analyse domomite sample CO3: Analyse various ferro-alloys and steel 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 characterisation of given material. It will enable students to analyse various materials like steel and alloys.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical related to analysis of samples**	
		Sub unit – a ,b, c	CO1, CO6
	Unit 2	**Practical related to determination of elements in a mixture**	
		Sub unit –a, b, c	CO2, CO6
	Unit 3	**Practical based to analysis of ferro alloys and steel**	
		Sub unit- a, b, c	CO3, CO6
	Unit 4	**Practical related to Applications of jobs method**	
		Sub unit – a, b, c	CO4, CO6
	Unit 5	**Practical based to synthesis and characterization of metal complexes.**	
		Sub unit - a, b, c	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	Vogel's "Textbook of quantitative Analysis", Pearson.

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHP4105.1	3	1	1	1	1	1	3	1
CHP4105.2	3	1	1	1	1	2	3	1
CHP4105.3	3	1	1	1	2	2	3	3
CHP4105.4	3	2	1	1	2	2	3	3
CHP4105.5	3	1	1	1	2	1	3	3
CHP4105.6	3	1	1	1	1	2	3	2

CHP4106 Advanced Organic Chemistry Lab II

School: SSES		**Batch: 2025-2027**
Programme: M.Sc.		**Current Academic Year: 2025-26**
Branch: Chemistry		**Semester: II**
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 Description	This course provides an in-depth exploration of qualitative and synthetic techniques in organic chemistry. Students will analyze binary mixtures, perform organic syntheses, and apply chromatographic separation methods. They will also gain hands-on experience in instrumental analysis for product identification. By the end of the course, students will develop essential

		laboratory skills necessary for research and industrial applications in organic chemistry	
8	Outline syllabus		CO Mapping
	Unit 1	**Qualitative analysis of organic compounds-I**	
	A	To analyze the mixture of two components. (Mixture 1)	CO1, 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.

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHP4106.1	3	2	1	2	3	1	1	2
CHP4106.2	3	1	1	1	3	1	1	2
CHP4106.3	3	2	1	2	3	1	1	2
CHP4106.4	3	2	1	2	3	1	1	2
CHP4106.5	3	2	1	2	3	1	1	2
CHP4106.6	3	1	1	1	3	1	1	1

CHP4107 Advanced Physical Chemistry Lab II

School: SSES		**Batch: 2025-27**
Programme: M.Sc.		**Current Academic Year: 2025-26**
Branch:Chemistry		**Semester:II**
1	**Course Code**	**CHP4107**
2	**Course Title**	**Advanced 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 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 deterrmine 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	This lab provides hands-on training in essential analytical instruments, including spectrophotometers, conductometers, polarimeters, and potentiometers, which are widely used in research and industrial applications. This course equips students with the skills to operate these instruments effectively, enabling them to perform advanced experiments such as constructing adsorption curves and thermometric titration curves and computing atomic parameters. Emphasizing both theoretical and practical aspects, the lab enhances students' understanding of instrumental techniques, preparing them for careers in scientific research, quality control, and industrial chemistry**.**

8	Outline syllabus		CO Mapping
	Unit 1	**Practical based Conductometer and Potentiometer**	
	A& 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 $\Delta tGmix$ of the surfactant.	**CO5**
	Unit 4	**Practical based on Polarimeter and Spectrophotometer**	
	A	Find out the rate constant of acid-catalysed hydrolysis of sucrose by polarimeter. Study the rate equation for mutarotation of D-glucose in water using polarimeter.	**CO2**
	B & C	To deterrmine the concentration of $KMnO_4$ solution after adsorption using UV/Visible spectrophotometer.	**CO2**
	Unit 5	**Computational Modeling, Salt line and Double Alkali Method**	
	A	To calculate the atomic parameters using density function calculations and molecular simulations.	**CO4**
	B & C	Titrate using conductometer 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: 60%	ESE: 40%
	Text book/s		
	Other References	Practical Physical Chemistry by B. D. Khosla, R. Chand and Co., New Delhi	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CHP4107.1	3	1	1	1	3	1	1	1
CHP4107.2	3	1	1	1	3	1	1	1
CHP4107.3	3	2	1	2	3	1	1	2
CHP4107.4	3	2	1	2	3	1	1	2
CHP4107.5	3	2	1	2	3	1	1	2
CHP4107.6	3	1	1	1	3	1	1	1

CHP5101 Advanced Organic Chemistry III

School: SSES		**Batch:2025-2027**	
Programme: M.Sc			
Branch: Chemistry		**Semester III**	
1	**Course number**	**CHP5101**	
2	**Course Title**	**Advanced Organic Chemistry Lab III**	
3	**Credits**	**2**	
4	**Contact Hours (L-T-P)**	**0-0-4**	
5	Course Objective	This course aims to 1. Understand and apply various techniques for the extraction and separation of organic compounds from natural sources. 2. Develop proficiency in the qualitative and quantitative analysis of organic compounds. 3. Utilize chromatographic and spectroscopic techniques for the identification and characterization of organic compounds. 4. Perform the synthesis of organic compounds using standard laboratory protocols. 5. Enhance analytical and problem-solving skills in organic chemistry through experimental procedures.	
6	Course Outcomes	Upon successful completion of this course, students will be able to CO1: Extract and analyze organic compounds from natural sources, such as caffeine, piperine, and plant pigments. CO2: Separate and identify ternary organic mixtures using standard laboratory techniques. CO3: Perform quantitative estimations of organic compounds, including glucose, amino acids, and aspirin purity. CO4: Synthesize organic compounds using multi-step procedures and protecting group strategies. CO5: DESErmine the structure of unknown organic compounds using spectroscopic methods such as IR and ^{1}H-NMR. CO6: Develop proficiency in the extraction, separation, synthesis, and structural elucidation of organic compounds using analytical and spectroscopic techniques, enhancing their practical skills and problem-solving abilities in organic chemistry	
7	Outline syllabus		CO Mapping
	Unit 1	**Extraction of Organic Compounds**	
	A	To study the extracted caffeine from tea leaves and report its percentage yield and m.pt.	CO1, CO6
	B	To study the extract piperine from black pepper and report its percentage yield and m.pt.	CO1, CO6

	C	To extract plant pigments and then identify these pigments by chromatography.	CO1, CO6
	Unit 2	**Separation of Organic compounds in a ternary mixture**	
	A	To separate and identify the organic mixture containing 3 components.	CO2, CO6
	B	To separate and identify the organic mixture containing 3 components.	CO2, CO6
	C	To separate and identify the organic mixture containing 3 components.	CO2, CO6
	Unit 3	**Quantitative estimation of Organic compounds**	
	A	To determine the amount of Glucose by Fehling's solution.	CO3, CO6
	B	To determine the strength of amino acid in given unknown solution by Sorenson's formol titration.	CO3, CO6
	C	To determine the purity of synthesized aspirin by TLC and titration method.	CO3, CO6
	Unit 4	**Synthesis of Organic compounds**	
	A & B	To prepare *p*-nitroaniline from aniline using the three steps protecting group strategy.	CO4, CO6
	C	To prepare *m*-nitroaniline from nitrobenzene and confirm its identity with FTIR.	CO4, CO6
	Unit 5	**Structure elucidation of Organic compounds**	
	A	To determine the structure of the given unknown compound with the help of its IR and ^{1}HNMR.	CO5, CO6
	B	To determine the structure of the given unknown compound with the help of its IR and ^{1}HNMR.	CO5, CO6
	C	To determine the structure of the given unknown compound with the help of its IR and ^{1}HNMR.	CO5, CO6
	Mode of examination	Practical/Viva	
	Weightage Distribution	CA	ESE
		60%	40%
	Text book	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.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CHP5101.1	3	2	1	2	3	1	1	2
CHP5101.2	3	2	1	2	3	1	1	2
CHP5101.3	3	2	1	2	3	1	1	2
CHP5101.4	3	1	1	1	3	1	1	2
CHP5101.5	3	2	1	2	3	1	1	3
CHP5101.6	3	2	1	2	3	1	1	2

CHP5102 Advanced Physical Chemistry Lab III

School: SSES		**Batch:2025-2027**
Programme: M.Sc.		
Branch: Chemistry		**Semester III**
1	**Course Code**	**CHP5102**
2	**Course Title**	**Physical Chemistry Lab III**
3	**Credits**	**2**
4	**Contact hours**	**0-0-4**
	Course Status	**Core**
5	Course Objectives	To learn methods for determination of various physical properties of compounds using spectrophotometric, UV-Vis, FTIR and kinetic studies.
6	Course Outcome	Student will be able to: 7. Learn to use instruments like UV/Vis spectrophotometers and FTIR to determine the composition, characteristics, and dissociation constants of different chemicals/solutions. 8. Determine the parameters from enzyme kinetic reaction. 9. Explain the phase diagram of a two-component system. 10. Measure the molecular weight of a polymer. 11. Correlate the concept of Chemical kinetics and its application in measuring rate constant and activation energy. 12. Design experiments, analyse experimental results and represent the data through writing.
7	Course Description	The course will help students learn the concepts of various physical chemistry techniques from a practical point of view. It will also help students understand experiments related to spectrophotometric, UV-Vis, and IR spectroscopy, kinetics, viscosity, Phase diagrams of binary mixtures, etc. This course is framed to explain the methods used in physical experiments.
8	Outline Syllabus		CO mapping
Unit 1	**Practical related to Spectrophotometric analysis**		CO1, CO6
	1. Deterrmine the dissociation constant of phenolphthalein spectrophotometrically. 2. Calculate the composition of a metal complex using Job's method and the mole ratio method.		
Unit 2	**Practical related to UV and IR Spectroscopy**		CO1, CO6
	1. Study the effect of solvent on the UV spectra of organic compound (Propanone).		

	2. To study the effect of conjugation length on the electronic structure of a molecule via UV-vis absorption and IR spectroscopy. 3. Deterrmine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture spectrophotometrically.	
Unit 3	**Practical related to Phase diagram**	CO3, CO6
	1. To deterrmine the eutectic temperature and the composition of the eutectic mixture for the naphthalene and p-nitrotoluene system 2. To deterrmine the phase diagram of a binary system (urea and benzoic acid) and find the eutectic composition and temperature. 3. To investigate the eutectic behavior of a naphthalene-diphenylamine system.	
Unit 4	**Practical based on Polymer**	CO4, CO6
	1. Determination of the molecular weight of a polymer from intrinsic viscosity measurements**.** 2. To deterrmine the number-average molecular weight (Mn) of a polymer using osmotic pressure data.	
Unit 5	**Practical based on Kinetics**	CO2, CO5
	1. To determine the enzyme kinetics paramESErs (Km and Vmax) using substrate concentration vs. reaction rate data. 2. To measure enzyme activity using a color change reaction.	

Mode of examination	Practical/Viva	
Weightage Distribution	CA	ESE
	60%	40%
Text book/s*	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.	
Other References	Vogel's "Textbook of Quantitative Analysis", Pearson.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CHP5102.1	3	1	1	1	3	3	2	2
CHP5102.2	3	1	1	1	3	3	2	2
CHP5102.3	3	2	1	2	3	3	2	2
CHP5102.4	3	1	1	1	3	3	2	2
CHP5102.5	3	1	1	1	3	3	1	2
CHP5102.6	3	1	1	1	3	3	2	2

CHP5103 Advanced Inorganic Chemistry Lab III

School:		**SSES**	
Department		**Department of Chemistry & Biochemistry**	
Program:		**M.Sc**	
Branch:		**Chemistry**	
1	**Course Code**	**CHP5103**	
2	**Course Title**	**Advance Inorganic Chemistry Lab III**	
3	**Credits**	**2**	
4	**Contact Hours (L-T-P)**	**0-0-4**	
	Course Status	**Core**	
5	Course Objective	The main objective of this course is: 1. To explain various types of titrations. 2. To illustrate gravimetric analysis. 3. To provide information about analysis of ores and cement. 4. To explain analysis of alloys like brass and steel. 5. To learn to synthesize and characterize inorganic compounds.	
6	Course Outcomes	After doing this course the student should be able to CO1: Analyze brass sample CO2 :Analyze cement sample CO3: Analyze a sample of alloy and steel CO4 :To carry out the photochemical reactions CO5 To synthesize and characterize transition metal complexes CO6 : Analyze samples of industrial and construction industry along with synthesis of transition metal complexes	
7	Course Description	Various industrial and construction materials are a combination of various different substances. In this course the student will learn to analyse such complex mixture.	
8	Outline syllabus		CO Mapping
	Unit 1	**Analysis of industrially important materials-I**	
	A	Estimation of copper in a sample of brass	CO1,C06
	B	Estimation of tin in a sample of brass	CO1,C06

	C	Estimation of lead in a sample of brass	CO1,C06
	Unit 2	**Analysis of industrially important materials-II**	
	A	Analysis of silica in Portland cement	CO2,C06
	B	Analysis of Fe_2O_3 in Portland cement	CO2,C06
	C	Analysis of CaO in Portland cement.	CO2,CO6
	Unit 3	**Analysis of ores**	
	A	Estimation of Mn(II) in pyrolusite.	CO3,C06
	B	Estimation of available oxygen in pyrolusite	CO3,C06
	C	Analysis of P in steel.	CO3,C06
	Unit 4	**Synthesis and characterization of transition metal complexes-I**	
	A	Synthesis and characterization of Salen ligand	CO4,CO6
	B	Synthesis and characterization of metal complexes of Salen ligand	
	C	Crystallization and characterization of compounds	CO4, CO6
	Unit-5	**Synthesis and characterization of transition metal complexes-II**	
	A	Synthesis of cis-$[Co(NH_3)_2Cl_2]Cl$ and its characterization	CO5, CO6
	B	Synthesis of trans-$[Co(NH_3)_2Cl_2]Cl$ and its characterization	CO5, CO6
	C	Synthesis of $K_3[Fe(C_2O_4)_3]Cl$ and study its photochemical reaction	CO5, CO6

Mode of Examination	Practical/Viva	
Weightage Distribution	CA	ESE
	60%	40%
Text books*	• A Text Book of Qualitative Organic Analysis, A I Vogel • O.P. Pandey, D.N. Bajpai, S. Giri, " Practical Chemistry", S. Chand & Co	
Other References	• Systematic experiments in Chemistry Arun Sethi, New Age International(P) Ltd.	

Mapping of CO vs. PO

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHP5103.1	3	2	1	1	1	1	3	3
CHP5103.2	3	2	1	2	1	1	3	3
CHP5103.3	3	2	1	1	1	2	3	3
CHP5103.4	3	2	1	1	2	2	3	3
CHP5103.5	3	2	1	1	2	2	2	1
CHP5103.6	3	2	1	1	2	2	2	2

PHT1151 Artificial Intelligence and Machine Learning

School: SSES		**Batch: 2025-2027**
Programme: M.Sc		**Current Academic Year: 2025-2026**
Branch: Chemistry		**Semester: I**
Branch:		**2025-26**
1	**Course Code**	**PHT1151**
2	**Course Title**	**Artificial Intelligence and Machine Learning**
3	**Credits**	**2**
4	**Contact Hours (L-T-P)**	**2-0-0**
	Course Status	**SEC**
5	Course Objective	This course provides a rigorous introduction to the core principles, algorithms, and mathematical foundations of Artificial Intelligence (AI) and Machine Learning (ML). Students will learn the theoretical aspects of AI and ML as well as their practical applications in solving complex real-world problems.
6	Course Outcomes	CO1. To provide a comprehensive understanding of Artificial Intelligence (AI) and Machine Learning (ML), their definitions, history, and types (Narrow AI vs General AI), and their practical applications across various fields. CO2. To introduce and explore key supervised learning algorithms, including regression models, classification techniques, and support vector machines (SVM), alongside concepts like regularization, decision trees, random forests, and neural networks. CO3. To cover unsupervised learning techniques such as clustering (k-means, hierarchical, DBSCAN, Gaussian Mixture Models) and dimensionality reduction methods (PCA, t-SNE, ICA), along with anomaly dESEction techniques. CO4. To delve into the fundamentals and optimization techniques of neural networks and deep learning, including CNNs, RNNs, auto encoders, transfer learning, and strategies for overcoming issues like vanishing gradients. CO5. To examine ethical considerations in AI and ML, focusing on fairness, privacy, security, and accountability in AI systems, as well as discussing the social implications and regulatory challenges posed by AI advancements. CO6. To explore recent advances in AI and ML, current trends and challenges in the industry, and equip students with research skills, including how to read and understand academic papers, write research proposals, and ensure reproducibility and research ethics.
7	Course Description	This course provides a comprehensive introduction to Artificial Intelligence (AI) and Machine Learning (ML), covering their theories, algorithms, and real-world applications. Topics include supervised and unsupervised learning,

		neural networks, deep learning, and optimization techniques. Additionally, ethical considerations and recent advances in AI and ML are explored to prepare students for both research and industry challenges.	
8	**Outline Syllabus**		CO Mapping
	Unit 1	**Introduction to AI**	
	A	Overview of Artificial Intelligence (AI): Definition and history, Types of AI: Narrow AI vs General AI, AI in practice: Applications in different fields	CO1
	B	Machine Learning (ML): Definition, scope, and goals,	CO1
	C	Types of Machine Learning: Supervised Learning, Unsupervised Learning, Reinforcement Learning	CO1
	Unit 2	**Supervised Learning**	
	A	Regression Models: Linear Regression, Logistic Regression	CO2
	B	Classification Models: k-Nearest Neighbors (k-NN) Decision Trees and Random Forests	CO2
	C	Naive Bayes Classifier	CO2
	Unit 3	**Unsupervised Learning**	
	A	Clustering: k-Means Clustering, Hierarchical Clustering, DBSCAN, Gaussian Mixture Models	CO3
	B	Dimensionality Reduction: Principal Component Analysis (PCA), t-SNE (t-Distributed Stochastic Neighbor Embedding)	CO3
	C	Independent Component Analysis (ICA), Anomaly DESEction	CO3
	Unit 4	**Neural Networks and Deep Learning**	
	A	Introduction to Neural Networks: Perceptron and Multilayer Perceptron's (MLP), Activation Functions, Back propagation and training process	CO4
	B	Deep Learning: Convolutional Neural Networks (CNNs)	CO4
	C	Recurrent Neural Networks (RNNs), Auto encoders and Generative Models	CO4
	Unit 5	**Ethics and Future of AI and ML**	
	A	Ethical Considerations in AI: Bias and fairness in AI models, Privacy and security concerns, AI in decision-making: accountability and transparency	CO5
	B	AI Safety: Alignment and control problems, AI and employment: social implications, Autonomous systems and regulations	CO5

	C	Recent Advances in AI and ML: Current state-of-the-art techniques and models, AI in industry: Trends and challenges, Research Methods in AI and ML: Reading and understanding academic papers, Writing research proposals, Research ethics and reproducibility			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MSE	ESE	
		25%	25%	50%	
	Text book/s*	1. "Pattern Recognition and Machine Learning" by Christopher Bishop 2. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville 3. "Artificial Intelligence: A Modern Approach" by Stuart Russell and PESEr Norvig 4. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy			
	Other References	1. Coursera's "Machine Learning" by Andrew Ng 2. Fast.ai's deep learning courses 3. Stanford's CS231n (Convolutional Neural Networks for Visual Recognition)			

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
PHT1151.1	1	2	3	3	1	2	1	1
PHT1151.2	2	3	3	3	1	2	1	1
PHT1151.3	1	3	3	3	1	2	1	1
PHT1151.4	2	3	3	3	1	2	1	1
PHT1151.5	1	3	3	3	1	3	2	1
PHT1151.6	2	3	3	3	1	3	2	1

PHP1153 Data Analysis Using Python

School: SSES	Batch: 2025-2027

Programme: M.Sc		Current Academic Year: 2025-2026	
Branch: Chemistry		Semester: I	
1	Course Code	PHP1153	
2	Course Title	Data Analysis Using Python	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	SEC	
5	Course Objective	This course introduces Master's students to core statistical concepts and their application using Python. It covers data analysis, hypothesis testing, regression models, and statistical inference with libraries like NumPy, pandas, and statsmodels. Students will gain practical skills through hands-on coding assignments and projects.	
6	Course Outcomes	CO1. To introduce students to Python libraries for statistics (NumPy, pandas, Matplotlib, Seaborn, SciPy, and statsmodels) and enable them to manipulate data structures such as arrays, Series, and Data Frames for statistical analysis and visualization. CO2. To teach regression analysis techniques, including simple and multiple linear regression, logistic regression, and model evaluation metrics such as R-squared, MSE, MAE, and AUC, helping students build and interpret predictive models. CO3. To provide a solid foundation in time series analysis, focusing on key concepts such as trends, seasonality, noise, stationarity, and time series decomposition for effective data analysis. CO4. To enable students to apply time series forecasting models, specifically ARIMA and Seasonal ARIMA (SARIMA), for making accurate predictions based on historical data, including model selection, fitting, and forecasting using Python's statsmodels library. CO5. To provide students with the opportunity to apply the statistical methods and techniques learned throughout the course to analyze a real-world dataset, including data cleaning, exploratory data analysis (EDA), and statistical inference. CO6. To develop students' ability to present their findings from the analysis, effectively communicating their results and insights using appropriate statistical tools and Python libraries.	
7	Course Description	This course covers statistical methods and their application using Python, focusing on regression analysis, time series forecasting, and real-world data analysis. Students will learn to work with key Python libraries for data manipulation and visualization, apply forecasting models like ARIMA and SARIMA, and gain hands-on experience through a capstone project that involves data cleaning, analysis, and presentation of findings.	
8	**Outline Syllabus**		CO Mapping

	Unit 1	**Introduction to Python for Statistics**	
	A	Python Libraries for Statistics: NumPy, Pandas,	CO1
	B	Data Structures and Manipulation: Arrays, Series, DataFrames	CO1
	C	Matplotlib, Seaborn, SciPy, statsmodels	CO1
	Unit 2	**Regression Analysis**	
	A	Simple Linear Regression: Theory, assumptions, model fitting in Python using statsmodels	CO2
	B	Multiple Linear Regression: Model interpretation, multicollinearity, regularization	CO2
	C	Polynomial Regression: Fitting and evaluating higher-degree models, fitting of custom equation	CO2
	Unit 3	**Time Series Analysis**	
	A	Time Series Basics: Trends, seasonality, and noise	CO3
	B	Time Series Decomposition: Trend, seasonal	CO3
	C	Residual components	CO3
	Unit 4	Time Series Forecasting Models	
	A	ARIMA Model: Concept and components (AR, I, MA):Model selection: Autocorrelation Function (ACF)	CO4
	B	Fitting and forecasting with ARIMA in statsmodels	CO4
	C	Seasonal ARIMA (SARIMA)**:** Extension of ARIMA for seasonal data, Identifying seasonal components (SARIMA model structure),SARIMA model fitting and forecasting	CO4
	Unit 5	Data Analysis Project	
	A	Capstone Project**:** Students will apply the statistical methods.	CO5
	B	Students will apply Python tools learned throughout the course to analyze a real-world dataset.	CO5
	C	The project will require data cleaning, exploratory data analysis (EDA), statistical inference, and the presentation of findings.	CO6
	Mode of examination	Practical	
	Weightage Distribution	CA: 60 / ESE: 40	
	Text book/s*	1. "Python for Data Analysis" by Wes McKinney 2. "Statistics for Business and Economics" by Paul Newbold, William L. Carletta, and Theresa L. Miller	

		3. "Practical Statistics for Data Scientists" by PESEr Bruce and Andrew Bruce 4. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy	
	Other References	1. Python Documentation for NumPy, pandas, Matplotlib, SciPy, and statsmodels 2. Kaggle: Practical datasets and tutorials for applying statistics to real-world problems with Python.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
PHP1153.1	1	2	3	2	1	2	1	1
PHP1153.2	2	3	3	3	1	2	1	1
PHP1153.3	1	2	3	3	1	2	1	1
PHP1153.4	2	3	3	3	1	2	1	1
PHP1153.5	1	2	2	2	3	3	2	1
PHP1153.6	2	2	3	2	3	3	2	1

CHP5104 Instrumental Methods of Analysis Lab

School: SSES	**Batch:2025-27**
Programme: M.Sc.	**Current Academic Year: 2025-26**
Branch: Chemistry	**Semester: III**

1	Course Code	**CHP5104**	
2	Course Title	**Instrumental Methods of Analysis Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	DSE	
5	Course Objective	1. To demonstrate AAS for determining the metal ion concentrations 2. To explain physicochemical and biochemical properties of environmental and biological samples 3. To interpret concept of CV 4. To provide demo of Column chromatography and HPLC. 5. To explain interpretation of analytical data.	
6	Course Outcomes	After doing this course the student should be able to CO1: Handle AAS to determine metal concentration CO2: Explain working of Conductometer, UV/Vis spectrophotometer CO3: Analyze samples using concept of voltammetry CO4: Conduct analysis using column chromatography and HPLC CO5: Gain the practical knowledge of different analytical techniques and data interpretation. CO6: Apply the skills in industries	
7	Course Description	Analysis of food, water and soil samples for purity and chemical composition.	
8	Outline syllabus		CO Mapping
	Unit 1	To determine the concentration of different dyes and metal ions in given sample using colorimeter.	
		To compare the lambda max of different organic sample using UV and their quantification in given sample.	CO1, CO6
		Viva	
	Unit 2	To Analyse the physicochemical properties of water/soil .	
		To Analyse the Biochemical properties of plant leaves.	CO2, CO6
		Viva	
	Unit 3	To understand the working of Cyclic voltammogram using K3[Fe(CN)6]	
		Cu and Zn from tap water by differential pulse polarography and by square wave polarography.	CO3, CO6
		Vitamin-C analysis in given sample using cyclic voltammetry.	
	Unit 4	To prepare chromatography column and perform the separation of mixture of Organic Compounds.	

		To quantify the caffeine in given samples of tea using HPLC.	CO4, CO6
	Unit 5	To prepare the standard calibration graphs of Pb, Cd, Zn and Fe by AAS	
		To perform digestions of metal samples for analysis using AAS.	
		To determine the metal ions in given samples using AAS.	CO5, CO6
	Mode of examination	Practical/Viva	
	Weightage Distribution	CA	ESE
		60	40

	Text book/s*	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.

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHP5104.1	3	1	2	2	1	3	3	2
CHP5104.2	3	1	2	2	1	3	3	2
CHP5104.3	3	1	2	2	1	3	3	2
CHP5104.4	3	2	2	2	1	3	3	2
CHP5104.5	3	1	2	2	1	3	3	2
CHP5104.6	3	1	2	2	1	3	3	2

CHP5106 : Advanced Organic Chemistry Lab IV

School: SSBSR		**Batch:2025-27**	
Programme: M.Sc		**Current Academic Year: 2025-26**	
Branch: Chemistry		**Semester IV**	
1	Course Code	**CHP5106**	
2	Course Title	Advanced Organic Chemistry Lab IV	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	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: Estimate elements CO2: Analyse ores CO3:Estimate elements in alloys. CO4: Estimate elements colorimetrically. CO50synthesize metal complexes CO6: Analyze elements and ores and prepare metal complexes.	
7	Course Description	The course aims to appraise the students to learn methods of estimate elements in ores and alloys. It will enable students to prepare metal complexes	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on active pharmaceutical ingredients**	
	A & B	Separation of active single component and mixture of components from pharmaceutical tablets; identification of components by m.p., functional groups and spectral data	CO1, CO2,CO6
	C	Quantitative estimation of the components in pharmaceutical tablets	
	Unit 2	**Practical related to reagents**	
	A & B	Preparation of Grignard Reagent and it's reaction	CO3, CO6
	C	Preparation of Wittig reagent and it's reaction	
	Unit 3	**Multi-step synthesis of Organic Compounds**	
	A	Advanced organic synthesis :Resorcinol → 7-Hydroxy-4-methylcoumarin →	CO4, CO6

		7-Acetoxy-4-methylcoumarin → 4- Methyl-7-hydroxy-8-acetylcoumarin	
	B	Advanced organic synthesis :Hydroquinone→ Hydroquinone Diacetate → 2,5 -Dihydroxyacetophenone → 2, 5 Dibenzoxyacetophenone	
	C	Direct Oxidative esterification of Aldehyde (using Iodine and Alcohol).	CO5, CO6
	Unit 4	**Green Synthesis of Organic compounds(any 2)**	
	A, B & C	1. The Aldol Condensation Reaction 2.ELECTROPHILIC AROMATIC SUBSTITUTION REACTION-I (Nitration of phenol) 3.COENZYME CATALYZED BENZOIN CONDENSATION (Thiamine hydrochloride catalyzed synthesis of benzoin) 4.ACETYLATION OF PRIMARY AMINE (Preparation of acetanilide) 5.RADICAL COUPLING REACTION (Preparation of 1, 1-bis-2-naphthol)	CO4, CO6
	Unit 5	**Practical based to synthesis and characterization of metal complexes.**	
	A	Application of column chromatography	CO5, CO6
	B		
	C		
	Mode of examination	Practical/Viva	

	Weightage Distribution	CA	CE	ETE
		25%	25%	50%

	Text book/s*	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.
	Other References	Vogel's "Textbook of quantitative Analysis", Pearson. https://faculty.ksu.edu.sa/sites/default/files/green-chem.pdf

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHP5106.1	3	1	1	1	1	1	3	1
CHP5106.2	3	1	1	1	1	2	3	1
CHP5106.3	3	1	1	1	2	2	3	3
CHP5106.4	3	2	1	1	2	2	3	3
CHP5106.5	3	1	1	1	2	1	3	3
CHP5106.6	3	1	1	1	1	2	3	2

CHP5108 Advanced Physical Chemistry Lab IV

School: SSES		**Batch:2025-2027**
Programme: M.Sc.		
Branch: Chemistry		**Semester**
1	Course Code	CHP5108
2	Course Title	Advanced Physical Chemistry Lab IV
3	Credits	2
4	Contact hours	0-0-3
	Course Status	Compulsory
5	Course Objectives	The objective of the Advanced Physical Chemistry Lab IV course is to equip students with hands-on experience in applying physicochemical techniques to study complex chemical systems. The course aims to develop a comprehensive understanding of chemical kinetics through the oxidation of alcohols, spectrophotometric analysis of acid-base indicators, and UV-Visible spectroscopy for determining dissociation constants. It further introduces potentiometric and conductometric titrations for accurate analysis of redox reactions, halide ions, and acid-base equilibria, along with complexometric and precipitation reactions. Students will also gain skills in pH-metric titrations for quantifying components in commercial samples like washing soda, determining molecular weights of macromolecules via viscometry, and exploring semiconductor properties through band-gap determination. Overall, the course emphasizes analytical thinking, experimental precision, and interpretation of physicochemical data.
6	Course Outcome	Student will be able to: 1. Apply principles of chemical kinetics to determine the order, rate constant, activation energy, and propose mechanisms for oxidation reactions (e.g., alcohol oxidation by potassium dichromate). 2. Utilize spectrophotometric and UV-Visible techniques to determine dissociation constants of acid-base indicators and weak acids across different pH conditions. 3. Perform potentiometric titrations to accurately determine the concentration of redox-active species and

		halide ions using standard solutions and electrochemical methods. 4. Conduct conductometric titrations to study acid-base, complexometric, and precipitation reactions, and interpret conductivity changes to identify equivalence points. 5. Employ pH-metric titrations to estimate the composition of basic salts (e.g., Na_2CO_3 in washing soda), enhancing understanding of acid-base equilibria. 6. Determine physical properties such as the molecular weight of macromolecules by viscometry and band-gap energy of semiconductors using spectroscopic analysis.	
7	Course Description	Advanced Physical Chemistry Lab IV is designed to provide students with practical exposure to experimental techniques that reinforce theoretical concepts in physical chemistry. The course focuses on a diverse range of topics, including reaction kinetics, spectrophotometry, electrochemical analysis, and the study of the physicochemical properties of substances. Through experiments such as oxidation kinetics, colorimetric and UV-Visible analysis of dissociation equilibria, potentiometric and conductometric titrations, pH-metric analysis, viscometry, and band-gap determination, students gain hands-on experience with essential laboratory instruments and analytical methods. These experiments are aimed at enhancing students' abilities to collect and analyze data, interpret results, and apply fundamental principles to real-world chemical problems. The course outcomes are tailored to build competencies in both classical and modern physical chemistry techniques, preparing students for research and industry-oriented roles in chemistry and allied sciences.	
8	Outline Syllabus		CO mapping
Unit 1	**Experimental Studies in Chemical Kinetics and Catalysis**		CO1, CO6
	1. Study the kinetics of oxidation of isopropyl alcohol/ ethanol by potassium dichromate. 2. Determine the order, rate constant, energy of activation and possible mechanism for the reaction. 3. Study the kinetics of the acid-catalyzed iodination of acetone.		
Unit 2	**Spectrophotometric Determination of Acid-Base Equilibria**		CO1, CO6
	1. Determine the dissociation constant of an indicator (methyl red) colourimetrically **2.** Determination of pKa of p-Nitrophenol (in aqueous or aqueous-ethanol medium)		

Unit 3	**Potentiometric Analysis of Redox and Precipitation Reactions**	CO3, CO6
	1. Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration). 2. Determination of concentration of halide ion(s) in the given solution potentiometrically.	
Unit 4	**Conductometric Titrations and Ionic Interactions**	CO4, CO6
	1. Conductometric titration of (I) strong acid, monobasic weak acid or polybasic weak acid with strong base - zinc with EDTA 2. Conductometric titration of (I) strong acid, monobasic weak acid or polybasic weak acid with strong base- KCl vs AgNO3	
Unit 5	**Physicochemical Characterization Techniques**	CO5, CO6
	1. Determination of Na2CO3 content (in %) of washing soda using a pH meter 2. The determination of the molecular weight of a macromolecule by viscometry. **3.** Determination of band-gap of a semiconductor	

Mode of examination	Practical/Viva	
Weightage Distribution	CA	ESE
	60%	50%
Text book/s*	O.P. Pandey, D.N. Bajpai, S.Giri, " Practical Chemistry", S. Chand & Co.	
Other References	Vogel's "Textbook of Quantitative Analysis", Pearson.	

Mapping of CO vs. PO

CO/PO	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4
CHP5108.1	3	1	1	1	3	3	2	2
CHP5108.2	3	1	1	1	3	3	2	2
CHP5108.3	3	2	1	2	3	3	2	2
CHP5108.4	3	1	1	1	3	3	2	2
CHP5108.5	3	1	1	1	3	3	1	2
CHP5108.6	3	1	1	1	3	3	2	2

CHP5107 : Advanced Inorganic Chemistry Lab IV

School: SSES		**Batch:2025-27**	
Programme: M.Sc		**Current Academic Year: 2025-26**	
Branch: Chemistry		**Semester IV**	
1	Course Code	**CHP5107**	
2	Course Title	Advanced Inorganic Chemistry Lab IV	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	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: Estimate elements CO2: Analyse ores CO3:Estimate elements in alloys. CO4: Estimate elements colorimetrically. CO50synthesize metal complexes CO6: Analyze elements and ores and prepare metal complexes.	
7	Course Description	The course aims to appraise the students to learn methods of estimate elements in ores and alloys. It will enable students to prepare metal complexes	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical based on Estimation of elements**	
	A B C	Estimation of Iron Estimation of Manganese Estimation of Copper	CO1, CO2,CO6
	Unit 2	**Practical related to Analysis of ores**	
	A B C	Analysis of Dolomite Analysis of Pyrulosite Analysis of Galena	CO3, CO6
	Unit 3	**Practical related to analysis of alloys**	
	A B C	Estimation of lead in solder Estimation of copper and zinc in brass Estimation of Chromium and Nickel in stainless steel	CO4, CO6
	Unit 4	**Practical related to Colorimetric analysis**	
	A	Colorimetric estimation of Iron	CO5, CO6

	B C	Colorimetric estimation of Nickel Colorimetric estimation of Manganese	
	Unit 5	**Practical based to synthesis and characterization of metal complexes.**	
	A **B** **C**	Synthesis and characterization of Tris(ethylenediamine)cobalt(III) chloride Synthesis and characterization of Diisothiocyanato dipyridine manganese Synthesis and characterization of Bis(acetylacetonato)copper(II)	CO6 CO6 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	Vogel's "Textbook of quantitative Analysis", Pearson.

Mapping of CO Vs PO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2
CHT5107.1	3	1	1	1	1	1	3	1
CHT5107.2	3	1	1	1	1	2	3	1
CHT5107.3	3	1	1	1	2	2	3	3
CHT5103.4	3	2	1	1	2	2	3	3
CHT5103.5	3	1	1	1	2	1	3	3
CHT5103.6	3	1	1	1	1	2	3	2

CHT5108 Research Methodology and Intellectual Property Rights

School: SSES		**Batch: 2025-2027**		
Program: M.Sc.		**Current Academic Year: 2025-26**		
Branch: Chemistry		**Semester: III**		
1	**Course Code**	CHT5108		
2	**Course Title**	Research Methodology and Intellectual Property Rights		
3	**Credits**	1		
4	**Contact hours**	2-0-0		
	Course Status	Compulsory	SEC	Theory
5	**Course Objectives**	The course aims to equip students with the knowledge and skills to conduct research effectively and understand the importance of Intellectual Property Rights (IPR), including how to protect and utilize them.		
6	**Course Outcomes**	**CO1:** Know about types of publications, types of journals with their indexing & metrics, publication houses and academic social networking websites, and able to search relevant literatures to find research problems, gaps in research, research objectives & design research methodology. **CO2:** Identify the keywords for the search of different kinds of literatures on various search engines and get to know about various software's for the management of citations and references **CO3:** Learn about different components of research papers, review articles andsoftwares for formatting of papers, preparation of posters and slides. **CO4:** Understand basics of intellectual property rights. **CO5:** To learn about copyright for their innovative works. **CO6:** Understand the fundamentals of research, manuscript/research proposal writing, communication and research ethics		
7	**Course Description**	This course will give an overview of basic concepts employed in quantitativeand qualitative research. It focuses on ethical issues associated with research writing and publication. Also describes the use of various computer applications required for research.		

8	**Outline Syllabus**		**CO mapping**
	Unit 1	**Introduction to Research**	
	A	Meaning and importance of Research – Types of Research – Selection and formulation of Research	CO1, CO6
	B	Developing a Research Plan – Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Designs	CO1, CO6
	C	Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive – Inductive logical process – Different types of inductive logical methods.	CO1, CO6
	Unit 2	**Importance of literature survey**	
	A	Planning a literature search, Identifying key concepts and key words, locating relevant literature, Reliability of a source.	CO2, CO6
	B	Introduction to literature review process, types of literature review: descriptive, systematic, state-of-the-art, etc. Literature review using different platforms like Google, PubMed, science direct,	CO2, CO6

		Elsevier, ACS etc.	
	C	Research ethics with respect to science and research, scientific misconducts:Falsification, Fabrication, and Plagiarism (FFP)	CO2, CO6
	Unit 3	**Academic Writing & Reference Management**	
	A	Structure and components of scientific reports, types of report, Significance	CO3, CO6
	B	Different steps in the preparation, layout, structure and language of typical reports, illustrations and tables, bibliography	CO3, CO6
	C	Citation styles: definition, components, types such as APA, Chicago, Harvard, IEEE, etc., reference management tools such as Mendeley, Zotero, Endnote, etc.	CO3, CO6
	Unit 4	**Intellectual Property Rights**	
	A	Introduction to intellectual property rights, concept of corporeal and incorporeal property	CO4, CO6
	B	Types of intellectual property rights, Introduction to patents, patent act 1970 – amendments of 1999, 2000, 2002 and 2005, patentable and non-patentable inventions, GMO patents in India and abroad	CO4, CO6
	C	IP Rights and regulatory concerns for genetically modified seeds/plants in India, patent registration process, restoration of lapsed patents, surrender and revocation of patents, infringement of patents	CO4, CO6
	Unit 5	**Patents, copyrights, and trademarks**	
	A	Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties.	CO5, CO6
	B		CO5, CO6
	C	Indian copyright: definition, genesis, copyright laws etc., concept of trade mark and trademark laws-national and international, International regime related to IPR, TRIPS and other treaties (WIPO, WTO, GATTA)	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MSE: 25% / ESE: 50%	
	Text book/s*	1. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. India: New Age International (P) Limited. 2. Thomas, C. G. (2021). Research Methodology and Scientific Writing. Germany: Springer International Publishing. 3. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.	
	Other References	1. Mukherjee, S. P. (2019). A Guide to Research Methodology: An Overview of Research Problems, Tasks and Methods. United States: CRC Press. 2. Ramakrishna, B., Anil Kumar, H. S. (2017). Fundamentals of Intellectual	

		Property Rights: For Students, Industrialist and Patent Lawyers. India: Notion Press.	

Mapping of CO vs. PO

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PSO6	PSO1	PSO2
CHT5108.1	3	3	2	2	1	3	2	2
CHT5108.2	3	2	2	2	1	2	2	2
CHT5108.3	2	2	2	2	1	1	2	1
CHT5108.4	2	1	2	2	1	1	2	2
CHT5108.5	2	2	2	2	1	1	2	2
CHT5108.6	2	1	2	2	1	1	2	2

CHR4101 Project

School: SSES		**Batch:2025-27**		
Programme: M. Sc.		**Current Academic Year:2025-26**		
Branch: Chemistry		**Semester:04**		
1	**Course Code**	CHR4101		
2	**Course Title**	Project		
3	**Credits**	4		
4	**Contact Hours (L-T-P)**	0-0-8		
5	**Course Type**	**Qualifying**	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.		

CHR5101 Dissertation I(RBL-1)

School: SSES		**Batch 2025-27**		
Programme: Master of Science		**Current Academic year 2025-26**		
Branch: Chemistry		Semester: III		
1	**Course Code**	CHR5101		
2	**Course Title**	Dissertation I(RBL-1)		
3	**Credits**	6		
4	**Contact Hours (L-T-P)**	**0-0-12**		
5	**Course Type**		DSE	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		

CHR5102 Dissertation I(RBL-1)

School: SSES		**Batch:2025-27**		
Programme: M.Sc.		**Current Academic Year:2025-26**		
Branch: Chemistry		Semester: III		
1	**Course Code**	CHR5102		
2	**Course Title**	Dissertation I(RBL-1)		
3	**Credits**	2		
4	**Contact Hours (L-T-P)**	0-0-4		
5	**Course Type**	DSE	Compulsory	Project
6	**Course Objective**	1. Demonstrate an ability to plan a research project, such as is required in a research proposal prior to the launch of their work		
		2. Demonstrate an ability to comply with ethical, safety, and documentation processes appropriate to their project.		
		3. Demonstrate expert knowledge in the subject of their research project, such as through an integrated literature survey		
		4. Demonstrate expert knowledge in the research methods appropriate to generating reliable data for their research questions		
		5. Demonstrate the ability to project manage and to make constructive use of expertise associated with their project, while working as an independent learner Demonstrate an ability to relate their original data to existing literature, or to create a novel synthesis of existing materials		
		6. Demonstrate an ability to assemble their findings into a substantial piece of writing that presents a clear thesis and a cohesive, evidence-based argument		
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		

CHR5103 Dissertation I(RBL-1)

School: SSES		**Batch:2025-2027**
Programme: M.Sc.		**Current Academic Year: 2024-25**
Branch:Chemistry		**Semester III**
1	Course Code	**CHR5103**
2	Course Title	Dissertation I(RBL-1)
3	Credits	16
4	Contact Hours (L-T-P)	(0-0-32)
	Course Status	Compulsory
5	Course Objective	Develop knowledge of a specific area of specialization. Develop research skills in project writing and oral presentation.
6	Course Outcomes	CO1: Understand the objectives of research. CO2: Acquire the methodology of scientific work. CO3: Understand the reason behind scientific research. CO4: Prepare the model of research work. CO5: Prepare the roadmap for research work. CO6: Prepare students to face challenges in solving unsolved problems.
7	Course Description	This course is designed for students to study topics not offered in regularly available courses. This course encourages reading a field of special interest and gain in-depth update knowledge about it.

CHR5104 Dissertation II(RBL-2)

School: SSES		Batch:2025-2027
Programme: M. Sc.		**Current Academic Year: 2024-25**
Branch:Chemistry		**Semester IV**
1	Course Code	**CHR5104**
2	Course Title	Dissertation II(RBL-2)
3	Credits	14
4	Contact Hours (L-T-P)	(0-0-28)
	Course Status	Compulsory
5	Course Objective	• This course will help to ensure that students are able to demonstrate advanced knowledge of the role of science and of its contribution to the disciplines related to the field of technology. Critically analyze and interpret the results of scientific and technological research, and evaluate its limits and possibilities with respect to knowledge and its implementation.
6	Course Outcomes	CO1: To be able to identify and describe methods within the philosophy of science in general. CO2: Extract line of approach to overcome the research gap. CO3: To acquire an overview of important characteristics within technological research and development. CO4: To identify the relation between pure science on the one hand and applied research on the other, the relation between research and practice, and the relation between technology and society. CO5: To demonstrate an understanding of the limits and possibilities for research in science and technology. CO6: To acquire skills of presenting arguments and results of scientific and technological research.
7	Course Description	This course will deepen the student's understanding of research in general, and with basic science and technological research in particular. The students are expected to apply knowledge of methodology, concepts, philosophical problems and arguments presented in this course to their own fields of exploration.

CHR5105 Minor project/Term paper(Dissertation II / RBL-2)

School: SSES		**Batch :2025-27**
Programme: M.Sc.		
Branch: Chemistry		**Semester: IV**
1	Course Code	CHR5105
2	Course Title	Minor project/Term paper(Dissertation II or RBL-2)
3	Credits	3
4	Contact Hours (L-T-P)	0-0-6
	Course Status	Compulsory
5	Course Objective	1.To enhance the practical knowledge and result analysis skills. 2.To enable the students experience a real-life problem solving under the supervision of faculty members. 3.To prepare the students perform functions that demand higher competence in national/international organizations. 4.To train the students in scientific research. 5.To help the students find meaning in life by broadening their field of vision. 6.Develop deep knowledge of a specific area of specialization by literature search.
6	Course Outcomes	CO1: Able to do literature search, develop deeper interest / inquisitiveness in chemistry and interdisciplinary subjects. CO2: Able to prepare stock solutions, buffers etc . CO3: Understand the basics of chemistry and become familiar with qualitative and qualitative estimations. CO4: Able to understand the chemistry of reactions. CO5: Able to analyse the results and understand the chemical reactions involved. CO6: Enhance the practical skills.
7	Course Description	This course provides the applied knowledge of chemistry and gives confidence and a solid foundation for future learning.

CHR5106 Dissertation II(RBL-2)

School: SSES		Batch :2025-27
Programme: M.Sc.		
Branch: Chemistry		Semester: IV
1	Course Code	CHR5106
2	Course Title	Dissertation II(RBL-2)
3	Credits	6
4	Contact Hours (L-T-P)	0-0-12
	Course Status	Compulsory
5	Course Objective	1.To enhance the practical knowledge and result analysis skills. 2.To enable the students experience a real-life problem solving under the supervision of faculty members. 3.To prepare the students perform functions that demand higher compESEnce in national/international organizations. 4.To train the students in scientific research. 5.Develop research/ experimentation skills as well as enhancing project writing and oral presentation skills 6.Inculcate team spirit and time management.
6	Course Outcomes	CO1: Able to use lab instruments independently. CO2:Cultivate the understanding of problem, study design, methodology/ experimentation, significance of reproducibility of results. CO3:Understanding of ethics of science and research for supporting higher studies. CO4:Learn effective project organizational skills along with discussions, result interpretation and paper writing. CO5: Able to analyse the results and understand the chemical reactions involved. CO6: Enhance the practical skills.
7	Course Description	This course will help to develop knowledge and research skills applicable to a career in chemistry.

CHR4104 Basic Chemistry Softwares

School: SSES		**Batch: 2025-27**	
Program: M.Sc.		**Current Academic Year: 2025-26**	
Branch: Chemistry		**Semester: I**	
1	Course Code	CHP4104	
2	Course Title	Basic Chemistry Softwares	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Type	Core	
5	Course Objective	Students will gain knowledge and skills on the various important software tools used in chemistry. They will learn how to plot a graph in Microsoft Excel, origin, draw, and visualize the chemical structure in ChemDraw, origin, CCDC, etc. Students will also develop presentation skills in this course. Students will know of: • Drawing the graph in Microsoft Excel, Origin • Drawing and visualizing the chemical structure in ChemDraw, origin, CCDC • Students will also develop presentation skills in this course.	
6	Course Outcomes	CO1: The student will be able to understand the basis of Microsoft Excel and the tool used in the plotting of graphs and calculations. CO2: The student will be able to learn how to draw structures in chem draw and chem craft. CO3: The student will be able to learn the basis of origin and plotting of graph in origin CO4: The student will be able to learn how to visualize and draw any chemical structure using CCDC and mercury CO5: The student will be able to gain knowledge of the importance of citation in a research article CO6: The student will be able to gain knowledge of the important software used in chemistry	
7	Course Description	This course introduces the most frequent and important software and tools in chemistry for making and analyzing the structure and basics of Microsoft Excel, and PowerPoint. Students will be capable of utilizing this software knowledge during their research and higher studies.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Microsoft Excel**	
	A	Download Microsoft Office365, and Excel Program and view the basics of Excel, and Excel spreadsheets for data entry, and create simple formulas in an Excel spreadsheet to analyze data.	CO1, CO6
	B	Introduction to Excel Charting, Chart and Graph Editing, Formatting Chart elements, Handling Graph in Chart	CO1, CO6
	C	Application of Excel in chemistry with a few examples	CO1, CO6
	Unit 2	**ChemDraw and ChemSketch**	
	A	Introduction of ChemDraw, chemical name to structure conversion, chemical structure to name conversion	CO2, CO6

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