

INDIRA GANDHI UNIVERSITY, MEERPUR, REWARI
(A State University Established under Haryana Act No.29 of 2013)
(Recognized u/s 12B & 2f of UGC Act, 1956)



Syllabus and Scheme of Examination
(as per NEP 2020)
for
Post Graduate Programme
in
Chemistry

Effective from Academic Year: 2026-27

Department of Chemistry
Faculty of Physical Sciences
Indira Gandhi University Meerpur-Rewari (122502)
Haryana, India

Details of Approvals

Council/Board	Date	Remark
Staff Council		
Board of Studies		
Faculty		
Academic Council		
Year of implementation		

Chairperson
(Signature with Stamp)

VISION AND MISSION OF THE UNIVERSITY

VISION

To be a globally renowned university, recognized for excellence in teaching, innovative research, and welfare of the society, imbibing the spirit of “*Vasudhaiv kutumbkam*”.

MISSION

- To introduce and implement innovation in teaching and learning process matching up the global standards to strengthen academic delivery through curriculum design, teaching pedagogy and usage of ICT.
- To develop a mechanism that attracts talented, qualified and experienced faculty from across the globe for pursuing their academic and research careers at the University.
- To offer academic programs at UG, PG, doctoral, Post-Doctoral levels which are learner- centric, industry focused, and adhere to outcome based international models.
- To create an ambiance that is conducive for undertaking sponsored research, innovation and consultancy services to a wide spectrum of societal and industrial requirements while encouraging interdisciplinary approach of learning, team work, and research.
- To establish state of art centres of excellence in frontier areas of research and design innovation through industry collaboration to innovate and incubate the products and services.
- To establish smart campus and promote e-governance activities in the university for the digitally empowered society and knowledge economy.
- To provide a hygienic, modern, environment friendly and vivacious campus attuned to the urgent needs of Green Technology.
- To consider and implement norms, metrics, standards, procedures and benchmarks for assessing and improving the quality in every aspect of University system and achieve quality certifications by National and International bodies.
- To make society self-reliant by organizing various programmes including literacy, gender sensitization, health awareness, and dissemination of information

about livelihood generation.

VISION AND MISSION OF THE DEPARTMENT

VISION

To train students to be highly effective instructors, researchers, and contributors to chemical based industries and stakeholders globally. Be regarded as a prestigious centre of scholarly achievement worldwide.

MISSION

- To advance chemical sciences research, science, and education.
- To create skilled employees for businesses and industries based on chemistry's experimental methods and methodologies.
- To offer learning environments that are centred on the needs of the students in order to help them develop as people as a whole.
- To introduce summer training and research projects to strengthen academic delivery.
- To establish smart classrooms and well-equipped laboratory for assessing and improving the quality in every aspect of academic and research.
- To make students and researchers self-reliant by organizing various programmes like workshop, seminars, national and international conferences, educational tours and industrial visit.

ABOUT THE PROGRAMME

The Post-Graduate Programme in Chemistry will impart advanced knowledge of basic and applied chemical sciences to the graduates. It will prepare the students for taking up challenging assignments in academia and industry and also empower them with skill and knowledge for generating employment for their own and others. The Programme introduces the students to advanced developments in chemical sciences as well as in the field of other allied sciences, by providing them interdisciplinary courses. The design of choice-based curriculum can enrich students with analytical and problem-solving capabilities. It is designed to bring out the best of the abilities of each student, allow them to sharpen the scientific temper and be abreast with the contemporary developments in the area.

The programme includes a balanced combination of Core, Discipline centric Electives Courses, Open Elective Courses, Foundation Elective Courses, summer trainings and Project work to fulfil the aim of NEP-2020. The courses are designed in such a way to cover the entire spectrum of chemical sciences from fundamentals (that will bring admitted students from various backgrounds to a common level) to most recent advancements in the field (that will make them ready to take up challenging assignments in the real world). Statistical Techniques and its application, IT Skills, Polymer materials and Laboratory based practical are included in the programme to foster the development of creative and divergent competencies. Sustainable and green Chemistry paper is included in the programme to sensitize students for cross-cutting issue “Environment and Sustainability” which is relevant to the current concerns both nationally and internationally.

The programme includes summer training to teach students professional ethics.

The M.Sc. (Chemistry) Programme is of two years duration which is divided into four semesters. The teaching and learning in the Programme will involve theory (lectures), practicals, tutorial and presentation-based classes.

The curriculum will be taught through formal lectures with the aid of pre-made presentations, audio and video tools whenever necessary. Other teaching aids can also be used as and when required.

The Aims of the programme include

- To inculcate basic and advanced knowledge of chemical sciences among students.
- To provide higher education, disciplinary and inter -disciplinary research-oriented knowledge to the students to make them lifelong learners.
- To provide a learned, skilled and creative pool of graduates who are ready to take up challenging assignments in different kinds of chemical industries, research institutions and academia.
- To mould responsible, proactive citizens who are equipped with scientific thinking and skills to address problems of their locality
- Adequate blend of theory, computation and hands-on experiments.
- Modernized lab courses – close to recent/current research.

MINIMUM ELIGIBILITY CRITERIA

As per University Ordinance

PASSING CRITERIA

As per University Ordinance

ELIGIBILITY FOR EXAMINATION

As per University Ordinance

DURATION FOR PASSING THE PROGRAMME

As per University Ordinance

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	To have fundamental as well as advanced knowledge of the chemistry domain.
PEO 2	To provide the professional services to industries, Research organization, in the domain of super specialization.
PEO 3	To opt for higher education, disciplinary & multi-disciplinary research and to be a life-long learner.

PROGRAMME LEARNING OUTCOMES (PLOs)

PLO 1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study.
PLO 2	Research Aptitude	Capability to ask relevant/ appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis.
PLO 3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large.
PLO 4	Problem-Solving	Capability of applying knowledge to solve scientific and other problems.
PLO 5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, multidisciplinary settings.
PLO 6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research-based knowledge including design of experiments, analysis and interpretation of data to provide conclusions.
PLO 7	Modern Tool Usage	Ability to use and learn techniques, skills and modern tools for

		scientific practices.
PLO 8	Scientific temperament	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices.
PLO 9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life.
PLO 10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work.
PLO 11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.

Scheme of Examination for Postgraduate Programme	
Subject	Chemistry
Total number of Semesters	4
Total Marks	2700
Total Credit	108
Framework	2
Scheme	P

INDIRA GANDHI UNIVERSITY, MEERPUR, REWARI
Scheme of Examination for Postgraduate Programme M.Sc. Chemistry
as per NEP 2020 Curriculum and Credit Framework for
Postgraduate Programmes (CBCS LOCF) with effect from the
session 2026-27 Framework-2
Scheme-P

Semester-I
(Total 26 Credits)

Course Type	Course Code	Nomenclature of course	Theory (Th)/ Practical (P)	Credits	Contact hours per week L: Lecture P: Practical T: Tutorial				Internal Assessment Marks	End Term Examination Marks	Total Marks	Exam hours
					L	T	P	Total				
CC-1	26L6.0-CHE-101	Inorganic Chemistry-I	Th	4	4	0	0	4	30	70	100	3
CC-2	26L6.0-CHE-102	Physical Chemistry-I	Th	4	4	0	0	4	30	70	100	3
CC-3	26L6.0-CHE-103	Organic Chemistry-I	Th	4	4	0	0	4	30	70	100	3
CC-4	26L6.0-CHE-104	Green Chemistry	Th	3	3	0	0	3	25	50	75	3
PC-1	26L6.0-CHE-105	Practical-1	P	3	0	0	6	6	25	50	75	3
PC-2	26L6.0-CHE-106	Practical-2	P	3	0	0	6	6	25	50	75	3
PC-3	26L6.0-CHE-107	Practical-3	P	3	0	0	6	6	25	50	75	3
SEM	26L6.0-CHE-108	Seminar	S	2	0	0	0	2	0	50	50	0

Semester-II
(Total 26 Credits)

Course Type	Course Code	Nomenclature of course	Theory (Th)/ Practical (P)	Credits	Contact hours per week L: Lecture P: Practical T: Tutorial				Internal Assessment Marks	End Term Examination Marks	Total Marks	Exam hours
					L	T	P	Total				
CC-5	26L6.0-CHE-201	Inorganic Chemistry-II	Th	4	4	0	0	4	30	70	100	3
CC-6	26L6.0-CHE-202	Physical Chemistry-II	Th	4	4	0	0	4	30	70	100	3
CC-7	26L6.0-CHE-203	Organic Chemistry-II	Th	4	4	0	0	4	30	70	100	3
CC-8	26L6.0-CHE-204	Spectroscopy and XRD	Th	3	3	0	0	3	25	50	75	3
PC-4	26L6.0-CHE-205	Practical-4	P	3	0	0	6	6	25	50	75	3
PC-5	26L6.0-CHE-206	Practical-5	P	3	0	0	6	6	25	50	75	3
PC-6	26L6.0-CHE-207	Practical-6	P	3	0	0	6	6	25	50	75	3
CHM	26L6.0-CHM-201	Constitutional, Human and Moral Values and IPR	Th	2	2	0	0	2	15	35	50	2
Internship	26L6.0-CHE-INT	An internship course of 4 Credits of 4-6 weeks duration during summer vacation after 2 nd semester is to be completed by every student. Internship can be either for enhancing the employability or for developing the research aptitude.							50	50	100	

Semester-III
(Total 26 Credits)

Course Type	Course Code	Nomenclature of course	Theory (Th)/ Practical (P)	Credits	Contact hours per week L: Lecture P: Practical T: Tutorial				Internal Assessment Marks	End Term Examination Marks	Total Marks	Exam hours
					L	T	P	Total				
CC-9	26L6.5-CHE-301	Advanced Organic Spectroscopy	Th	4	4	0	0	4	30	70	100	3
CC-10	26L6.5-CHE-302	Physical Chemistry-III	Th	4	4	0	0	4	30	70	100	3
DEC-1 (Select any one)	26L6.5-CHE-303a	Inorganic Chemistry Special-I	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-303b	Physical Chemistry Special-I	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-303c	Organic Chemistry Special-I	Th	4	4	0	0	4	30	70	100	3
DEC-2 (Select any one)	26L6.5-CHE-304a	Inorganic Chemistry Special-II	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-304b	Physical Chemistry Special-II	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-304c	Organic Chemistry Special-II	Th	4	4	0	0	4	30	70	100	3
PC-7* (Select any one)	26L6.5-CHE-305a	Inorganic Chemistry Special Practical-I	P	4	0	0	8	8	30	70	100	3
	26L6.5-CHE-305b	Physical Chemistry Special Practical-I	P	4	0	0	8	8	30	70	100	3
	26L6.5-CHE-305c	Organic Chemistry Special Practical-I	P	4	0	0	8	8	30	70	100	3
PC-8* (Select any one)	26L6.5-CHE-306a	Inorganic Chemistry Special Practical-II	P	4	0	0	8	8	30	70	100	3
	26L6.5-CHE-306b	Physical Chemistry Special Practical-II	P	4	0	0	8	8	30	70	100	3
	26L6.5-CHE-306c	Organic Chemistry Special Practical-II	P	4	0	0	8	8	30	70	100	3
OEC (Select any one)	The Open Elective Course (OEC) is to be chosen from the pools of open elective courses provided by the University.		Th	2	2	0	0	2	15	35	50	2

Note - A student will opt for an Open Elective Course (OEC) of 2 Credits from a pool of courses, or students can opt OEC, other than its subject, from online courses offered by Indira Gandhi University or through SWAYAM/ NPTEL/MOOCs other platforms recognized by UGC and registered on ABC/APAAR.

Semester-IV
(Total 26 Credits)

Course Type	Course Code	Nomenclature of course	Theory (Th)/ Practical (P)	Credits	Contact hours per week L: Lecture P: Practical T: Tutorial				Internal Assessment Marks	End Term Exam Marks	Total Marks	Exam hours
					L	T	P	Total				
CC-11	26L6.5-CHE-401	Inorganic Chemistry-III	Th	4	4	0	0	4	30	70	100	3
CC-12	26L6.5-CHE-402	Organic Chemistry-III	Th	4	4	0	0	4	30	70	100	3
DEC-3 (Select any one)	26L6.5-CHE-403a	Inorganic Chemistry Special- III	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-403b	Physical Chemistry Special- III	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-403c	Organic Chemistry Special-III	Th	4	4	0	0	4	30	70	100	3
DEC-4 (Select any one)	26L6.5-CHE-404a	Inorganic Chemistry Special- IV	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-404b	Physical Chemistry Special- IV	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-404c	Organic Chemistry Special-IV	Th	4	4	0	0	4	30	70	100	3
PC-9* (Select any one)	26L6.5-CHE-405a	Inorganic Chemistry Special Practical- III	P	4	0	0	8	8	30	70	100	3
	26L6.5-CHE-405b	Physical Chemistry Special Practical-III	P	4	0	0	8	8	30	70	100	3
	26L6.5-CHE-405c	Organic Chemistry Special Practical-III	P	4	0	0	8	8	30	70	100	3
PC-10* (Select any one)	26L6.5-CHE-406a	Inorganic Chemistry Special Practical- IV	P	4	0	0	8	8	30	70	100	3
	26L6.5-CHE-406b	Physical Chemistry Special Practical-IV	P	4	0	0	8	8	30	70	100	3
	26L6.5-CHE-406c	Organic Chemistry Special Practical-IV	P	4	0	0	8	8	30	70	100	3
EEC (Select any one)	26L6.5-CHE-407a	Skills in Chemistry	Th	1	1	0	0	1	5	20	25	2
			PC	1	0	0	2	2	5	20	25	2
	26L6.5-CHE-407b	Computational Chemistry	Th	2	2	0	0	2	15	35	50	2

*For PC-7, PC-8, PC-9, PC-10, the total number of Practical Groups should not exceed the total intake divided by the Group Size: $60/20 = \text{number of Practical Groups} \leq 3$

Semester-IV
(When a student opts for Dissertation work or Project work)
(Total 26 Credits)

Course Type	Course Code	Nomenclature of course	Theory (Th)/ Practical (P)	Credits	Contact hours per week L: Lecture P: Practical T: Tutorial				Internal Assessment Marks	End Term Examination Marks	Total Marks	Exam hours
					L	T	P	Total				
DEC-3 (Select any one)	26L6.5-CHE-403a	Inorganic Chemistry Special- III	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-403b	Physical Chemistry Special- III	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-403c	Organic Chemistry Special-III	Th	4	4	0	0	4	30	70	100	3
DEC-4 (Select any one)	26L6.5-CHE-404a	Inorganic Chemistry Special- IV	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-404b	Physical Chemistry Special- IV	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-404c	Organic Chemistry Special-IV	Th	4	4	0	0	4	30	70	100	3
DEC-5 (Select any one)	26L6.5-CHE-408a	Inorganic Chemistry Special-V	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-408b	Physical Chemistry Special-V	Th	4	4	0	0	4	30	70	100	3
	26L6.5-CHE-408c	Organic Chemistry Special-V	Th	4	4	0	0	4	30	70	100	3
DW or P W	26L6.5-CHE-409	Dissertation Work or Project Work	P	12			1 2	12	150	150	300	
EEC	26L6.5-EEC-RPE-400	Research ethics (as per university guidelines)	Th	2	2			2	15	35	50	2

Semester	Core Courses (CC+DEC+PC)	Minor Courses (Seminar/Value Added Course/Open Elective Course/ Employability & Entrepreneurship Skills Course)	Total Number of Courses
1 st	4+0+3	1	8
2 nd	4+0+3	1	8
3 rd	2+2+2	1	7
4 th	2+2+2	1	7
Grand Total	12+4+10	4	30

CC-1

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Part A - Introduction

Name of Programme	M.Sc. Chemistry		
Semester	I		
Nature of Course/Course Composition	Theory		
Name of the Course	Inorganic Chemistry-I		
Course Code	26L6.0-CHE-101		
Course Type	CC-1		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG Level		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able:	CLO 1: To know about the basic aspects of symmetry and group theory and also their applications CLO 2: To know about the concept of bonding using VSEPR theory and applications of Huckel theory to various molecules and also some substitution reactions of boron, silicon and Nitrogen. CLO 3: To know about the metal equilibria in solutions with reference to stability and factors affecting the stability of complexes. CLO 4: To know about the limitations of crystal field theory and its effects in coordination complexes and to apply the concept of molecular orbital theory to tetrahedral square planar and octahedral complexes.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper-Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.

Unit	Topics	Contact Hours/ CLO Attempt

I	Symmetry and Group Theory in Chemistry Definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Symmetry elements and symmetry operation, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation for the C _n , C _{nv} , C _{nh} , D _{nh} etc. groups to be worked out explicitly). Character of a representation, reducible and irreducible representations, The great orthogonality theorem (without proof) and its importance, Derivation of character tables of C _{2v} , C _{3v} and their use. Molecular asymmetry, dissymmetry and optical activity.	15 CLO 1
II	Stereochemistry and Bonding in Main Group Compounds: VSEPR Theory, Walsh diagrams (tri- atomic molecules), Hybridization including energetics of hybridization, dπ-pπ bonds, Bent rule. Some simple substitution reactions of covalently bonded molecules of boron, silicon and nitrogen- (i) Atomic inversion (ii) Bery pseudo rotation (iii) Nucleophilic displacement (iv) Free radical mechanism.	15 CLO 2
III	Metal-Ligand Equilibria in Solution Stepwise and overall formation constants and their interaction, trends in stepwise constants, inert and labile complexes, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry. Substitution reactions in octahedral complexes, theories of trans effect with respect to Pt(II) complexes.	15 CLO 3
IV	Metal-Ligand Bonding Crystal field theory and its limitations of crystal field theory, Crystal field effects on ionic radii, Lattice energies, Heat of hydration & Geometry of coordination complexes, John-Teller distortion, Consequences of John-Teller distortion, Nephelauxetic effect and Nephelauxetic series, spin-orbital coupling, Molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without n-bonding).	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.		
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.		
3. Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.		
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.		
5. The Chemical bond; J. N. Murrell, SFA Kettle and J.M. Tedder; Wiley, New York.		
6. Modern Aspects of Inorganic Chemistry; H. J. Emeleus and Sharpe.		
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J. J. Alexander; John Wiley and Sons.		
8. Inorganic Chemistry, A Modern Introduction; T Moeller, John Wiley and Sons.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	1	2	1	–	1	–	–
CLO ₂	3	2	1	3	1	2	1	–	1	–	–
CLO ₃	3	2	1	3	1	3	2	1	1	–	–
CLO ₄	3	2	1	3	1	3	2	–	1	–	–

Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Metal-ligand equilibria, determination of formation constants by pH-metry and spectrophotometry, bonding theories relevant to chemical industries, pharmaceuticals, and research laboratories.	16
Skill Enhancement	Character table derivation (C_{2v} , C_{3v}), symmetry analysis, VSEPR applications, Walsh diagrams, stereochemical predictions, interpretation of spectroscopic and coordination chemistry data.	25
Communication Development	Scientific representation of symmetry operations, molecular structures, character tables, and coordination complexes through diagrams and presentations.	3
Indian Knowledge System	Basic understanding of atomic and molecular structure supporting traditional Indian chemical and metallurgical knowledge systems.	2
Environmental Awareness	Stability and reactivity of metal complexes in environmental systems, chelation, metal-ion interactions, and pollution remediation concepts.	5
Current Issues and Social Awareness	Applications of coordination chemistry in catalysis, medicine, environmental monitoring, and advanced materials.	3
Women empowerment/ Gender issues	No direct content	0
Public policies	Relevance of coordination chemistry in environmental regulations, industrial safety standards, and chemical waste management policies.	2
Any Other	Development of analytical thinking, problem-solving skills, research aptitude, and higher-order understanding of molecular symmetry and bonding.	4

CC-2

Session: 2025-26

Part A - Introduction

Name of Programme	M.Sc. Chemistry		
Semester	I		
Nature of Course/Course Composition	Theory		
Name of the Course	Physical Chemistry-I		
Course Code	26L6.0-CHE-102		
Course Type	CC-2		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG Level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To apply the concepts of chemical potential and partial molar properties to evaluate the thermodynamic behavior of ideal gas mixtures and determine the thermodynamic functions of mixing. CLO 2: To apply collision theory and transition state theory to analyze reaction rates, and solve kinetic problems involving opposing, consecutive, and chain reactions. CLO 3: To understand the electrochemistry of ion- ion interaction and concept of electrical double layer CLO 4: To apply the postulates of quantum mechanics and Schrödinger wave equation to determine the energy levels, wave functions of particle in a box and the harmonic oscillator.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.

Unit	Topics	Contact Hours/ CLO Attempt
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I	Partial Molar Properties: Recapitulation of thermodynamic laws, Partial molar quantities, chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential of ideal gas mixture(s), determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy).	15 CLO 1
II	Chemical Kinetics: Collision theory of reaction rates, Arrhenius equation, Temperature dependence of pre-exponential factors, Conventional Transition State Theory (CTST), Equilibrium hypothesis, Comparison of Collision theory and CTST, Thermodynamic formulation of activated complex theory, Kinetics of opposing reactions, consecutive reaction, Chain reactions (hydrogen-halogen reaction).	15 CLO 2
III	Electrochemistry: Debye-Hückel theory of ion-ion interaction, Debye -Huckel reciprocal length, Debye-Hückel limiting law of activity coefficients and its limitations, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient, activity coefficients and mean activity coefficient of an electrolyte, Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance and its limitations, Debye- Falkenhagen effect, Wein effect, Debye Huckle Bjerrum equation, Structure of electrified interfaces: Helmholtz -Perrin model, Gouy Chapman model, Stern model.	15 CLO 3
IV	Quantum Mechanics-I The postulates of quantum mechanics, Linear and Hermitian operators, Commutator operators, Eigen functions Eigenvalues, Schrödinger wave equation, Application of Schrödinger equation for particle in 1D box and 3D box, Degeneracy, Schrödinger equation for linear harmonic oscillator and its solution, zero point energy.	15 CLO 4

Total Contact Hours 60

Evaluation Methods

Internal Assessment: 30		End Term Examination: 70
• Class Participation:	5	Written Examination: 70
• Seminar/presentation/assignment/quiz/class test etc.:	10	
• Mid-Term Exam:	15	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub.
2. Physical Chemistry, P.W. Atkins, Oxford University Press.
3. Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press.
4. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin.
5. Chemical Kinetics, K.J. Laidler, McGraw Hill.
6. Kinetics and Mechanism, A. A. Frost and R.G. Pearson, John Wiley and Sons.
7. Electrochemistry, S. Glasstone, Affiliated East-West Press.
8. Physical Chemistry, G.W. Castellan, Narosa.
9. Heterogeneous Catalysis: Fundamentals and Applications, Julian R.H. Ross, Wiley-VCH; 2nd, Revised and Enlarged Edition edition (October 1, 2007).

10. Concepts of Modern Catalysis and Kinetics, I. Chorkendorff and J. W. Niemantsverdriet.
11. Physical Chemistry, by Robert J. Silbey, Robert A. Alberty, Moungi G. Bawendi, Wiley India; Fourth edition (1 January 2015)
12. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
13. Quantum Chemistry, I.M. Levine, Prentice Hall.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	-	2	1	-	2	-	-
CLO ₂	3	3	1	3	-	3	1	-	2	-	-
CLO ₃	3	2	1	2	-	2	2	1	2	-	-
CLO ₄	3	3	1	3	-	3	2	-	2	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Application of thermodynamics, kinetics, electrochemistry, and quantum mechanics in chemical industries, energy storage systems, pharmaceuticals, materials science, and research-based careers.	16
Skill Enhancement	Analytical skills through partial molar properties, chemical potential, reaction kinetics, Debye–Hückel theory, electrified interfaces, and quantum mechanical calculations.	20
Communication Development	Interpretation and presentation of thermodynamic, kinetic, electrochemical, and quantum mechanical concepts through assignments and seminars.	6
Indian Knowledge System	Promotes scientific reasoning, logical analysis, and mathematical understanding of physical chemistry concepts.	3
Environmental Awareness	Electrochemical principles related to batteries, fuel cells, corrosion control, pollution monitoring, and sustainable energy technologies; thermodynamic aspects of environmental processes.	5
Current Issues and Social Awareness	Relevance of kinetics and electrochemistry in renewable energy, climate change mitigation, green technologies, and industrial sustainability.	2
Women empowerment/ Gender issues	No direct mapping; however, the course promotes equal participation and opportunities in scientific education and research.	1
Public policies	Basic concepts related to energy technologies, electrochemical systems, and scientific research.	2
Any Other	Critical thinking, research aptitude, scientific temper, innovation, computational skills, and lifelong learning.	5

CC-3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Name of the Course	Organic Chemistry-I		
Nature of Course/Course Composition	Theory		
Course Code	26L6.0-CHE-103		
Course Type	CC-3		
Level of the course	400-499		
Prerequisite for the course (if any)	Chemistry as a subject at UG Level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To understand the general aspects (theoretical and experimental) of organic reaction mechanisms and reaction intermediates. CLO 2: To understand mechanistic details of aliphatic nucleophilic substitution reactions and elimination reactions. CLO 3: To understand the stereo-chemical terms and conformational aspects in cyclic and acyclic systems. CLO 4: To understand the important stereochemical terms and aspects related to asymmetric synthesis. Idea about conformations of sugars and decalines.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Reaction Mechanism: Structure and Reactivity: Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment - The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation. Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining reaction mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.		15 CLO 1

II	Mechanism of Nucleophilic Aliphatic Substitution: The limiting cases SN1 and SN2, detailed mechanistic description and borderline mechanisms, nucleophilicity and solvent effects, ambident nucleophiles, hard and soft nucleophiles and electrophiles, leaving group effects, steric and other substituent effects on substitution and ionization rates, stereochemistry of nucleophilic substitution, S _N i, S _N 1', S _N 2' and S _N i' mechanisms. Mechanism of Elimination Reactions: The E1, E1cB and E2 mechanisms, Orientation Effects in Elimination Reactions, Saytzeff and Hoffman rules, Stereochemistry of E2 Elimination Reaction and Eclipsing Effects in E2 Eliminations, Dehydration of Alcohols, Pyrolytic eliminations.	15 CLO 2
III	Stereochemistry-I: Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formula. Conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat conformations) and acyclic systems. Axial and planar chirality, optical isomerism in allenes, biphenyls (atropisomerism), spiranes, hemi-spiranes. Elementary ideas about stereochemistry of tertiary amines, quaternary salts, sulfur and phosphorus compounds.	15 CLO 3
IV	Stereochemistry –II: Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenicity, chirogenicity, pseudo asymmetry and prochiral center. Stereospecific and stereoselective reactions. Elementary idea of principal categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule, Stereochemistry of decalins, Chemical correlation of configuration - determination of relative configuration of 2-butanol, isoserine, alanine, malic acid, lactic acid and mandelic acid.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.		
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.		
3. A Guide-Book to Mechanism in Organic Chemistry, Peter Sykes, Longman. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.		
4. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.		
5. Modern Organic Reactions, H. O. House, Benjamin.		
6. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.		
7. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.		
8. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.		
9. Stereochemistry of Organic Compounds, P.S, Kalsi, New Age International.		
10. Stereochemistry of Organic compounds, E.L. Eliel, Mc Graw Hills, 1962.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	-	2	-	2	1	-	1	-	-
CLO ₂	3	2	-	3	-	2	1	-	1	-	-
CLO ₃	3	1	-	2	-	2	1	-	1	-	-
CLO ₄	3	2	-	3	-	2	1	-	1	-	-

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Reaction mechanisms, stereochemistry, mechanistic interpretation, industrial and pharmaceutical relevance	24
Skill Enhancement	Mechanism prediction, stereochemical analysis, nomenclature, problem-solving skills	18
Communication Development	Scientific nomenclature, mechanism presentation, structural representation	4
Indian Knowledge System	No direct content	0
Environmental Awareness	Indirect relevance through efficient reaction design and mechanistic understanding	2
Current Issues and Social Awareness	Modern organic chemistry concepts supporting research and innovation	4
Women empowerment/ Gender issues	No direct content	0
Public policies	No direct content	0
Any Other	Foundation for advanced research, competitive examinations, and higher studies	8

CC-4

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Nature of Course/Course Composition	Theory		
Name of the Course	Green Chemistry		
Course Code	26L6.0-CHE-104		
Course Type	CC-4		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG Level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To understand the need of green chemistry and its principles and to have an elementary idea of green reagent, green solvent, green catalyst, solid phase, mw and ultrasound assisted. CLO 2: To know the concept of atom economy for different types of reactions. CLO 3: To understand catalysis and Renewable raw materials. Introduction to catalysis. Homogeneous and Heterogeneous catalysis, Phase-transfer catalysis and Biocatalysis.		
Credits	Theory	Practical	Total
	3	0	3
Teaching Hours per week	3	0	3
Internal Assessment Marks	25	0	25
End Term Exam Marks	50	0	50
Max. Marks	75	0	75
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 7 questions selecting two questions from each of the three units with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question comprising 4 short answer type questions carrying two marks each (total 08marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt four questions: the compulsory question no. 1 and 1 question from the each of the three units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	History of emergence of Green Chemistry , Definition, Need and role of Green Chemistry, Principles and concepts of green chemistry synthesis: Chemistry in the context of sustainable development, Green Chemistry v/s Environmental Chemistry, End of pipe v/s Cleaner production, Current status and future perspective. The twelve principles of Green Chemistry and their illustrations with examples, Evaluation of Greenness, Environmental factor, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.		15 CLO 1
II	Catalysis and Renewable raw materials. Introduction to catalysis. Homogeneous and Heterogeneous catalysis, Phase-transfer catalysis and		15

	Biocatalysis. Photocatalysis, Catalysis for Green Chemistry with examples, Renewable raw materials, Chemical products based on renewable sources. Alternative Green solvents, Volatile organic compounds (VOCs), Supercritical fluids.	CLO 2
III	Green technology and sources of alternative energy. Photochemical and Electrochemical reactions. Green photo-chemical reactions, Green Chemical Reactions under Microwave (Microwave Assisted Synthesis), Role of Sonication and Ball milling in Green chemical synthesis with examples. Flow techniques and role of Flow chemistry for sustainable development.	15 CLO 3
Total Contact Hours		45
Evaluation Methods		
Internal Assessment: 25		End Term Examination: 50
● Class Participation:	5	Written Examination:50
● Seminar/presentation/assignment/quiz/class test etc.:	5	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. S. E. Manahan, Fundamentals of Environmental Chemistry, 3rd ed. (2009) CRC Press.		
2. R. A. Sheldon, I. Arends and U. Hanefeld, Green Chemistry and Catalysis, 1st ed. (2007) Wiley- VCH.		
3. V. K. Ahluwalia and M. Kidwai, New Trends in Green Chemistry, 1st ed. (2004) Springer.		
4. T. Clifford, Fundamentals of Supercritical Fluids, 1st ed. (1999) Oxford press.		
5. C. –J. Li, T. –K. Chan, Organic Reactions in Aqueous Media, 1st ed. (1997) Wiley- Inter science, New York.		
6. Recent review articles relevant to above topics (reprints to be handed over to students).		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	1	-	2	-	1	2	3	2	3	-
CLO ₂	3	2	-	3	-	2	1	3	1	3	-
CLO ₃	3	2	-	3	-	2	2	3	2	2	1

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Green chemistry principles, catalysis, renewable feedstocks, green technologies, flow chemistry	20
Skill Enhancement	Atom economy calculations, catalysis, microwave-assisted synthesis, sonication, ball milling, photochemical & electrochemical techniques	15
Communication Development	Seminar/discussion on sustainable chemistry and evaluation of greenness	2
Indian Knowledge System	Sustainable use of renewable resources and eco-friendly practices	2
Environmental	Green chemistry, VOCs, cleaner production, alternative solvents, sustainable development	18

Awareness		
Current Issues and Social Awareness	Climate change, pollution prevention, renewable energy, sustainability	3
Women empowerment/ Gender issues	Not specifically addressed	0
Public policies	Sustainable development and environmental policy concepts	2
Any Other	Evaluation of greenness and integrated sustainable practices	13

PC-1

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Nature of Course/Course Composition	Practical		
Name of the Course	Practical-1		
Course Code	26L6.0-CHE-105		
Course Type	PC-1		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Identify and analyze less common metal ions such as Tl, Se, Te, Mo, W, Ti, Zr, and V through systematic qualitative analysis. CLO2: Perform quantitative estimations of analytes such as ferrous ions, oxalate, and nitrite using cerimetric titration methods. CLO3: Analyze and determine the composition of insoluble inorganic compounds including oxides, sulphates, and halides using appropriate analytical techniques.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 25.			
Unit	Topics	Contact Hours\CLO Attempt	
I	1. Qualitative Analysis: (i) Less common metal ions- Tl, Se, Te, Mo, W, Ti, Zr & V.	30	CLO1
II	1. Quantitative Analysis: Determination of Ferrous, Oxalate, Nitrite, etc. by Cerimetry.	30	CLO2
III	1. Quantitative Analysis: (i) Insoluble - Oxides (Al ₂ O ₃ , Cr ₂ O ₃ , SnO ₂ , TiO ₂ , SiO ₂); Sulphates (Lead Sulphate, Barium Sulphate Strontium Sulphate, and Calcium Sulphate); Halides (CaF ₂ , AgCl,	30	CLO3

	AgBr, AgI).	
Total Contact Hours		90
Evaluation Methods		
Internal Assessment: 25		End Term Examination: 50
➤ Practical	25	➤ Practical 50
• Class Participation:	5	Lab record 10
• Seminar/Demonstration/Viva-Voce/Lab Record/etc.:	5	Viva Voce 15
• Mid-Term Exam:	15	Write-up and execution of the practical 25
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. A Text Book of Macro and Semi-micro Quantitative Analysis, A. I. Vogel, Orient Longman. 2. A Vogel's TextBook of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London. 3. Practical Inorganic Chemistry, G. Pass and H. Sutcliffe 4. Quantitative Chemical Analysis, Daniel C. Harris 5. https://nptel.ac.in/courses?utm 6. https://swayam.gov.in?utm		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	1	3	2	-	1	1	-
CLO ₂	3	2	1	3	1	3	2	-	1	1	-
CLO ₃	3	2	1	3	1	3	2	-	1	1	-

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/Entrepreneurship	Development of laboratory skills in qualitative and quantitative chemical analysis useful in chemical industries, testing laboratories, pharmaceuticals, and quality control sectors.	25
Skill Enhancement	Identification of less common metal ions (Tl, Se, Te, Mo, W, Ti, Zr, V); volumetric analysis by cerimetry; analysis of insoluble oxides, sulphates, and halides.	45
Communication Development	Preparation of laboratory reports, recording observations, interpretation of analytical results, and scientific communication of findings.	5
Indian Knowledge System	Understanding analytical techniques that support traditional practices related to metallurgy, minerals, and material characterization.	2
Environmental Awareness	Detection and analysis of metal ions and inorganic compounds relevant to environmental monitoring, pollution control, and waste management.	5

Current Issues and Social Awareness	Application of analytical chemistry in water quality assessment, industrial effluent analysis, and public health monitoring.	3
Women empowerment/ Gender issues	Promotes equal participation and skill development in laboratory sciences and STEM-related careers.	1
Public policies	Supports regulatory compliance, environmental standards, and quality assurance practices in chemical and industrial sectors.	2
Any Other	Enhances precision, critical thinking, problem-solving ability, experimental competence, and research aptitude.	2

PC-2

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Nature of Course/Course Composition	Practical		
Name of the Course	Practical-2		
Course Code	26L6.0-CHE-106		
Course Type	PC-2		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Apply viscometric and surface tension techniques to determine the physicochemical properties of liquids, estimate polymer molar mass, and analyze the composition of binary liquid mixtures. CLO2: Perform conductometric titrations to determine the concentration and composition of acidic solutions. CLO3: Analyze adsorption phenomena by verifying Freundlich and Langmuir adsorption isotherms.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	3 hours		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 25.			
Unit	Topics		Contact Hours\ CLO Attempt
I	1. Viscosity (i) To determine the relative and absolute viscosity of a given liquid using Ostwald Viscometer. (ii) Determine the Molar Mass of a polymer. (iii) To determine the percentage composition of the liquids in the given binary mixtures using Ostwald's Viscometer. 2. Surface Tension (i) Determine the surface tension of given organic solvents using drop number/weight methods. (ii) To determine the percentage composition of the liquids in the given binary mixtures		35 CLO1

II	Conductometry (i) Determine the strength of weak acid by conductometric titration with a strong base. (ii) Determine the strength of strong acid by conductometric titration with strong base. (iii) Determine the strength of strong acid and weak acid in a mixture by conductometric titration with a strong base.	35 CLO2	
III	Adsorption (i) Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid on activated charcoal. (ii) Verify the Freundlich and Langmuir adsorption isotherms for adsorption of oxalic acid on activated charcoal.	20 CLO3	
Total Contact Hours		90	
Evaluation Methods			
Internal Assessment: 25		End Term Examination: 50	
• Practical	25	• Practical	50
• Class Participation:	5	Lab record	10
• Seminar/Demonstration/Viva-Voce/Lab Record/etc.:	5	Viva Voce	15
• Mid-Term Exam:	15	Write-up and execution of the practical	25
Part C-Learning Resources			
Recommended Books/e-resources/LMS:			
1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman. 2. Findley’s Practical Physical Chemistry, B.P. Lavitt, Longman. 3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science. 4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill. 5. Advanced Practical Physical Chemistry, J. B. Yadav Krishna Prakashan 6. Systematic experimental Physical Chemistry, T.K. Chander Shekhar & S.K. Rajbhoj Anjali Publication. 7. A Comprehensive Guide to Physical Chemistry Experiments and Viva Questions, Neelam Seedher.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	1	3	3	–	2	1	–
CLO ₂	3	2	1	3	1	3	3	–	2	1	–
CLO ₃	3	3	1	3	1	3	2	–	2	1	–

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/	Hands-on training in viscosity, surface tension, conductometry, and adsorption techniques widely used in chemical, pharmaceutical,	18

Entrepreneurship	polymer, petroleum, food, and environmental industries.	
Skill Enhancement	Development of laboratory skills, experimental design, instrumental handling, data analysis, titration techniques, and interpretation of physicochemical properties.	30
Communication Development	Preparation of laboratory records, report writing, data presentation, result interpretation, and scientific discussion of experimental observations.	10
Indian Knowledge System	Promotion of scientific inquiry and experimental learning aligned with India's tradition of knowledge generation and practical applications of science.	4
Environmental Awareness	Study of adsorption processes for pollutant removal, characterization of liquid systems, and analytical methods relevant to environmental monitoring and water quality assessment.	8
Current Issues and Social Awareness	Applications of polymers, adsorption technologies, and analytical techniques in sustainable development, water treatment, and industrial quality control.	8
Women empowerment/ Gender issues	Encourages equal participation and skill development in laboratory-based scientific education and research.	2
Public policies	Supports scientific understanding relevant to environmental regulations, industrial quality standards, and sustainable technology development.	4
Any Other	Scientific temper, critical thinking, research aptitude, teamwork, precision in experimentation, and problem-solving abilities.	6

PC-3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Nature of Course/Course Composition	Practical		
Name of the Course	Practical-3		
Course Code	26L6.0-CHE-107		
Course Type	PC-3		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO1: To understand the basic laboratory glasswares; purification techniques in organic chemistry and to perform the experimentation and evaluate the results. CLO2: To understand the Melting point, boiling point and chromatographic techniques used in organic purification. CLO3: To understand the preparation of organic compound preparation.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 25.			
Unit	Topics		Contact Hours/CL O Attempt

I	General Knowledge of Common laboratory glassware's and instruments – Make a report	15 CLO1
II	Purification of organic solids i) Purification of organic compounds by sublimation ii) Recrystallisation of benzoic acid from water iii) Purification of organic liquids by simple distillation. iv) Determination of melting point of solid organic compounds. v) Determination of boiling point of liquid organic compounds. vi) Separation of organic compounds by TLC, column chromatography.	30 CLO2
III	Preparation of following organic compounds: (Any four) (i) Preparation of benzanilide from aniline. (ii) Preparation of methyl orange from aniline. (iii) Preparation of tribromoaniline from aniline.	45 CLO3

	(iv) Preparation of 2,4-dinitrophenylhydrazine from chlorobenzene. (v) Preparation of benzanilide from benzophenone. (vi) Preparation of adduct of anthracene and maleic anhydride by Diels- Alder reaction. Any other reaction as per requirement.		
Total Contact Hours		90	
Evaluation Methods			
Internal Assessment: 25		End Term Examination: 50	
• Practical	25	• Practical	50
• Class Participation:	5	Lab record	10
• Seminar/Demonstration/Viva-Voce/Lab Record/etc.:	5	Viva Voce	15
• Mid-Term Exam:	15	Write-up and execution of the practical	25
Part C-Learning Resources			
Recommended Books/e-resources/LMS:			
1. A Handbook of Organic Analysis Qualitative and Quantitative by H.T. Clarke and revised by B. Maynes, Edward Arnold (Pub.) Ltd. London, 1975).			
2. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Ltd., London 1959.			
3. A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis by Arthur Vogel, Longmans Green and Co., Ltd., London 1966.			
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, CBS Publishers & Distributors.			
5. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	2	3	3	-	2	2	-
CLO ₂	3	1	-	2	-	2	3	-	2	1	-
CLO ₃	3	2	1	3	2	3	3	-	2	2	1

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/Entrepreneurship	Knowledge and handling of common laboratory glassware and instruments; development of practical skills required in chemical industries, pharmaceutical laboratories, quality control laboratories, and research laboratories. Purification techniques, distillation, chromatography, and synthesis of organic compounds provide industrially relevant skills.	20
Skill Enhancement	Training in purification of organic solids and liquids by sublimation, recrystallization, simple distillation; determination of melting and boiling points; separation of organic compounds using	45

	TLC and column chromatography; preparation and characterization of organic compounds through various synthetic reactions including benzanilide, methyl orange, tribromoaniline, DNPH, and Diels–Alder adduct.	
Communication Development	Preparation of laboratory reports, recording experimental observations, interpretation of results, presentation of experimental procedures, and scientific documentation following standard laboratory practices.	5
Indian Knowledge System	Understanding the traditional importance of natural organic compounds and their derivatives; awareness of organic materials used historically in dyes, medicines, and chemical applications.	5
Environmental Awareness	Safe handling, storage, and disposal of organic solvents and chemical waste; awareness about solvent recovery, green purification methods, and minimizing environmental hazards during laboratory operations.	5
Current Issues and Social Awareness	Awareness regarding the role of organic chemistry in pharmaceuticals, dyes, agrochemicals, and materials development; importance of sustainable chemical practices in modern society.	3
Women empowerment/ Gender issues	Equal participation and skill development opportunities in laboratory training, research activities, and professional careers in chemistry and allied industries.	2
Public policies	Awareness of laboratory safety regulations, chemical handling guidelines, occupational safety standards, and ethical practices in scientific research.	3
Any Other	Development of analytical thinking, problem-solving ability, research aptitude, and familiarity with experimental techniques used in advanced organic chemistry laboratories.	2

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Name of the Course	Seminar		
Course Code	26L6.0-CHE-108		
Course Type	SEM		
Level of the course			
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: Hands on experience on any aspect of their learning for research-based activity CLO 2: Aspect covered is practically practiced by the participants.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	0	0	0
End Term Exam Marks	50	0	50
Max. Marks	50	0	50
Examination Time	30 minutes per student (Internal evaluation only)		
Part B- Contents of the Course			
Objectives: A seminar is primarily an activity based academic event that is organized to provide the students a one to one and hands on experience on any aspect of their learning for research-based activity. Seminar to acquaint new postgraduate students with departmental research. The trainer has to make sure that the aspect covered is practically practiced by the participants. The evaluation will be done by Board of examiners comprising of the faculties. This one will be one time event in one semester.			
Unit	Topics		Contact Hours
I	Major Themes for Seminar The seminar may be conducted on any of the following major themes: • Nuclear Chemistry • Modern trend in Inorganic Chemistry • Modern trend in Organic Chemistry • Modern trend in Physical Chemistry • Nanotechnology and its application • Polymer Chemistry • Pharmaceuticals • Food Technology • Agriculture Chemistry • Computational Chemistry • Green Chemistry • Any other relevant topics • Research topics of students These themes are merely indicative and other recent and relevant topics of study may be included.		30
Total Contact Hours			30
Suggested Evaluation Methods			
End Term Examination: 50			
• Class Participation:	05		
• Literature Search:	15		

• Assignment/ Write up	15
• Seminar/presentation/assignment/quiz/class test etc.:	15
Part C-Guidelines	
Guidelines for Seminar: The procedure for earning credits from seminar consists of the following steps: • Relevant study material and references will be provided by the trainer in advance. • The participants are expected to explore the topic in advance and take active part in the discussions held • Attending and Participating in all activities • Group Activities have to be undertaken by students as guided by the trainer. • Evaluation of Seminar activities would be done through Power Point Presentation. • Submitting a write up of at least 500 words about the learning outcome from the workshop.	

CC-5

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	II		
Nature of Course/Course Composition	Theory		
Name of the Course	Inorganic Chemistry-II		
Course Code	26L6.0-CHE-201		
Course Type	CC-5		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To know about electronic transitions occurring in the metals and their complexes and also to apply the concept for assignment of absolute configuration in optically active metal chelates and their stereochemical information. CLO 2: To learn about basics of organometallic chemistry, the synthesis, structural characteristics, chemical properties and reactivity of metal complexes. CLO 3: To know the various classifications of metal cluster compounds and to categories the metal boranes carboranes, metallo-boranes and metallo-carboranes and their various aspects. CLO 4: To learn about basic concepts of photochemistry viz photochemical laws, quantum yield, electronically excited states and to learn about the Energy dissipation by radiative and non-radiative processes along with Franck condon principle.		
Credits	Theory	Tutorial	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt

I	Electronic Spectra and Magnetic Properties of Transition Metal Complexes Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term symbols, spectroscopic terms, spectral terms of d ² to d ⁸ metal ions, Determining the ground state terms-Hund's rules, derivation of the term symbols for a closed subshell. Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d ¹ -d ⁹ states), calculations of Dq, B and b parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.	15 CLO 1
II	Organometallic Chemistry Valence electron count (16/18 electron rules), Total electron count (TEC), Compliance and violation of the 18-electron rule, Introduction and Classification of organometallic compounds by bond types viz. covalent, ionic, electron deficient and cluster compounds. Important reactions of organometallic compounds. Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important chemical reactions of metal carbonyls.	15 CLO 2
III	Metal Clusters Boranes: Introduction, Nomenclature, synthesis and properties of some important members (B ₂ H ₆ , B ₄ H ₁₀ , B ₅ H ₉ , B ₅ H ₁₁ and B ₁₀ H ₁₄), bonding in Boranes, STYX code, Borane anions, Carboranes: Introduction, general methods of preparations and important properties, Polyhedral skeletal electron pair theory, Metalloboranes and metallocarboranes: Introduction, general methods of preparation and properties, Isolobal analogy, Metal carbonyl and halide clusters, introduction, Structure and bonding of compounds having M-M bonds, calculation of M-M bond.	15 CLO 3
IV	Photochemistry Absorption, absorption spectra, excitation, photochemical laws, quantum yield, electronically excited states- Jablonski Diagrams: Vibrational Relaxation, Internal Conversion, Intersystem Crossing, Fluorescence, and Phosphorescence; Fluorescence Spectra, Rules of fluorescence, Fluorescence Quantum Yield, Franck-Condon principle, Radiative Lifetime. Bimolecular quenching: Stern-Volmer relation, photochemical kinetics, photochemical stages-primary and secondary.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley. Inorganic Chemistry, J.E. Huhey, Harper & Row.
2. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon. Introduction to Ligand fields; B.N. Figgis, Wiley, New York.
4. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe. Introduction to Ligand Field Theory; C. J. Ballahyen, McGraw Hill, New York. Organometallic Chemistry; R.C. Mehrotra and A. Singh, New Age International.
5. Concepts and Models of Inorganic Chemistry; B. Douglas, D. H. McDaniel and J .J. Alexander; John Wiley.
6. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
7. Basic concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
8. Photochemistry of coordination compounds, K. Balzani and V. Carassti, Academic press.
9. Elements of Inorganic Photochemistry; G.J. Ferraudi, Wiley.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	-	-	2	-	2	1	-	1	-	-
CLO ₂	3	1	-	2	-	2	1	-	1	-	-
CLO ₃	3	1	-	2	-	2	-	-	1	-	-
CLO ₄	3	2	-	2	-	3	1	-	1	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Electronic spectra and magnetic properties of transition metal complexes; organometallic compounds and metal carbonyls; electron counting (16/18-electron rule); photochemistry and its industrial, catalytic and materials applications.	18
Skill Enhancement	Calculation of microstates and spectroscopic term symbols; interpretation of Orgel and Tanabe–Sugano diagrams; calculation of Dq, B and β (nephelauxetic) parameters; total electron counting (TEC); M–M bond calculations in metal clusters; fluorescence quantum yield, Stern–Volmer relation and photochemical kinetics.	24
Communication Development	Interpretation, analysis and presentation of spectroscopic, magnetic, organometallic and photochemical data through reports, assignments, seminars and scientific discussions.	5
Indian Knowledge System	Historical contributions of Indian scientists to coordination and inorganic chemistry.	2
Environmental Awareness	Photochemical processes in environmental remediation; organometallic catalysis for green and sustainable synthesis; fluorescence-based environmental monitoring; environmentally responsible handling and disposal of metal-containing compounds.	5
Current Issues and Social Awareness	Applications of transition metal complexes, organometallic compounds and metal clusters in catalysis, energy conversion, medicine, nanotechnology and environmental sustainability.	4
Women empowerment/ Gender issues	No direct content	0
Public policies	Chemical safety protocols; handling, storage and disposal of organometallic	2

	and metal-containing chemicals; laboratory safety regulations; environmental policies related to hazardous chemical management.	
Any Other	Electronic spectra and magnetic properties of transition metal complexes; organometallic compounds and metal carbonyls; electron counting (16/18-electron rule); photochemistry and its industrial, catalytic and materials applications.	18

CC-6

Session: 2025-26

Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	II		
Nature of Course/Course Composition	Theory		
Name of the Course	Physical Chemistry-II		
Course Code	26L6.0-CHE-202		
Course Type	CC-6		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To analyze the quantum mechanical description of rigid rotators and hydrogen atoms to explain energy states, wave functions, and atomic orbital characteristics. CLO 2: To understand different adsorption models and their application in heterogeneous catalysis. CLO 3: To apply the concepts of polymerization kinetics to analyze polymer formation mechanisms and determine molecular mass parameters of polymers. CLO 4: To understand the concepts of nuclear stability and radioactive processes to explain nuclear reactions, radiation detectors, and radiation dosimetry.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics		Contact Hours\ CLO Attempt
I	Quantum Mechanics-II Energy levels and wave-functions of Rigid rotator. Hydrogen atom: Complete solution (separation of variables in spherical polar coordinates and its solution), Radial probability distributions, shapes of atomic orbitals upto d-level and their discussion.		15 CLO 1
II	Surface Chemistry and Catalysis: Adsorption, Physical and Chemical adsorption, Langmuir adsorption isotherm (L.A.I.) and its derivation for non- dissociative and dissociative adsorption,		15 CLO 2

	BET adsorption isotherm, its derivation and applications, Gibbs Adsorption Isotherm. Heterogeneous catalysis: Unimolecular and bimolecular surface reactions, Activation energies, Comparison of Homogenous and Heterogenous reaction rates.	
III	Polymers: Basic concepts, Kinetics of Polymerization: Mechanism and Kinetics of chain growth polymerization: free-radical, cationic, anionic and coordination polymerization. Mechanism and Kinetics of step-growth polymerization. Comparison between step-growth and chain polymerization. Molecular mass of polymers: Significance of average molecular mass. Poly-dispersity. Determination of molecular mass by viscosity method.	15 CLO 3
IV	Nuclear and Radiochemistry Nuclear stability and binding energy. Mass and binding energy, Nuclear fission and nuclear fusion, fission cross section, chain fission, fission product and fission yield. Interaction of nuclear radiation with matter, Detectors (Proportional, Geiger-Muller and Scintillation counters) and their principles. Units for measuring radiation absorbed, radiation dosimetry.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.		
2. Quantum Chemistry, I.M. Levine, Prentice Hall.		
3. Essentials of Nuclear Chemistry, 4th Edition (1995), H.J. Arnika, Wiley Eastern, New Delhi.		
4. Nuclear & Radiochemistry, 3rd Edition (1981), G. Fridlander, J.W. Kennedy, E. S. Macias, and J. M. Miller, John Wiley, New York.		
5. Polymer Chemistry, Billmayer.		
6. Polymer Chemistry, Gowarikar.		
7. Principles of Polymerization, Geroge Odian.		
8. Quantum Chemistry, B. K. Sen, Kalyani Publishers.		
9. Quantum Chemistry, R.K. Prasad, New Age International.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	–	3	2	–	2	–	–
CLO ₂	3	2	1	2	–	2	1	1	2	–	–
CLO ₃	3	3	1	3	–	3	2	–	2	–	1
CLO ₄	3	2	1	2	–	2	2	2	2	1	–

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
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Employability/ Entrepreneurship	Applications of quantum mechanics, adsorption and catalysis, polymers, and radiochemistry in research, chemical, polymer, and nuclear industries.	14
Skill Enhancement	Analytical skills through hydrogen atom, adsorption isotherms (Langmuir, BET), catalysis, polymerization kinetics, molecular mass determination, nuclear reactions, radiation detectors, and dosimetry.	22
Communication Development	Interpretation and presentation of quantum models, adsorption, polymerization, and nuclear chemistry through assignments and seminars.	4
Indian Knowledge System	Promotes scientific reasoning and logical thinking through fundamental chemical principles.	2
Environmental Awareness	Catalysis, polymers, radiation safety, and dosimetry relevant to sustainable technologies and environmental protection.	6
Current Issues and Social Awareness	Applications in advanced materials, clean energy, healthcare, and nuclear technology.	6
Women empowerment/ Gender issues	No direct content.	0
Public policies	Basic concepts of radiation safety, nuclear energy, and environmental regulations.	2
Any Other	Development of research aptitude, critical thinking, and interdisciplinary learning.	4

Part A - Introduction

Name of Programme	M.Sc. Chemistry		
Semester	II		
Nature of Course/Course Composition	Theory		
Name of the Course	Organic Chemistry-II		
Course Code	26L6.0-CHE-203		
Course Type	CC-7		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To know the concept of Aromatic substitution/displacement reactions. CLO 2: To understand the concept of neighboring group participation and carbocation rearrangements. CLO 3: To describe the generation, structure, stability and reactivity of free radicals and to know the mechanisms of addition to alkenes and alkynes. CLO 4: To understand the concept of addition to carbon hetero atom multiple bonds with emphasis on $>C=O$ group.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.

Unit	Topics	Contact Hours/ CLO Attempt
I	Aromatic Electrophilic Substitution Aromatic substitution reactions, structure- reactivity relationship in mono substituted benzene ring, orientation in other ring systems, partial rate factor, energy profile diagram, Vilsmeier- Haack reaction, Reimer-Tiemann reaction, Bischler-Napieralski reaction, Pechmann reaction, Houben-Hoesch reaction, Fries rearrangement. Nucleophilic Aromatic Substitution Mechanism of Nucleophilic substitution in aromatic systems via diazonium ions, by addition-elimination and elimination-addition mechanism (involving arynes); von-Richter rearrangement, Sommelet-Hauser, Stevens and Smiles rearrangements. General aspects of generation, structure, stability and reactivity of arynes.	15 CLO 1

II	Neighboring Group Participation and Carbocation Rearrangements Anchimeric assistance, neighboring group participation by non-bonding electrons, sigma and Pi-bonds, classical and non-classical carbocations. Carbocations rearrangements: migratory aptitudes, Wagner Meerwein rearrangement, pinacol pinacolone rearrangement, Demjanov rearrangement, Tiffeneau-Demjanov ring expansion, aldehyde-ketone rearrangement, dienone-phenol rearrangement and trans-annular rearrangements.	15 CLO 2
III	Addition to C-C Multiple Bond: General mechanistic considerations, Mechanism of addition of hydrogen halide, H ₂ O, halogens, HOX and mercuric salt to alkenes and alkynes. Hydroboration, formation of C-C bonds <i>via</i> organoboranes, hydroboration of acetylenes, nucleophilic addition to alkenes.	15 CLO 3
IV	Addition to Carbon-Hetero Atoms Multiple Bonds: General mechanistic considerations and reactivity, Hydration and Addition of Alcohols to Aldehydes, Ketones and Acids. Addition - Elimination Reactions of Ketones and Aldehydes, Reactivity of carbonyl compounds towards Addition: Lithium aluminum hydride reduction of carbonyl compounds, acids, esters, nitriles. Additions of Grignard reagents. Reformatsky reaction, Wittig reaction, Claisen condensation, Dieckman reaction, Aldol condensation, Knoevenagel condensation, Perkin reaction, Cannizzaro reaction, Benzoin condensation, Mannich Reaction, Robinson-Mannich reaction, Ester hydrolysis, aminolysis of esters, amide hydrolysis.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	05	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.		
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.		
3. A GuideBook to Mechanism in Organic Chemistry, Peter Sykes, Longman.		
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.		
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.		
6. Modern Organic Reactions, H. O. House, Benjamin.		
7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.		
8. Advanced Organic Chemistry and Reaction Mechanisms, Reinhard Bruckner, Academic Press		
9. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	-	-	2	-	1	-	-	1	-	-
CLO ₂	3	1	-	2	-	2	-	-	1	-	-
CLO ₃	3	2	-	3	-	2	-	-	1	-	-

CLO ₄	3	1	-	3	-	2	-	-	1	-	-
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Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Aromatic substitution, rearrangements, addition reactions, and named reactions applicable in pharmaceutical, agrochemical, and fine chemical industries.	25
Skill Enhancement	Mechanistic analysis, reaction prediction, retrosynthetic thinking, synthetic strategy, and problem-solving skills.	20
Communication Development	Scientific presentation of reaction mechanisms, reaction pathway illustration, and technical discussion.	2
Indian Knowledge System	No direct content in this course.	0
Environmental Awareness	Selective synthetic methodologies (e.g., hydroboration) promoting efficient and atom-economic transformations.	3
Current Issues and Social Awareness	Contemporary applications of organic reactions in medicinal chemistry and sustainable synthesis.	4
Women empowerment/ Gender issues	No direct coverage.	0
Public policies	No direct coverage.	0
Any Other	Advanced named reactions, carbocation rearrangements, organometallic additions, and mechanistic interpretation.	6

CC-8

Session: 2025-26

Part A - Introduction

Name of Programme	M.Sc. Chemistry		
Semester	II		
Nature of Course/Course Composition	Theory		
Name of the Course	Spectroscopy and XRD		
Course Code	26L6.0-CHE-204		
Course Type	CC-8		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand the principles and applications of NMR and NQR spectroscopy in molecular structure determination. CLO 2: Understand basics and significance of NQR and ESR techniques in Chemistry. CLO 3: Understand the principles of crystal symmetry, space groups, reciprocal lattices, and X-ray diffraction for the analysis of crystal structures.		
Credits	Theory	Practical	Total
	3	0	3
Teaching Hours per week	3	0	3
Internal Assessment Marks	25	0	25
End Term Exam Marks	50	0	50
Max. Marks	75	0	75
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The paper setter shall prepare 7 questions selecting two questions from each of the three units with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question comprising 4 short answer type questions carrying two marks each (total 08 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt four questions: the compulsory question no. 1 and 1 question from the each of the three units.

Unit	Topics	Contact Hours/ CLO Attempt
I	Nuclear Magnetic Resonance Spectroscopy Basic principles of NMR, theory of nuclear magnetic resonance, spin lattice relaxation, spin-spin relaxation, experimental techniques, chemical shift, the origin of shielding constant, pattern of coupling, origin of spin-spin coupling. Nuclear Quadrupole Resonance Spectroscopy Introduction, energies of quadrupole transitions, relationship between electric field gradient and molecular structure, applications, interpretations of structural information from NQR spectra.	15 CLO 1

II	Raman Spectroscopy Classical and quantum theories, pure rotational Raman spectra of linear molecules, vibrational Raman spectra, mutual exclusion principle, polarization of the light and Raman effect, depolarization of Raman lines. Electron Spin Resonance Spectroscopy Basic principles of ESR, experimental technique, hyperfine splitting and hyperfine structure (Hydrogen, methyl radical etc.), Instrumentation of ESR and its applications to the study of free radicals and Mc-Connell relationship.	15 CL O2
III	X-ray Crystallography Symmetry elements in crystals, stereographic projections, point groups (illustration of R, R-bar, Rm, R/m, (R-bar)m point groups only), space lattices, space groups P1, Pbar1, P2, P21, Pm, Pc, C2, Cm, Cc. Bragg's Law, Reciprocal lattice concept and its importance, Definition of Reciprocal lattice vector (derivation excluded). Interplanar spacing using reciprocal lattice concept for cubic, tetragonal, orthorhombic and hexagonal crystal systems, Structure factor calculations for primitive, base-centered, body-centered and face centered unit cells. Relation of structure factor to electron density and intensities (derivation excluded).	15 CL O3
Total Contact Hours		45
Evaluation Methods		
Internal Assessment: 25		End Term Examination: 50
● Class Participation:	5	Written Examination:50
● Seminar/presentation/assignment/quiz/class test etc.:	5	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill. 2. Modern Spectroscopy, J.M. Hollas, John Wiley. 3. Basic Principles of Spectroscopy, R. Chang, McGraw Hill. 4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill. 5. Physical Method in Chemistry, R.S. Drago, Saunders College. 6. Elementary Crystallography, L. Azaroff. 7. Structure Determination by X-ray Crystallography, M. Ladd and R. Palmer. 8. X-Ray Structure Determination: A Practical Guide, 2nd Edition by George H. Stout and Lyle H. Jensen. 9. X-Ray Diffraction: A Practical Approach by C. Suryanarayana and M. Grant Norton 10. An Introduction to Crystallography by F. C. Phillips		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	—	3	3	—	2	—	—
CLO ₂	3	2	1	2	—	2	2	—	2	—	—
CLO ₃	3	3	1	3	—	3	3	—	2	—	—

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Advanced spectroscopic and crystallographic techniques (NMR, NQR, Raman, ESR, X-ray Crystallography) widely used in pharmaceuticals, chemical industries, material science, forensic science, and research laboratories.	12
Skill Enhancement	Development of analytical, instrumental, structural interpretation, data analysis, and problem-solving skills through modern characterization techniques.	12
Communication Development	Enhancement of scientific communication through spectral interpretation, technical report writing, data presentation, seminars, and research discussions.	4
Indian Knowledge System	Promotes scientific inquiry, logical reasoning, and advancement of scientific knowledge contributing to modern chemical sciences and technology.	2
Environmental Awareness	Applications of spectroscopic techniques in environmental monitoring, pollutant analysis, material characterization, and sustainable technology development.	4
Current Issues and Social Awareness	Relevance to drug discovery, nanotechnology, advanced materials, forensic investigations, healthcare diagnostics, and emerging scientific technologies.	4
Women empowerment/ Gender issues	Encourages inclusive participation and equal opportunities in scientific research, instrumentation, and higher education.	1
Public policies	Supports scientific evidence-based decision-making in healthcare, environmental monitoring, industrial quality control, and research governance.	2
Any Other	Research aptitude, scientific temper, innovation, critical thinking, computational skills, precision in measurements, and lifelong learning.	4

PC-4

Session: 2025-26

Part A - Introduction

Name of Programme	M.Sc. Chemistry		
Semester	II		
Nature of Course/ Course Composition	Practical		
Name of the Course	Practical-4		
Course Code	26L6.0-CHE-205		
Course Type	PC-4		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO1: To determine concentration of metal ions by spectrophotometric method. CLO2: To prepare and determine λ_{max} of complexes by spectrophotometric method. CLO3: To determine mixture of metal ions by volumetric & gravimetric method.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 25.

Unit	Topics	Contact Hours\ CLO Attempt
I	Determination of some metal ions, such as iron, nickel, manganese, chromium, vanadium etc. and fluoride, nitrite and phosphate etc. by Spectrophotometric Method.	22 CLO1
II	Preparation of acetylacetonato complex of Fe (III), Cu (II), Ni (II) and determine the λ_{max} of the complex using Spectrophotometer.	23 CLO2
III	Quantitative Analysis: Separation and determination of two metal ions such as Ag- Cu, Cu- Ni, Cu- Zn, Ni- Zn, Cu-Fe, Ba-Cu, Fe-Ni, Cu-Mg, Pb-Cu, Zn-Mg. etc. involving volumetric and gravimetric methods.	45 CLO3
Total Contact Hours		90

Evaluation Methods

Internal Assessment: 25		End Term Examination: 50	
• Practical	25	• Practical:	50
• Class Participation:	5	Lab record	10
• Seminar/Demonstration/Viva-Voce/Lab Record/etc.:	5	Viva Voce	15
• Mid-Term Exam:	15	Write-up and execution of the practical	25

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A. I. Vogel, Orient Longman.
2. A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.
3. Vogel's Qualitative Inorganic Analysis, G. Svehla, Orient Longman, New Delhi.
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand Reinhold Company, London.
5. Advanced Practical Inorganic Chemistry, D. M. Adams and J. B. Raynor, John Wiley & Sons, New York.
6. Synthetic Inorganic Chemistry, W. L. Jolly, Prentice Hall, New Jersey.
7. Handbook of Preparative Inorganic Chemistry, G. Brauer, Academic Press, New York.
8. Inorganic Syntheses, H. S. Booth (Ed.), McGraw-Hill Book Company, New York.
9. Instrumental Methods of Chemical Analysis, G. R. Chatwal and S. K. Anand, Himalaya Publishing House, Mumbai.
10. Experimental Methods in Inorganic Chemistry, W. G. Palmer, Cambridge University Press, Cambridge.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	2	1	-	2	-	3	3	-	1	2	-
CLO ₂	2	2	-	2	-	3	3	-	1	2	-
CLO ₃	2	1	-	3	-	3	2	-	1	2	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Spectrophotometric determination of metal ions and anions; preparation and characterization of metal–acetylacetonate complexes; quantitative analysis of binary mixtures using volumetric and gravimetric techniques; laboratory practices relevant to analytical, pharmaceutical and chemical industries.	26
Skill Enhancement	Experimental skills in spectrophotometric analysis; preparation of coordination compounds; determination of λ_{max} ; calibration and operation of spectrophotometer; separation and quantitative estimation of metal ions by volumetric and gravimetric methods; data recording, calculations and error analysis.	40
Communication Development	Preparation of laboratory records, calculation sheets, interpretation of analytical results, graphical representation of spectrophotometric data, viva-voce, and presentation of experimental findings.	6
Indian Knowledge System	Traditional Indian practices in metallurgy and metal extraction; historical development of analytical methods in chemical sciences.	2
Environmental Awareness	Green analytical chemistry; safe handling and disposal of heavy metal ions and laboratory chemicals; waste minimization and environmental monitoring using spectrophotometric techniques.	7
Current Issues and Social Awareness	Applications of analytical chemistry in environmental monitoring, water quality analysis, food analysis, pharmaceuticals and industrial quality control.	4

Women empowerment/ Gender issues	Contributions of women scientists in analytical chemistry, coordination chemistry and instrumental analysis	1
Public policies	Laboratory safety guidelines, chemical hygiene practices, hazardous waste management, Good Laboratory Practices (GLP), and environmental regulations related to chemical laboratories.	4
Any Other	Spectrophotometric determination of metal ions and anions; preparation and characterization of metal–acetylacetonate complexes; quantitative analysis of binary mixtures using volumetric and gravimetric techniques; laboratory practices relevant to analytical, pharmaceutical and chemical industries.	25

PC-5**Session: 2025-26****Part A - Introduction**

Name of Programme	M.Sc. Chemistry		
Semester	II		
Nature of Course/Course Composition	Practical		
Name of the Course	Practical-5		
Course Code	26L6.0-CHE-206		
Course Type	PC-5		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO1: To apply kinetic methods to determine reaction rate constants and analyze the kinetics of ester hydrolysis and saponification reactions CLO2: To apply pH-metric titration techniques to determine the strength of acids and evaluate the dissociation constant of weak acids. CLO3: To apply potentiometric titration techniques to determine the strength of strong and weak acids through quantitative analysis.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 25.

Unit	Topics	Contact Hours\ CLO Attempt
I	Chemical Kinetics (i) Study kinetics of hydrolysis of an ester in the presence of acid. (ii) Study saponification of ethyl acetate by sodium hydroxide solution using the same initial concentration of both the reactants. Electrochemical techniques (i) Record cyclic Voltammogram and find anodic and cathodic oxidative peaks.	35 CLO1
II	Potentiometry (i) Determine the strength of strong acid by potentiometric titration with strong base. (ii) Determine the strength of weak acid by potentiometric titration with strong base.	35 CLO2

	Refractometry (i) Determine the refractive index of the given liquid. (ii) To determine the percentage composition of liquids in the given binary mixture.			
III	pH-metry (i) Determine the strength of strong acid by pH-metric titration with strong base. (ii) Determine the strength of weak acid by pH-metric titration with strong base. (iii) Determine the strength of weak acid by pH-metric titration with weak base. (iv) Determine the strength of strong acid by pH-metric titration with weak base. (v) Determine the dissociation constant of weak acid.			20 CLO3
Total Contact Hours				90
Evaluation Methods				
Internal Assessment: 25			End Term Examination: 50	
➤ Practical		25	➤ Practical:	50
● Class Participation:		5	Lab record	10
● Seminar/Demonstration/Viva-Voce/Lab Record/etc.:		5	Viva Voce	15
● Mid-Term Exam:		15	Write-up and execution of the practical	25
Part C-Learning Resources				
Recommended Books/e-resources/LMS: 1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman. 2. Findley’s Practical Physical Chemistry, B.P. Lavitt, Longman. 3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science. 4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill. 5. Advanced Practical Physical Chemistry, J. B. Yadav Krishna Prakashan 6. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj Anjali Publication. 7. A Comprehensive Guide to Physical Chemistry Experiments and Viva Questions, Neelam Seedher.				

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	1	3	2	—	2	1	—
CLO ₂	3	2	1	3	1	3	3	—	2	1	—
CLO ₃	3	2	1	3	1	3	3	—	2	1	—

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Training in chemical kinetics, potentiometry, cyclic voltammetry, pH-metry, and refractometry enhances employability in analytical laboratories, pharmaceuticals, chemical industries, quality control, and research organizations.	18
Skill Enhancement	Development of practical laboratory skills, instrumental handling, analytical techniques, data interpretation, titration methods, and electrochemical measurements.	30
Communication Development	Strengthens scientific report writing, presentation of experimental results, maintenance of laboratory records, and interpretation of analytical data.	10
Indian Knowledge System	Encourages scientific inquiry, experimental learning, and evidence-based understanding of physicochemical phenomena.	4
Environmental Awareness	Applications of electrochemical and analytical techniques in environmental monitoring, water quality assessment, pollution analysis, and sustainable chemical practices.	8
Current Issues and Social Awareness	Relevance to industrial quality control, pharmaceutical analysis, environmental protection, and development of modern analytical technologies.	8
Women empowerment/ Gender issues	Promotes equal participation and skill development opportunities in laboratory-based scientific education and research.	2
Public policies	Supports scientific understanding relevant to environmental regulations, industrial quality standards, laboratory safety, and analytical testing protocols.	4
Any Other	Critical thinking, scientific temper, research aptitude, problem-solving ability, precision in experimentation, teamwork, and lifelong learning.	6

PC-6

Session: 2025-26

Part A - Introduction

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	II		
Nature of Course/Course Composition	Practical		
Name of the Course	Practical-6		
Course Code	26L6.0-CHE-207		
Course Type	PC-6		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO1: To introduce chemical identification of simple organic compounds. To analyze qualitatively the presence of extra elements and functional groups in organic compounds along with understanding of chemical reaction involved. CLO2: To make them able to differentiate between aromatic/aliphatic, saturated/unsaturated, hydrocarbon/heterocycles and develop the capabilities of preparing derivatives of different organic compounds bearing various organic functionalities. CLO3: To know the concept of Colorimetric determination of some organic compounds.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 25.

Unit	Topics	Contact Hours\ CLO Attempt
I	Qualitative Analysis Identification of the given organic compound by Chemical tests	25 CLO1
II	Qualitative Analysis Preparation of derivatives of different organic compounds bearing various organic functionalities. (One set to be given in the examination)	20 CLO2

III	Colorimetric determination of the following: (i) Carbohydrates (ii) Ascorbic acid (iii) Amino acids (iv) Proteins (v) Cholesterol (vi) Urea	45 CLO3	
Total Contact Hours			90
Evaluation Methods			
Internal Assessment: 25		End Term Examination: 50	
• Practical	25	• Practical:	50
• Class Participation:	5	Lab record	10
• Seminar/Demonstration/Viva-Voce/Lab Record/etc.:	5	Viva Voce	15
• Mid-Term Exam:	15	Write-up and execution of the practical	25
Part C-Learning Resources			
Recommended Books/e-resources/LMS:			
1. A Handbook of Organic Analysis Qualitative and Quantitative by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.) Ltd. London, 1975).			
2. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Ltd., London 1959.			
3. A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis by Arthur Vogel, Longmans Green and Co., Ltd., London 1966.			
4. Elementary Practical Organic Chemistry by Arthur I. Vogel, CBS Publishers & Distributors.			
5. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	-	3	2	-	1	-	-
CLO ₂	3	2	1	3	-	2	2	-	1	-	-
CLO ₃	2	2	1	3	-	3	3	-	1	-	-

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/Entrepreneurship	Development of analytical skills through qualitative organic analysis, preparation of organic derivatives, and quantitative estimation techniques useful in chemical industries, pharmaceutical analysis, food analysis, and quality control laboratories.	15
Skill Enhancement	Hands-on training in identification of organic compounds by chemical tests, preparation of derivatives, colorimetric analysis of carbohydrates, ascorbic acid, amino acids, proteins,	35

	cholesterol, and urea using laboratory techniques and instrumentation.	
Communication Development	Scientific documentation of experimental procedures, observations, calculations, interpretation of results, and preparation of laboratory reports following scientific writing standards.	10
Indian Knowledge System	Study and analysis of natural products and biomolecules such as carbohydrates, proteins, vitamins, and other bioactive compounds obtained from natural sources and their relevance in traditional and modern applications.	5
Environmental Awareness	Understanding safe handling of chemicals, waste management practices, reduction of chemical hazards, and adoption of environmentally responsible laboratory practices during organic analysis and biochemical estimations.	10
Current Issues and Social Awareness	Application of biochemical analysis methods for quality assessment of food products, nutritional supplements, healthcare-related materials, and monitoring of compounds affecting human health.	5
Women empowerment/ Gender issues	Development of laboratory skills and scientific competency among students irrespective of gender, promoting equal participation in chemical research and analytical fields.	2
Public policies	Awareness about standards, regulations, and quality control guidelines related to pharmaceutical products, food materials, and biochemical substances.	3
Any Other	Research aptitude development through interpretation of analytical data, accuracy improvement, problem-solving ability, and exposure to modern analytical approaches.	5

CHM

Session: 2025-26			
Part-A - Introduction			
Name of the Programme	M.Sc. Chemistry		
Semester	II		
Nature of Course/Course Composition	Theory		
Name of the Course	Constitutional, Human and Moral Values, and IPR		
Course Code	26L6.0-CHM-201		
Course Type	CHM		
Level of the course	400-499		
Pre-requisite for the course (if any)	Not any		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understanding the Law and Moral Values. Learn Humanism and Human Values. CLO 2: Understand Concept of IPR, Copyright, patent, trademark and similar IPs.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	2 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 5 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory . Examinees will be required to attempt three questions : the compulsory question no. 1 and 1 question from each of the two units.			

Unit	Topics	Contact Hours/ CLO Attempt
As Per University Guideline		

Session: 2025-26			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Advanced Organic Spectroscopy		
Course Code	26L6.5-CHE-301		
Course Type	CC-09		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Understand UV-Vis spectroscopy (electronic transitions, influencing factors), Fieser-Woodward rules for conjugated systems, and IR spectroscopy principles for functional group identification. CLO 2: Understand NMR phenomenon and fundamentals, including chemical shift, coupling constant, 1st/2nd-order NMR spectra, and 2D-NMR. Develop skill to predict NMR spectra, interpret them, and use NMR data to determine structure of Organic molecules. CLO 3: Analyse mass spectrometry principles: fragmentation patterns, influencing factors, ion analysis techniques, and structural determination using spectral data. CLO 4: Enable student compare ^1H-NMR and ^{13}C-NMR techniques and use C-13 NMR along with other spectra techniques in solving composite structural problems in organic chemistry.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/CLO Attempt

I	Ultraviolet and Visible Spectroscopy Introduction and understanding of UV phenomenon, Various electronic transitions (185-800 nm), Chromophores, Auxochromes, Bathochromic and Hypsochromic shift, Hyperchromic and Hypochromic effect, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds. Infrared Spectroscopy Principle and Theory, Modes of stretching and bending vibrations, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. Problems related to IR spectroscopy.	15 CLO1
II	Nuclear Magnetic Resonance Spectroscopy: General introduction: Theory and basic principles of NMR, Chemical shift: Definition, mechanism of measurement, shielding mechanism, factors affecting chemical shifts, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto). Spin-Spin coupling: Theory, splitting patterns, coupling constants and their significance, magnetic and chemical equivalence, factors affecting coupling constant, complex spin-spin interaction between two, three, four and five nuclei (first order spectra). Hindered rotation and NMR: Temperature effects and splitting patterns. Spin system: Pople notation. Second order spectra, Virtual coupling, Stereochemistry: concept of topicity, effect of enantiomeric and diastereomeric protons. Tools for simplification of complex NMR spectrum (chemical and instrumental):- Deuteration, changing solvent, trifluoroacetylation, basification and acidification, lanthanide shift reagents, increased magnetic field strength, double resonance and nuclear overhauser effect (NOE), variable temperature probe.	15 CLO2
III	Mass Spectrometry Introduction: ion production - EI, CI, FD and FAB, Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, Nitrogen rule, molecular weight determination, molecular formula from isotopic ratio data, isotope profile of halogen compounds, Fragmentation pattern - simple cleavage, retro- Diels Alder, Hydrogen transfer rearrangement like scrambling, ortho effect, McLafferty rearrangement, fragmentation patterns of hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles.	15 CLO3
IV	2D-NMR spectroscopy: Principle, comparison with 1D-NMR. Informations provided by 2D-NMR experiments: COSY, NOESY, HSQC and HMBC. Carbon-13 NMR Spectroscopy General considerations: Comparison between ^1H and ^{13}C-NMR, Proton coupled and proton-decoupled ^{13}C-NMR, Chemical shifts for different	15 CLO4

carbon environments (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), Coupling constants, Nuclear Overhauser effect in ¹³ C-NMR. Introduction to DEPT NMR and information provided by various DEPT experiments (DEPT-45, DEPT- 90, and DEPT-135). Composite Problems: Problems involving the application of the above spectroscopic techniques (UV/Visible, IR, NMR and Mass) for structural elucidation of organic molecules.		
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Introduction to Spectroscopy-A Guide for Students of Organic Chemistry, 2nd Edn. By Donald L. Pavia, Gary M. Lampman and George		
2. S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York.		
3. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.		
4. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.		
5. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill.		
6. Spectroscopy of Organic Compounds by P. S. Kalsi, Wiley Estern, New Delhi.		
7. Organic Spectroscopy by William Kemp, John Wiley.		
8. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co.		
9. Organic Spectroscopy (Principles & Applications) by Jagmohan.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	—	—	2	—	2	2	—	1	—	—
CLO ₂	3	2	1	3	—	3	3	—	1	—	—
CLO ₃	3	2	—	3	—	3	3	—	1	—	—
CLO ₄	3	3	1	3	—	3	3	—	2	—	—

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Spectroscopic techniques (UV-Visible, IR, NMR, Mass Spectrometry, 2D-NMR) widely used in pharmaceuticals, chemical industries, quality control, forensic science, research laboratories, and analytical instrumentation.	20
Skill Enhancement	Interpretation of UV, IR, ^1H -NMR, ^{13}C -NMR, DEPT, COSY, HSQC, HMBC, NOESY, Mass spectra, structural elucidation, and solving composite spectroscopic problems.	28
Communication Development	Scientific interpretation of spectra, presentation of analytical data, discussion of structural assignments, and technical reporting.	2
Indian Knowledge System	Application of spectroscopic methods in characterization and standardization of natural products, herbal medicines, Ayurvedic	2

	formulations, and phytochemicals.	
Environmental Awareness	Spectroscopic analysis for monitoring pollutants, environmental contaminants, green analytical methods, and safe laboratory practices.	2
Current Issues and Social Awareness	Role of spectroscopy in drug discovery, food safety, forensic investigations, biomedical diagnostics, and public health.	2
Women empowerment/ Gender issues	Encouraging equal participation in scientific research, analytical chemistry laboratories, and STEM education.	1
Public policies	Quality assurance, GLP, regulatory standards, pharmaceutical analysis, environmental monitoring, and laboratory accreditation.	1
Any Other	Advanced analytical research, multidisciplinary applications, and innovation in structural elucidation of organic molecules.	2

Session: 2025-26			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Physical Chemistry-III		
Course Code	26L6.5-CHE-302		
Course Type	CC-10		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Apply polarographic equations to analyze electrochemical behavior of reversible systems and interpret current-voltage data for quantitative and qualitative analysis. CLO 2: Understand the principles, instrumentation, factors affecting thermograms and thermal curves, and applications of thermogravimetry (TG), differential thermal analysis (DTA), and differential scanning calorimetry (DSC). CLO 3: Understand electrode potentials, polarization phenomena, and electrochemical methods for corrosion analysis and rate determination. CLO 4: Understand the mechanisms of different forms of corrosion and the principles of corrosion prevention and protection methods.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Polarography General principles of polarography, the limiting current, diffusion current, derivation of Ilkovic equation, consequences of the Ilkovic equation,, half -wave potential and its significance, equations for reversible cathodic, anodic, and cathodic-anodic waves, analysis of reversible polarographic wave, factors affecting the half- wave potential, reversible processes controlled by diffusion of complex ions, application of polarography.		15 CLO 1

II	Thermal Analysis Introduction to thermal analysis, thermogravimetry (TG), static and dynamic thermogravimetry, Instrumentation, thermogram, factors affecting thermograms, application of thermogravimetry. Differential thermal analysis (DTA), DTA curves, factors affecting DTA curves applications of DTA, Differential Scanning Calorimetry (DSC) Introduction, Instrumentation, Power compensated and Heat Flux DSC, factors affecting DSC curves, applications of DSC.	15 CLO 2
III	Electrochemistry of Corrosion Electrode potentials, Nernst equation, exchange current density, measurement of corrosion potential and corrosion current density, polarization of electrode (resistance, concentration and activation), mixed potential theory, polarization diagrams, pourbaix diagrams, corrosion rate expression and weight loss method for corrosion rate, galvanic series, Stern –Geary equation, Tafel equation, Tafel extrapolation and Linear polarization resistance methods.	15 CLO 3
IV	Corrosion Corrosion, importance and cost, Electrode reactions, Uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, corrosion fatigue, fretting corrosion, dealloying, hydrogen embrittlement, erosion corrosion, microbial induced corrosion, filiform corrosion and exfoliation. Protection Methods against Corrosion: Change of metal, design improvement, change of environment, anodic protection, cathodic protection and protective coatings.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. Handbook of Thermal Analysis and Calorimetry; M. E. Brown. 2. Instrumental methods of Analysis: Willard, Merritt & dean. 3. Advanced Analytical Chemistry: Meiter and Thomas. 4. Modern Electrochemistry Vol. 2B: Electrode in Chemistry, Engineering, Biology and Environmental Science" by John O'M. Bockris and Amulya K.N. Reddy. 5. Principles and Prevention of Corrosion" by Denny A. Jones. 6. Electrochemistry, S. Glasstone, Affiliated East -West Press. 7. Physical Chemistry, G.W. Castellan, Narosa. 8. D.A. Skoog, D. M. West, F. J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8thEdition, Thomson (2004). 9. A.I. Vogel, A text book of Quantitative Analysis, 5th Edition Revised by G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, ELBS (1989).		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	–	3	3	–	2	–	–
CLO ₂	3	2	1	2	–	2	3	–	2	–	–
CLO ₃	3	3	1	3	–	3	2	1	2	1	–
CLO ₄	3	2	1	3	–	2	2	3	2	2	1

Content Mapping with NEP thrust areas

Field	Content/s	Hours devoted
Employability/ Entrepreneurship	Knowledge of polarography, thermal analysis (TG, DTA, DSC), and corrosion science enhances employability in chemical industries, metallurgy, materials science, quality control, energy sectors, and research laboratories.	12
Skill Enhancement	Develops analytical, instrumental, electrochemical, and materials characterization skills through the study of polarographic techniques, thermal analysis, and corrosion monitoring methods.	20
Communication Development	Promotes scientific report writing, interpretation of experimental data, technical presentations, and discussion of analytical and corrosion-related results.	6
Indian Knowledge System	Encourages scientific reasoning, experimental learning, and technological innovation contributing to the advancement of chemical and materials sciences.	3
Environmental Awareness	Understanding corrosion prevention, material conservation, waste reduction, environmental degradation, and sustainable use of resources. Thermal analysis and electrochemical techniques aid environmental monitoring and material sustainability.	6
Current Issues and Social Awareness	Relevance to infrastructure durability, industrial safety, energy systems, sustainable development, corrosion management, and advanced materials technology.	5
Women empowerment/ Gender issues	Promotes equal participation and opportunities in scientific education, laboratory training, and research activities.	1
Public policies	Supports policies related to industrial safety, corrosion control, infrastructure maintenance, environmental protection, energy conservation, and sustainable technology development.	2
Any Other	Scientific temper, critical thinking, research aptitude, innovation, problem-solving ability, safety awareness, and lifelong learning.	5

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/ Course Composition	Theory		
Name of the Course	Inorganic Chemistry Special-I		
Course Code	26L6.5-CHE-303a		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To Learn about alkyl, aryls of transition metals and fluxional behavior of organometallic compounds CLO 2: To Learn about Compounds of Transition Metal-Carbon Multiple Bonds and Transition Metal Compounds with Bonds to Hydrogen CLO 3: To learn about Transition Metal π -Complexes CLO 4: To learn about Homogeneous catalysis		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Alkyls and Aryls of Transition Metals Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis Fluxional Organometallic compounds Fluxionality and dynamic equilibria in compounds such as η^2 -olefin, η^3 -allyl and dienyl complexes, Carbonyl scrambling.		15 CLO 1
II	Compounds of Transition Metal-Carbon Multiple Bonds, Alkylidenes, alkylidynes, low valent carbenes and carbynes- synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis Transition Metal Compounds with Bonds to Hydrogen: bonding and different types.		15 CLO 2

III	Transition Metal π-Complexes Transition metal π -complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.	15 CLO 3
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IV	Stoichiometric reactions for catalysis & Organometallic Reagents: Synthesis, properties, reactions and applications of lithium, Magnesium, zinc, cadmium, mercury, aluminium, Thallium, tin and silicon reagents, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), oxopalladation reactions, activation of C-H bond.	15 CLO 4
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Total Contact Hours		60
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Evaluation Methods		
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Internal Assessment:		30	End Term Examination: 70
• Class Participation:	5	Written Examination: 70	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources			
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Recommended Books/e-resources/LMS:

1. Principles and Application of Organo transition Metal Chemistry, J.P. Collman, L.S. Hegedus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
3. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
4. Coordination Chemistry; Banerjee; Tata McGraw Hill.
5. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons Inc.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	-	2	1	-	1	-	-
CLO ₂	3	2	1	2	-	2	1	-	1	-	-
CLO ₃	3	2	1	2	-	2	2	-	1	-	-
CLO ₄	3	2	1	3	1	2	2	1	2	-	1

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Organometallic chemistry concepts relevant to pharmaceuticals, petrochemicals, polymer industries, catalysis, and chemical manufacturing sectors.	18
Skill Enhancement	Synthesis and characterization of organometallic compounds, understanding catalytic mechanisms, metal-carbon bonding, and industrial catalytic processes.	25
Communication Development	Interpretation and presentation of reaction mechanisms, catalytic cycles, molecular structures, and scientific reports.	3
Indian Knowledge	Knowledge of metal-based catalysts and materials contributing to advances in chemical technology and materials science.	2

System		
Environmental Awareness	Study of catalytic processes that improve reaction efficiency, reduce waste generation, and support green chemistry practices.	5
Current Issues and Social Awareness	Applications in sustainable catalysis, polymer production, fuel processing, fine chemical synthesis.	3
Women empowerment/ Gender issues	No direct content	0
Public policies	No direct content	0
Any Other	Enhances analytical thinking, innovation, research aptitude, problem-solving skills, and understanding of advanced organometallic chemistry.	4

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Physical Chemistry Special-I		
Course Code	26L6.5-CHE-303b		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Know about the techniques of studying fast reactions i.e., flash photolysis, flow methods, relaxation techniques and shock tube technique. CLO 2: Understand the concepts of potential energy surfaces, methods for calculating activation energy, and the theories of unimolecular reaction mechanisms. CLO 3: Understand the concepts of surface-active agents, micellization, critical micellar concentration, and the formation of emulsions and microemulsions. CLO 4: Understand the concepts of entropy, phase rule, and phase equilibria for the construction and interpretation of phase diagrams.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Fast Reactions: Steady-state kinetics of chain reaction such as (pyrolysis of acetaldehyde, decomposition of ethane), photochemical (H_2-Cl_2) reactions & oscillatory reactions (Belousov-Zhabotinsky reaction). Relaxation methods for fast reactions: general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis, and NMR method.		15 CLO 1
II	Advanced Chemical Kinetics: Potential energy surfaces (Only basic Idea), London-Eyring-Polanyi method of calculation of energy of activation., Unimolecular reactions: Lindemann- Christiansen Hypothesis, Hinshelwood treatment, Kassel's theory (RRK), Rice-Ramsperger-Kassel-Marcus (RRKM) theory.		15 CLO 2

III	Micelles Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, shape and structure of micelles, of critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, phase separation and mass action models, solubilization, emulsions, micro emulsion, macro emulsions.	15 CLO 3
IV	Thermodynamics and Phase Equilibria: Nernst heat theorem, determination of absolute entropy, Concept of phases, components and degrees of freedom, Gibb's phase rule, Clausius Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, Phase diagram for one component system, (H ₂ O, CO ₂ and Sulphur system); Phase diagram for two completely miscible components systems, calculation of eutectic point, systems forming solid compounds A _x B _y with congruent and incongruent melting points. Phase diagram for three component systems, water-chloroform acetic acid system, triangular plots.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. Thermodynamics for Chemists, Affiliated East-West Press. 2. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benjamin. 3. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub 4. Micelles, Theoretical and Applied Aspects, V.Moroi, Plenum. 5. Chemical Kinetics, K.J. Laidler, McGraw Hill 6. Theories of Chemical Reaction Rates, K.J. Laidler, McGraw Hill. 7. Theory of Rate Processes, S. Glasstone, K.J. Laidler and H. Eyring, McGraw Hill. 8. Reaction Kinetics Oxford Press (1997), M. J. Pilling and P. W. Seakins.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	2	—	3	3	—	2	—	—
CLO ₂	3	3	1	3	—	3	2	—	2	—	—
CLO ₃	3	2	1	2	—	2	2	1	2	—	—
CLO ₄	3	3	1	3	—	3	2	1	2	—	—

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Applications of fast reaction kinetics, relaxation techniques (flow method, flash photolysis, NMR), micelles, emulsions, microemulsions, and phase equilibria in pharmaceuticals, chemical industries, petrochemicals, detergents, and materials research.	14
Skill	Development of practical and analytical skills through steady-state kinetics,	18

Enhancement	chain reactions, oscillatory reactions, potential energy surfaces, activation energy calculations, unimolecular reaction theories (Lindemann, RRK, RRKM), micellization, CMC determination, thermodynamics of micellization, Gibbs phase rule, Clausius–Clapeyron equation, and interpretation of phase diagrams.	
Communication Development	Interpretation and presentation of reaction mechanisms, kinetic data, micellar systems, thermodynamic concepts, and one-, two-, and three-component phase diagrams through assignments, tutorials, and seminars.	6
Indian Knowledge System	Promotion of scientific reasoning, experimental methodology, and logical analysis through the study of chemical kinetics, thermodynamics, and phase equilibria.	3
Environmental Awareness	Understanding the role of surfactants, micelles, emulsions, phase equilibria, and thermodynamic principles in pollution control, green chemistry, wastewater treatment, and sustainable industrial processes.	6
Current Issues and Social Awareness	Applications of fast reaction techniques, photochemical reactions, micellar systems, and phase equilibrium studies in drug delivery, nanotechnology, catalysis, environmental remediation, and advanced materials.	5
Women empowerment/ Gender issues	No direct content in the syllabus.	1
Public policies	Basic understanding of thermodynamics, phase equilibria, and environmentally relevant surfactant systems supporting industrial safety, environmental regulations, and sustainable chemical technologies.	2
Any Other	Development of research aptitude, critical thinking, scientific problem-solving, and interdisciplinary understanding through advanced kinetics, thermodynamics, and surface chemistry.	5

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Organic Chemistry Special-I		
Course Code	26L6.5-CHE-303c		
Course Type	DEC-1		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To understand the principle of oxidation, oxidative processes related to Hydrocarbons- alkenes, aromatic rings, activated and unactivated saturated C-H groups, alcohols, diols, aldehydes, ketones, ketals and carboxylic acids, amines, hydrazines, and sulphides. CLO 2: To understand the general pathways of reduction reactions. Reduction of Hydrocarbons – alkanes, alkenes, alkynes, substituted and unsubstituted aromatic rings, carbonyl compounds- aldehydes, ketones, acids and their derivatives, Epoxides, compounds containing nitro, nitroso, azo and oxime groups. CLO 3: To understand the light-induced reactions in carbonyl compounds (Paterno-Büchi reaction, photoreduction, etc.), photochemistry of unsaturated systems (olefins, 1,3-butadiene) CLO 4: To understanding of photochemical rearrangements (Di-π-methane, Photo-Fries, Barton, Hoffman-Löffler-Freytag) and their applications in biological systems, including vision mechanisms and neonatal jaundice treatment.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt

I	Oxidations Introduction: Different Oxidative processes. Hydrocarbon: Alkenes, aromatic ringssaturated C-H groups (activated and unactivated), Alcohols, diols, aldehydes, Ketones, Carboxylic acids, Amines, hydrazines, sulphides. Oxidations with ruthenium tetroxide iodobenzene diacetate and Tl(III) nitrate, Lead tetra acetate, SeO ₂ , MnO ₂ Ag ₂ CO ₃ , peracids. Oxidation of C=C perhydroxylation using KMnO ₄ , OsO ₄ , peracids.	15 CLO 1
II	Reduction: Introduction: Different Reductive process Hydrocarbons: Alkenes, alkynes, and aromatic rings, Carbonyl compounds – aldehydes, ketones, acids and their derivatives, Nitro, nitroso, azo and oxime group Hydrogenolysis. Catalytic hydrogenations, Reduction with metal in liquid ammonia (Birch reduction). Reduction by hydride transfer reagents: Aluminium alkoxide, LiAlH ₄ , NaBH ₄ , Diisobutyl aluminium hydrides, Sodium cyano borohydride, tryalkyl borohydirdes – Reduction with diimide.	15 CLO 2
III	Photochemistry: Excitation and excited states, Franck-Condon Principle, Jablonski diagram, energy transfer photosensitization, quenching, quantum yield, excimer and exciplex complex, P-type and E-type delayed fluorescence Photochemistry of carbonyl compounds (Norrish type I and type II changes, photoreaction of cyclic ketones, Paterno-Buchi reaction and Photoreduction. Photochemistry of olefins and 1,3-Butadiene (cis-trans isomerisation, dimerization, and cycloadditions).	15 CLO 3
IV	Photochemistry: Di- π -methane rearrangement, enone and dienone rearrangements, photochemistry of aromatic compounds (substitution, isomerization, cyclization and cycloaddition reactions), Photo-Fries rearrangement, photolysis of nitrile esters and Barton reaction, Hoffman-Loeffler- Freytag reaction.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		

Recommended Books/e-resources/LMS:

1. Some Modern Methods of Organic Synthesis, W. Carruther, Cambridge Univ. Press.
2. Advanced Organic Chemistry, Reactions Mechanism and Structure, J. March, John Wiley.
3. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
4. Advanced Organic Chemistry and Reaction Mechanisms, Reinhard Bruckner, Academic Press.
5. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press.
6. Organic Photochemistry, J Coxan & B. Halton, Cambridge University Press.
7. Introductory Photochemistry, A. Cox and T. Camp McGraw Hill.
8. Organic Photochemistry, V. Ramamurthy, CRC Press First Edition, 1997.
9. Organic Photocatalysts for Energy and Synthesis Emily R. Smith, James M. R. Narayanam Publisher: Royal Society of Chemistry Year: 2025.
10. Photoinduced Reactions in Organic Synthesis, Stefano Protti, Maurizio Fagnoni, Publisher: Wiley-VCH, Year: 2020.
11. Reaction Mechanisms in Organic Chemistry by S.M. Mukherjee and S.P. Singh, Lakshmi Publications.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	-	2	2	-	1	-	-
CLO ₂	3	2	1	3	-	2	2	-	1	-	-
CLO ₃	3	2	1	3	-	2	2	-	1	-	-
CLO ₄	3	2	2	3	-	2	1	2	1	-	-

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Oxidation and reduction methodologies widely used in pharmaceutical, fine chemical, agrochemical and research industries; photochemical reactions relevant to industrial synthesis and process development.	18
Skill Enhancement	Mechanistic understanding of oxidation, reduction and photochemical reactions; selection of reagents; reaction design; interpretation of reaction pathways and synthetic planning.	22
Communication Development	Scientific presentation, interpretation of reaction mechanisms, discussion of photochemical pathways, and technical writing during assignments and seminars.	2
Indian Knowledge System	Limited scope; reference to sustainable and green synthetic practices compatible with traditional resource-efficient approaches.	2
Environmental Awareness	Environmentally benign oxidants/reductants, atom economy, safer reaction conditions, photochemical processes as green alternatives, waste minimization.	6
Current Issues and Social Awareness	Importance of sustainable organic synthesis in pharmaceuticals, materials, healthcare, and environmental protection.	3
Women empowerment/ Gender issues	Not specifically addressed in the course.	0
Public policies	Awareness of laboratory safety, chemical handling regulations, and environmental guidelines related to chemical synthesis.	2
Any Other	Advanced synthetic strategy, reaction mechanism analysis, and research-oriented applications in modern organic chemistry.	5

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Inorganic Chemistry Special-II		
Course Code	26L6.5-CHE-304a		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To Learn about Reaction Mechanism of Transition Metal Complexes CLO 2: To Learn about Electron transfer reactions in transition metal complexes CLO 3: To learn about Photochemistry of transition metal complexes CLO 4: To learn about different defects in solids.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Reaction Mechanism of Transition Metal Complexes Energy profile of a reaction, reactivity of metal complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. ligand Substitution reactions in square planar complexes, factors affecting substitution reactions in square planar complexes, the Trans effect, mechanism of the substitution reactions.		15 CLO 1

II	Electron Transfer Reactions Redox reactions, electron transfer reactions, general discussion and kinetic rate laws., mechanism of one electron transfer reactions, outer-sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions, two electron transfer reactions, metal ion catalyzed reactions, mixed valence complexes and their electron transfer.	15 CLO 2
III	Excited States of Metal Complexes Electronically excited states of metal complexes: charge-transfer spectra, charge transfer transition, photosubstitution reactions, photo rearrangements, photoisomerisation, photoredox processes conditions of excited states to be useful redox reaction Illustration of some reducing and oxidizing character of Ru(2+) tris-bipyramidal complex. Transformation of chemical energy into light energy Metal Complex Sensitizers Metal complex sensitizer, photosensitised reactions in metal complexes, water photolysis, nitrogen fixation and carbon dioxide reduction	15 CLO 3
IV	Defects and Non-stoichiometry: Intrinsic and extrinsic defects- point defects, line and plane defects, vacancies- Schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects. Metals, insulators and semiconductors, electronic structure of solids- band theory, band structure of metals, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping semiconductors, pnjunctions, superconductors, Optical and Magnetic properties.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. Mechanism of Inorganic Reactions; F. Basolo and R.G. Pearson, John Wiley and Sons, New York. 2. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia. 3. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley. 4. Photochemistry of coordination compounds, K. Balzani and V. Carassti, Academic press. 5. Elements of Inorganic Photochemistry; G.J. Ferraudi, Wiley. 6. An Introduction to Crystal Chemistry; R.C. Evans, Cambridge University Press. 7. Introduction to solid state Physics; C. Kittel, Wiley New York. 8. Solid State Chemistry; N.B. Hannay; Prentice.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	-	2	1	-	1	-	-

CLO ₂	3	2	1	2	-	2	1	-	1	-	-
CLO ₃	3	2	1	2	-	2	2	1	1	-	-
CLO ₄	3	1	-	2	-	2	1	1	1	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Advanced knowledge of transition metal reaction mechanisms, photochemistry, semiconductors, and materials science relevant to chemical, electronics, energy, and research industries.	16
Skill Enhancement	Analysis of substitution and electron transfer reactions, photochemical processes, defect chemistry, semiconductor properties, and catalytic mechanisms.	25
Communication Development	Interpretation and presentation of reaction pathways, energy profiles, electronic transitions, solid-state defects, and scientific reports.	3
Indian Knowledge System	Fundamental understanding of materials and energy transformations supporting developments in metallurgy, materials science, and technological innovations.	2
Environmental Awareness	Applications in water photolysis, carbon dioxide reduction, nitrogen fixation, energy-efficient materials, and sustainable chemical processes.	5
Current Issues and Social Awareness	Relevance to renewable energy, solar energy conversion, semiconductor technology, environmental remediation, and advanced functional materials.	3
Women empowerment/ Gender issues	No direct content	0
Public policies	Supports policies related to clean energy, semiconductor manufacturing, environmental sustainability, advanced materials, and technological development.	2
Any Other	Develops critical thinking, problem-solving ability, research aptitude, innovation skills, and understanding of modern inorganic and solid-state chemistry.	4

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Physical Chemistry Special-II		
Course Code	26L6.5-CHE-304b		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand the principles of statistical mechanics, ensemble theory, and distribution laws, and explain the statistical behavior of molecular systems in terms of molecular velocities and energy distributions. CLO 2: Analyze classical and quantum statistical distributions and their applications in describing photon gases, electron gases, gas degeneration, and thermionic emission. CLO 3: Interpret the role of molecular partition functions in determining energy, entropy, and other thermodynamic properties of gases. CLO 4: Apply statistical thermodynamic principles to relate partition functions to thermodynamic properties, equilibrium constants, and radiation phenomena in molecular systems.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Statistical Mechanics-1 Concept and Need of Statistical Mechanics, Ensemble averaging, postulates of ensemble averaging. Micro canonical, canonical and grand canonical ensembles, macro and micro states, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Maxwell- distribution Law and its derivation, Maxwell distribution law of velocities and law of equipartition of energy (derivation also) using Statistical consideration, Average velocity,		15 CLO 1

	Most probable velocity, Root mean square velocity.	
II	Statistics Mechanics-II The Bose-Einstein statistics, statistics of a photon, gas degeneration, the Fermi-Dirac statistics, and extreme gas degeneration, Fermi energy, comparison of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Electron gas in metals, thermionic emission.	15 CLO 2
III	Statistical Thermodynamics – I Partition function and its factorization, translational partition function, vibrational partition function, rotational partition function and electronic partition function of atoms. Sackur-Tetrode equation, separation of internal partition function. Translational, Rotational and vibrational energies, entropy due to internal degrees of freedom. Rotational partitions function for polyatomic molecules.	15 CLO 3
IV	Statistical Thermodynamics – II Relation between partition function and thermodynamic properties i.e. internal energy, enthalpy, entropy, Helmholtz and Gibbs free energy, work function. Determination of thermodynamic properties using internal degree of freedom i.e. rotational, vibrational and translational. Application of Bose-Einstein statistics to black body radiation, free energy and enthalpy functions. Effect of zero point energy on Partition function and thermodynamic properties. Relationship between Partition function and equilibrium constant of gaseous systems.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Introduction to Statistical Thermodynamics, H. Dole.		
2. Theoretical Chemistry, S. Glasstone, Affiliated East-West Press.		
3. Thermodynamics, Lewis and Randall.		
4. Chemical Physics, J.C. Slater.		
5. Non-equilibrium Thermodynamics, C. Kalidas.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	–	3	2	–	2	–	–
CLO ₂	3	3	1	3	–	3	2	–	2	–	–
CLO ₃	3	3	1	3	–	3	2	–	2	–	–
CLO ₄	3	3	1	3	–	3	2	1	2	–	–

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Application of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics, electron gas in metals, thermionic emission, partition	14

	functions, and thermodynamic properties relevant to research laboratories, materials science, semiconductor technology, and higher studies.	
Skill Enhancement	Development of quantitative and analytical skills through ensemble averaging, statistical distribution laws, Maxwell distribution, partition functions, Sackur-Tetrode equation, calculation of internal energy, enthalpy, entropy, Helmholtz and Gibbs free energy, equilibrium constant, and thermodynamic calculations.	18
Communication Development	Presentation and interpretation of statistical distributions, partition functions, thermodynamic relationships, derivations, and numerical problem-solving during tutorials and assignments.	6
Indian Knowledge System	Promotion of scientific reasoning, mathematical analysis, and logical thinking through the study of statistical mechanics and thermodynamics.	2
Environmental Awareness	Understanding of black body radiation, energy distribution, thermodynamic functions, and equilibrium concepts that form the basis of energy science and sustainable technologies.	6
Current Issues and Social Awareness	Applications of quantum statistics, electron gas, thermionic emission, and thermodynamic principles in modern materials, nanotechnology, energy systems, and condensed matter research.	5
Women empowerment/ Gender issues	No direct content in the syllabus.	1
Public policies	Basic understanding of energy-related thermodynamic principles supporting scientific and technological developments in national research and innovation.	2
Any Other	Development of research aptitude, critical thinking, mathematical modelling, and interdisciplinary scientific approach through statistical mechanics and statistical thermodynamics.	6

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Organic Chemistry Special-II		
Course Code	26L6.5-CHE-304c		
Course Type	DEC-2		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand the role of Li, Mg, Zn, Cu, S, Si, and B reagents in organic synthesis- including their preparation, reactivity, mechanisms, and applications in bond- forming reactions. CLO 2: Master retrosynthetic analysis concepts: synthon identification, synthetic equivalents, functional group interconversion (FGI), and strategic disconnection approaches (C-X and C-C bonds). Explore selectivity principles (chemo-/regio-/stereo-selectivity) in reaction design. CLO 3: Apply advanced strategies like polarity reversal (umpolung), Wittig olefination, alkyne/nitro compound chemistry, and ring- forming reactions (3-6 membered rings) for target molecule synthesis. CLO 4: To develop the skill of protection/deprotection strategies (alcohols, amines, carbonyls, acids) in multistep organic synthesis, and multi-step disconnections using Diels-Alder reactions, 1,3-/1,5-difunctional systems, Michael additions, and Robinson annelation for complex molecule assembly.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Organometallic Reagents		15 CLO 1

	Principle, preparations, properties, and applications of the reagents of the following metals/non-metals in organic synthesis with mechanistic details: Li, Mg, Zn, Cu, S, Si and B.	
II	Disconnection Approach-I An introduction of synthons and synthetic equivalents, general principles of the disconnection approach, functional group interconversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, one group C-C disconnection, chemoselectivity, regioselectivity, regiospecificity, stereoselectivity, and stereospecificity.	15 CLO 2
III	Disconnection Approach-II Reversal of polarity, amine synthesis, use of Wittig reagents, use of acetylene and aliphatic nitro compounds in organic synthesis, synthesis of three-membered rings, photochemistry in organic synthesis-synthesis of four-membered rings, uses of ketenes in organic synthesis, synthesis of five and six-membered rings.	15 CLO 3
IV	Disconnection Approach-III Protective Groups: Introduction, principle of protection of alcoholic, amino, carbonyl, and carboxylic groups, Protection and deprotection of Alcohols: ethers, silyl ethers, acetals, esters, Carbonyl Groups: acetals/ketals, dithioacetals/dithioketals, Amino Groups: carbamates, amides, Carboxylic Groups: esters, silyl esters, amides. Two group C-C disconnections: Diels Alder reactions, 1,3-difunctionalized compounds and α,β -unsaturated carbonyl compounds, Control in carbonyl condensations, 1,5-difunctionalized compounds-Michael addition and Robinson Annelation.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Designing Organic Synthesis, S.Warren, Wiley.		
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.		
3. Advanced Organic Chemistry Reactions, Mechanisms and Structures, J. March, Wiley.		
4. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.		
5. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.		
6. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.		
7. Advanced Organic Chemistry and Reaction Mechanisms, Reinhard Bruckner, Academic Press.		
8. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	-	2	2	-	2	-	-
CLO ₂	3	3	1	3	-	3	2	-	2	-	-
CLO ₃	3	2	1	3	-	3	2	-	2	-	-
CLO ₄	3	3	1	3	-	3	2	-	2	-	1

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Organometallic reagents (Li, Mg, Zn, Cu, S, Si, B) and their applications in organic synthesis; Disconnection approach, retrosynthetic analysis, synthons and synthetic equivalents; Industrially relevant synthetic strategies and drug/intermediate synthesis	18
Skill Enhancement	Preparation and application of organometallic reagents; Functional group interconversions; Protection and deprotection strategies; Chemoselectivity, regioselectivity, stereoselectivity; Synthetic planning and reaction mechanism analysis	20
Communication Development	Scientific presentation of synthetic routes, interpretation of reaction mechanisms, discussion of research literature related to organic synthesis and modern synthetic methodologies	4
Indian Knowledge System	Traditional knowledge related to organic compounds, natural product synthesis, and utilization of indigenous chemical resources (linked with modern synthetic chemistry)	2
Environmental Awareness	Green synthetic approaches, atom economy, selective reactions, use of catalytic organometallic reagents, sustainable synthetic methodologies and photochemical reactions	6
Current Issues and Social Awareness	Role of synthetic chemistry in pharmaceuticals, agrochemicals, materials science and development of new therapeutic molecules	4
Women empowerment/ Gender issues	Contribution of women scientists in organic chemistry and pharmaceutical research; equal opportunities in chemical sciences	1
Public policies	Importance of chemical safety, regulatory aspects of pharmaceutical synthesis, responsible use of chemicals and laboratory practices	2
Any Other	Advanced synthetic strategies: Wittig reaction, Michael addition, Robinson annulation, Diels–Alder reactions, ketene chemistry, synthesis of cyclic compounds	3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Practical		
Name of the Course	Inorganic Chemistry Special Practical-I		
Course Code	26L6.5-CHE-305a		
Course Type	PC-7		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Perform spectrophotometric analyses and determine the λ_{max} of different substances using UV-Visible spectroscopy. Carry out potentiometric titrations and interpret titration curves for acid-base systems. CLO 2: Conduct conductometric titrations and validate physicochemical principles such as Ostwald's Dilution Law. CLO 3: Carry out separation of metal ions by Paper chromatography and calculating retention factors. CLO 4: Perform pH-metric titrations and apply modern instrumental techniques for quantitative chemical analysis.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	
Part B- Contents of the Course			
Instructions for Paper-Setter: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics	Contact Hours\ CLO Attempt	
I	Instrumentation: I Spectrophotometric Analysis To find out the λ_{max} of the different substances II Potentiometric Titrations i) Strong acid vs strong base ii) Strong acid vs weak base iii) Weak acid vs strong base Any other experiments related to this instrumentation	30 CLO1	

II	Conductometric Titrations: i) Strong acid vs strong base ii) Strong acid vs weak base iii) Weak acid vs strong base iv) Precipitation titrations v) To Validate the Ostwald's Dilution law Any other experiments related to this instrumentation	30 CLO2
III	Paper Chromatography: i) Ni (II) and Co (II) ii) Fe (II) and Al (II) iii) Fe (II), Al (II) and Cr (III) iv) Ni (II), Co (II), Mn (II) and Zn (II) Any other experiments related to this technique	30 CLO3
IV	pH metric Titrations: i) Strong acid vs strong base ii) Strong acid vs weak base iii) Weak acid vs strong base Any other experiments related to these titrations	30 CLO4
Total Contact Hours		120
Suggested Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
➤ Practical:	30	➤ Practical: 70
● Class Participation:	5	Lab record 10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce 20
● Mid-Term Exam:	15	Write-up and execution of the practical 40
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London. 2. Practical Chemistry, A.M. James and F.E. Prichard, Longman. 3. Modern Analytical Chemistry, David Harvey 4. Instrumental Methods of Analysis, Hobart H. Willard, Lynne L. Merritt Jr., John A. Dean, Frank A. Settle Jr. 5. Physical Chemistry (Conductance and Electrochemistry Chapters), P. W. Atkins and Julio de Paula 6. NPTEL: Analytical Chemistry – IIT lectures on spectroscopy, conductometry, potentiometry, and pH-metry. 7. SWAYAM – Online courses in Analytical and Physical Chemistry. 8. e-PG Pathshala (Chemistry) – UGC-supported learning modules on instrumental methods. 9. Virtual Labs (Chemical Sciences) – Simulations and virtual experiments for analytical		

techniques.

National Digital Library of India (NDLI) – E-books, lecture notes, and reference materials.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	1	2	3	-	1	-	-
CLO ₂	3	2	1	3	1	3	2	-	1	-	-
CLO ₃	3	2	1	3	1	3	3	-	1	-	-
CLO ₄	3	2	1	3	1	3	3	1	2	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Practical training in spectrophotometric, conductometric, potentiometric, and pH-metric analysis relevant to quality control, industrial laboratories, pharmaceuticals, and research organizations.	33
Skill Enhancement	Determination of λ_{max} , conductometric, potentiometric, and pH-metric titrations; operation and handling of analytical instruments; data analysis and interpretation.	60
Communication Development	Preparation of laboratory records, experimental reports, graphical data representation, and scientific presentation of analytical results.	6
Indian Knowledge System	Development of scientific measurement and analytical skills supporting advancements in chemical sciences and traditional knowledge validation.	3
Environmental Awareness	Applications in water quality monitoring, environmental sample analysis, pollution assessment, and chemical waste management.	8
Current Issues and Social Awareness	Use of instrumental techniques in healthcare, environmental monitoring, food safety, and industrial quality assurance.	5
Women empowerment/ Gender issues	Encourages equal participation and skill development in laboratory sciences, analytical chemistry, and STEM professions.	2
Public policies	No direct content	0
Any Other	Enhances precision, analytical thinking, problem-solving ability, laboratory competence, research aptitude, and professional ethics.	3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Practical		
Name of the Course	Physical Chemistry Special Practical-I		
Course Code	26L6.5-CHE-305b		
Course Type	PC-7		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Apply the technique of potentiometry for determining activity coefficients of different electrolytes, determining stability constants of the complexes and finding the solubility of sparingly soluble salts CLO 2: Perform thermochemical experiments to determine heats of neutralization and enthalpies of solution and interpret the energetic changes associated with chemical processes. CLO 3: Apply refractometric techniques to analyze binary liquid mixtures, determine percentage composition, and evaluate molar refraction of homologous alcohols, including the contribution of the $-\text{CH}_2$ group. CLO 4: Utilize dipolemetric methods to quantify molecular dipole moments and evaluate the influence of molecular geometry on polarity.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	
Part B- Contents of the Course			
Instructions for Paper-Setter: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics		Contact Hours\CLO Attempt
I	1. Potentiometry (i) Determination of first and second ionization constant of phosphoric acid. (ii) Study of silver-ammonia complex and determination of the stability constant. (iii) Determination of strength of ferrous ammonium sulphate using potassium dichromate or ceric sulphate and determination of redox potential. (iv) Determination of strength of HCl and CH_3COOH in a mixture using NaOH.		40 CLO 1

	(v) Titration of weak acid with strong base using quinhydrone and determination of dissociation constant of the acid. (vi) To determine the degree of hydrolysis of aniline hydrochloride. (vii) Titration of Potassium halides mixture (two/three) with AgNO ₃ potentiometrically.		
II	1. Thermochemistry (i) Determination of heat of neutralization (a) NaOH vs. HCl (b) NaOH vs. CH ₃ COOH (c) NaOH vs. oxalic acid. (ii) Determination of enthalpy of solution of various substances. (i) Determine the heat of hydration of anhydrous copper sulphate and sodium carbonate. (ii) Determine the heat of precipitation of barium sulphate.	30 CLO 2	
III	1. Refractometer (i) Determine the refractivity and molar refractivity of some organic liquids like methyl acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform. (ii) To determine the percentage composition of liquids in the given binary mixture. (iii) Study the variation of refractive index with concentration for KCl solution and thereafter determine the unknown concentration of given KCl solution. (iv) To determine the molar refraction of homologues methyl, ethyl and propyl alcohol. Show the constant contribution to the molar refraction of the -CH ₂ group.	30 CLO 3	
IV	Dipolemetry (i) To determine the dipole moment of various liquids. (ii) To determine the dielectric constant of various liquids. (iii) Determine magnetic moment of Mohr's salt. Note: Any experiment may be introduced/deleted in the practical class based on the availability / non-availability of the instruments / chemicals.	20 CLO 4	
Total Contact Hours		120	
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
➤ Practical	30	➤ Practical:	70
● Class Participation:	5	Lab record	10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce	20
● Mid-Term Exam:	15	Write-up and execution of the	40

		practical	
Part C-Learning Resources			
Recommended Books/e-resources/LMS:			
1. Practical Physical Chemistry, S.R. Palit and S.K. De, Science. 2. Senior Practical Physical Chemistry, B.D. Khosla, V.C. Garg and A. Gulati, S. Chand & Co. 3. Experimental Physical Chemistry, R.C. Das and B. Behera, McGraw Hill. 4. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman. 5. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman. 6. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj 7. A Comprehensive guide to physical chemistry experiments and viva questions, Neelam Seedhar, Notion Press.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	1	3	3	–	2	1	–
CLO ₂	3	2	1	3	1	3	2	–	2	1	–
CLO ₃	3	2	1	3	1	3	3	–	2	1	–
CLO ₄	3	2	1	3	1	3	3	–	2	1	–

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Practical training in potentiometry, thermochemistry, refractometry, and dipole moment measurements enhances employability in analytical laboratories, pharmaceuticals, chemical industries, quality control, environmental testing, and research organizations.	28
Skill Enhancement	Develops laboratory competency, instrumental handling, quantitative analysis, electrochemical measurements, thermodynamic calculations, and data interpretation skills.	36
Communication Development	Strengthens scientific report writing, laboratory record maintenance, result interpretation, data presentation, and technical communication skills.	12
Indian Knowledge System	Promotes scientific inquiry, experimental learning, logical reasoning, and evidence-based understanding of physicochemical principles.	6
Environmental Awareness	Applications in water quality analysis, chemical equilibrium studies, thermochemical processes, and environmentally responsible laboratory practices.	10
Current Issues and Social Awareness	Supports modern analytical techniques used in pharmaceuticals, industrial quality assurance, environmental monitoring, and chemical process optimization.	10
Women empowerment/ Gender issues	Encourages equal participation and skill development opportunities in laboratory-based scientific education, research, and professional careers.	3
Public policies	Provides scientific understanding relevant to industrial quality standards, laboratory safety regulations, environmental monitoring, and chemical analysis protocols.	5
Any Other	Scientific temper, critical thinking, precision in experimentation, research aptitude, teamwork, problem-solving ability, and lifelong learning.	10

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Practical		
Name of the Course	Organic Chemistry Special Practical-I		
Course Code	26L6.5-CHE-305c		
Course Type	PC-7		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Apply physical and chemical methods to separate the organic components of binary and ternary mixtures (liquid–liquid, liquid–solid, and solid–solid). CLO2: Characterize and identify the separated organic components through systematic chemical analysis and derivative preparation. CLO3: Interpret IR spectra to confirm the structure and identity of organic components present in binary and ternary mixtures. CLO4: Analyze NMR spectra and compile experimental observations, analytical results, and spectroscopic data into a comprehensive and well-organized laboratory record.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	
Part B- Contents of the Course			
Instructions for Paper- Setter: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics	Contact Hours\ CLO Attempt	
I	Qualitative Analysis: Separation of organic components of a binary or ternary (liquid-liquid, liquid-solid or solid-solid) organic mixture using physical and chemical methods.	30 CLO1	
II	Characterization of Organic Components separated from Binary/Ternary Mixtures by Chemical Analysis and Derivative Formation	30 CLO2	
III	Spectroscopic confirmation of the Organic Components of binary or ternary mixtures using IR tool (IR spectra will be provided).	30 CLO3	
IV	Spectroscopic confirmation of the Organic Components of binary or ternary mixtures using NMR tool (NMR spectra will be provided). Compile the results in the form of a lab record.	30 CLO4	
Total Contact Hours			120
Evaluation Methods			

Internal Assessment: 30		End Term Examination: 70	
➤ Practical	30	➤ Practical:	70
● Class Participation:	5	Lab record	10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce	20
● Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/e-resources/LMS: 1.Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (2023). Vogel's Textbook of Practical Organic Chemistry (6th ed.). Pearson. Harlow, England. 2.Mann, F. G., & Saunders, B. C. (2018). Practical Organic Chemistry (3rd ed.). Wiley. Hoboken, NJ. 3.Mohrig, J. R., Hammond, C. N., & Schatz, P. F. (2020). Modern Projects and Experiments in Organic Chemistry (2nd ed.). W.H. Freeman. New York, NY. 4.Doxsee, K. M., & Hutchison, J. E. (2021). Green Organic Chemistry: Strategies, Tools, and Laboratory Experiments (1st ed.). Cengage Learning. Boston, MA. 5.Leonard, J., Lygo, B., & Procter, G. (2019). Advanced Practical Organic Chemistry (3rd ed.). CRC Press. Boca Raton, FL. 6.Harwood, L. M., & Moody, C. J. (2020). Experimental Organic Chemistry (2nd ed.). Oxford University Press. Oxford, UK. 7.Lehman, J. W., & Morrill, T. B. (2021). Techniques in Organic Chemistry (4th ed.). Springer. Cham, Switzerland.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	1	–	3	–	2	2	–	1	–	–
CLO ₂	3	2	1	3	1	3	2	–	1	2	–
CLO ₃	3	3	3	3	1	3	3	–	2	2	1
CLO ₄	3	2	1	3	1	2	2	–	1	2	–

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/Entrepreneurship	Development of practical skills in organic mixture separation, purification techniques, identification of unknown organic compounds, chemical analysis, derivative preparation, and interpretation of analytical data useful for chemical industries and quality control laboratories.	25
Skill Enhancement	Hands-on training in qualitative organic analysis, physical and chemical separation methods, derivative formation, IR spectral interpretation, NMR spectral analysis, laboratory techniques, calculations, and preparation of scientific laboratory records.	40
Communication Development	Preparation of systematic laboratory records including experimental procedures, observations, results, calculations, and conclusions; scientific documentation and presentation of analytical findings.	15

Indian Knowledge System	Understanding the relevance of natural organic compounds, traditional sources of organic materials, and their identification and characterization through modern analytical techniques.	5
Environmental Awareness	Awareness regarding safe handling of organic solvents, chemical waste disposal, sustainable laboratory practices, and minimizing environmental impact during organic analysis experiments.	10
Current Issues and Social Awareness	Application of organic analysis and spectroscopy in areas such as pharmaceuticals, food analysis, environmental monitoring, and quality assessment of chemical products.	10
Women empowerment/ Gender issues	Promotion of equal participation, laboratory skill development, and professional opportunities for all students in chemical research and analytical fields.	3
Public policies	Understanding laboratory safety regulations, chemical handling guidelines, good laboratory practices (GLP), and compliance with scientific standards.	5
Any Other	Integration of analytical chemistry, spectroscopy, problem-solving ability, and research-oriented approaches for characterization of organic compounds.	7

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Practical		
Name of the Course	Inorganic Chemistry Special Practical-II		
Course Code	26L6.5-CHE-306a		
Course Type	PC-8		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Synthesize & characterize inorganic and coordination compounds mentioned in unit I using standard laboratory procedures. CLO2: Synthesize & characterize inorganic and coordination compounds mentioned in unit II using standard laboratory procedures. CLO3: Synthesize & characterize inorganic and coordination compounds mentioned in unit III using standard laboratory procedures. CLO4: Synthesize & characterize inorganic and coordination compounds mentioned in unit IV using standard laboratory procedures.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	
Part B- Contents of the Course			
Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics	Contact Hours\ CLO Attempt	
I	Preparation of given any others Inorganic Compound and their study by spectroscopic methods (IR, NMR, EPR etc.) i) Chloropentaamminecobalt (III) Chloride ii) Nitro/Nitritopentaamminecobalt (III) Chloride (Distinction between nitro and nitrito by IR) iii) Cis and trans $[\text{Co}(\text{en})_2\text{Cl}_2]$ iv) Tetraaminecarbonatocobalt (III) nitrate Any other related compounds preparation.	30 CLO1	
II	Preparation of given any others Inorganic Compound and their study by spectroscopic methods (IR, NMR, EPR etc.)	30 CLO2	

	i) Potassium trioxalatoferrate (III) trihydrate ii)Potassium trioxalatochromate (III) trihydrate iii)Cis - Potassium dioxalatodiaquachromate (III) iv)Trans - Potassium dioxalatodiaquachromate (III) Any other related compounds preparation.		
III	Preparation of given any others Inorganic Compound and their study by spectroscopic methods (IR, NMR, EPR etc.) i) Tris(acetylacetonato) manganese (III) ii) Tris(acetylacetonato)chromium(III) iii) Potassium Tris-Oxalato aluminate (III) iv) Sodium ferrioxalate Any other related compounds preparation.	30 CLO3	
IV	Preparation of given any others Inorganic Compound and their study by spectroscopic methods (IR, NMR, EPR etc.) i) Hexaaminenickel(II) chloride ii) Preparation of Ferrocene iii) Potash Alum iv) Chrome Alum Any other related compounds preparation.	30 CLO4	
Total Contact Hours		120	
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
➤ Practical	30	➤ Practical:	70
● Class Participation:	5	Lab record	10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce	20
● Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/e-resources/LMS:			
1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood. 2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London. 3. Inorganic Preparations: W. G. Palmer. 4. e-PG Pathshala (Chemistry) – UGC-supported learning modules on instrumental methods. 5. Virtual Labs (Chemical Sciences) – Simulations and virtual experiments for analytical techniques. 6. National Digital Library of India (NDLI) – E-books, lecture notes, and reference materials.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	2	2	2	-	1	1	-
CLO ₂	3	2	1	2	1	3	3	-	1	-	-
CLO ₃	3	2	1	2	1	3	2	-	1	-	-
CLO ₄	3	2	1	3	1	3	2	1	2	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Hands-on training in synthesis and characterization of coordination and organometallic compounds relevant to research laboratories, chemical industries, pharmaceuticals, and material science sectors.	30
Skill Enhancement	Preparation of inorganic compounds, purification techniques, and characterization using spectroscopic methods (IR, NMR, EPR); development of laboratory and analytical skills.	60
Communication Development	Preparation of laboratory reports, interpretation of spectral data, presentation of experimental findings, and scientific documentation.	6
Indian Knowledge System	Strengthens foundational chemical knowledge supporting advancements in materials, metallurgy, and chemical sciences.	3
Environmental Awareness	Safe handling of chemicals, waste management practices, and understanding the environmental impact of inorganic compounds and laboratory processes.	8
Current Issues and Social Awareness	Applications of coordination and organometallic compounds in catalysis, medicine, advanced materials, and sustainable technologies.	5
Women empowerment/ Gender issues	Promotes equal participation and skill development in laboratory research, chemical sciences, and STEM-related careers.	2
Public policies	Supports laboratory safety regulations, chemical handling protocols.	3
Any Other	Enhances experimental competence, analytical thinking, problem-solving ability, research aptitude, and professional ethics.	3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Practical		
Name of the Course	Physical Chemistry Special Practical-II		
Course Code	26L6.5-CHE-306b		
Course Type	PC-8		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Apply conductometric techniques to quantitatively analyze acid–base and precipitation titrations involving different electrolyte systems. CLO 2: Evaluate the concentration dependence of electrolyte conductance by determining equivalent conductance, and dissociation constants. CLO 3: Apply UV–Visible spectrophotometric techniques to verify the Lambert–Beer law and determine the concentration of absorbing species in solution. CLO 4: Analyze spectroscopic data to determine the composition of multicomponent mixtures and evaluate the dissociation constant of indicators using spectrophotometric methods.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	
Part B- Contents of the Course			
Instructions for paper: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics		Contact Hours\ CLO Attempt

I	1. Conductometry (i) Conductometric titration of: (a) Strong acid vs. strong base, (b) Strong acid vs. weak base, (c) Weak acid vs. strong base, (d) Weak acid vs. weak base (e) $\text{CH}_3\text{COOH} + \text{HCl}$ vs. NaOH , (f) CuSO_4 vs. NaOH . (iv) Determine solubility and solubility product of sparingly soluble salts like PbSO_4 , BaSO_4 . (v) Determination of the equivalent conductance of weak acid (benzoic/ acetic acid) at several concentrations and the dissociation constant of the acid.	30 CLO 1
II	1. Conductometry (i) Determination of the equivalent conductance of strong electrolytes such as HCl , KCl , KNO_3 and NaCl and the validity of Onsager equation. (ii) Study of degree of hydrolysis of aniline hydrochloride. (iii) Determine the critical micelle concentration (CMC) of surfactants by conductivity method. (iv) Study precipitation titration between KCl and AgNO_3 conductometrically. Determine the strength of given solution of AgNO_3	30 CLO 2
III	1. Colorimetry/Spectrophotometry (i) Verification of the Lambert-Beer's law using aqueous solutions of KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$ and CuSO_4 . (ii) Study of iron-iron and iron-salicylic acid complexes.	30 CLO 3
IV	1. Colorimetry/Spectrophotometry (i) Determination of the composition of Potassium dichromate and potassium permanganate mixture spectrophotometrically. (ii) Determine the dissociation constant of an indicator spectrophotometrically. Note: Any experiment may be introduced/deleted in the practical class based on the availability / non-availability of the instruments / chemicals.	30 CLO 4
Total Contact Hours		120
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70

➤ Practical	30	➤ Practical:	70
● Class Participation:	5	Lab record	10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce	20
● Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/e-resources/LMS: 1. Practical Physical Chemistry, S.R. Palit and S.K. De, Science. 2. Senior Practical Physical Chemistry, B.D. Khosla, V.C. Garg and A. Gulati, S. Chand & Co. 3. Experimental Physical Chemistry, R.C. Das and B. Behera, McGraw Hill. 4. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman. 5. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman. 6. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj 7. A Comprehensive guide to physical chemistry experiments and viva questions, Neelam Seedhar, Notion Press.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	1	3	3	—	2	1	—
CLO ₂	3	3	1	3	1	3	3	—	2	1	—
CLO ₃	3	2	1	3	1	3	3	—	2	1	—
CLO ₄	3	3	1	3	1	3	3	—	2	1	—

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Practical training in conductometry, colorimetry, and spectrophotometry equips students with analytical and instrumental skills required in chemical industries, pharmaceuticals, environmental laboratories, food testing, quality control, and research organizations.	28
Skill Enhancement	Develops proficiency in instrumental analysis, conductometric titrations, spectrophotometric measurements, data handling, quantitative analysis, and interpretation of physicochemical parameters.	36
Communication Development	Enhances laboratory report writing, scientific data presentation, result interpretation, record maintenance, and technical communication skills.	12
Indian Knowledge System	Promotes scientific inquiry, experimental learning, logical reasoning, and evidence-based problem-solving through laboratory investigations.	6
Environmental Awareness	Applications in water quality assessment, surfactant analysis, pollution monitoring, and chemical analysis relevant to environmental protection and sustainability.	10
Current Issues and Social Awareness	Supports modern analytical techniques used in healthcare, environmental monitoring, industrial quality assurance, and sustainable chemical processes.	10
Women empowerment/	Encourages equal participation and capacity building in scientific experimentation, research, and laboratory-based careers.	3

Gender issues		
Public policies	Provides scientific knowledge relevant to environmental regulations, laboratory safety standards, industrial quality control, and analytical testing protocols.	5
Any Other	Scientific temper, research aptitude, critical thinking, precision in experimentation, problem-solving ability, teamwork, and lifelong learning.	10

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Practical		
Name of the Course	Organic Chemistry Special Practical-II		
Course Code	26L6.5-CHE-306c		
Course Type	PC-8		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To understand the basics of quantitative analysis and application in analysis of the Amino group, hydroxyl group, acetoxy group, carbonyl group, unsaturation. CLO 2: To understand the basics of quantitative analysis and application in analysis of the reducing and non-reducing sugars. CLO 3: To understand the saponification value and iodine value of fats and oils, formalin and glycine. CLO 4: To determination of the molecular weight of acid by titration and by the silver salt method.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	
Part B- Contents of the Course			
Instructions for Paper- Setter: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics		Contact Hours\CLO Attempt
I	Quantitative estimation of the following: Amino group, hydroxyl group, acetoxy group, carbonyl group, unsaturation		30 CLO 1
II	Quantitative estimation of the following: reducing and non-reducing sugars.		30 CLO 2
III	Saponification value and iodine value of fats and oils, formalin and glycine		30 CLO 3
IV	Determination of the molecular weight of acid by titration and by the silver salt method.		30 CLO 4
Total Contact Hours			120
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
➤ Practical	30	➤ Practical:	70
● Class Participation:	5	Lab record	10

• Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce	20
• Mid-Term Exam:	15	Write-up and execution of the practical	40

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (2023). Vogel's textbook of practical organic chemistry (6th ed.). Pearson Education.
2. Mann, F. G., & Saunders, B. C. (2018). Practical organic chemistry (3rd ed.). Wiley.
3. Harris, D. C., & Lucy, C. A. (2020). Quantitative chemical analysis (10th ed.). W. H. Freeman.
4. Ahluwalia, V. K., & Dhingra, S. (2019). Advanced practical chemistry (2nd ed.). CRC Press.
5. Reaction Mechanisms in Organic Chemistry by S.M. Mukherjee and S.P. Singh, Lakshmi Publications.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	-	3	2	-	1	-	-
CLO ₂	3	2	1	3	-	3	2	1	1	-	-
CLO ₃	3	3	1	3	-	3	2	-	1	-	-
CLO ₄	3	2	1	3	-	3	2	1	1	-	-

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Analytical chemistry skills, quantitative estimation techniques, quality control methods, food/pharmaceutical analysis applications	28
Skill Enhancement	Volumetric analysis, functional group estimation, titration methods, determination of molecular weight, saponification and iodine value experiments, laboratory handling skills	44
Communication Development	Preparation of laboratory records, interpretation of analytical data, presentation of experimental results and scientific reporting	10
Indian Knowledge System	Traditional knowledge of oils, fats, natural products and their chemical analysis	10
Environmental Awareness	Analysis of fats/oils, sustainable laboratory practices, safe handling and disposal of chemical waste	07
Current Issues and Social Awareness	Application of analytical chemistry in food quality, health, pharmaceuticals and consumer safety	11
Women empowerment/ Gender issues	Equal participation in laboratory research, skill development and scientific activities	2
Public policies	Awareness about quality standards, regulations and analytical requirements in industries	3
Any Other	Research-oriented analytical approaches and advanced characterization techniques	05

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Inorganic Chemistry-III		
Course Code	26L6.5-CHE-401		
Course Type	CC-11		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To analyze the structure, bonding, and reactivity of transition metal complexes and apply the principles of organometallic cross-coupling reactions in synthesis. CLO 2: To evaluate the preparation, bonding, and chemical behavior of hydrides, noble gas compounds, and boron-containing compounds. CLO 3: To explain the synthesis, structure, properties, and technological applications of carbon- and silicon-based materials. CLO 4: To assess the structure, bonding, oxidation behavior, and reactivity of compounds of nitrogen, oxygen, and halogen group elements.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand. Coupling Reactions and Cross Coupling Reactions of Organometallic compounds: Stille coupling, Negishi coupling, Sonogashira coupling, Kumada coupling, Hiyama coupling.		15 CLO 1
II	Hydrogen, alkali and alkaline earth metals: Classification of hydrides - e-deficient, e-precise & e-rich hydrides, Application of crown ethers in extraction of alkali and alkaline earth metals.		15 CLO 2

	Noble gases: Isolation and properties. Preparation and structure of noble gas compounds Boron compounds: Preparation, structure, bonding, reactions and applications of boron halides, phosphine boranes, boron heterocycles, borazines.	
III	Compounds of carbon and silicon: Fullerenes and their compounds, Intercalation compounds of graphite, Synthesis, structure, properties, and applications of carbon nano-tubes, Carbides, fluorocarbons, silanes, silicon halides, silicates, aluminosilicates and silicones.	15 CLO 3
IV	Compounds of nitrogen group elements: Nitrogen activation. Oxidation states of nitrogen and their interconversion. Preparation, structure and bonding of Oxyacids of Phosphorous, Phosphazenes. Compounds of oxygen group elements: Metal selenides, tellurides, oxoacids of Sulphur, Structural features and reactivity of SN heterocycles Compounds of halogen group elements: Synthesis, properties, and applications of interhalogens, pseudohalogens, oxyacids of halogens.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. D.F.Shriver, P.W. Atkins and C.H. Langford, Inorganic Chemistry, Oxford Univ.Press,1998		
2. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry: Principle of StructureandReactivity, Pearson Education,2004.		
3. F.A. Carey, G. Wilkinson, C.A. Murillo and M. Bochman, Advanced Inorganic Chemistry, Wiley Interscience,2003.		
4. C.E. Housecroft and A.G. Sharpe, Inorganic Chemistry, Prientice Hall,2005.		
5. N.N Greenwood and A. Earnshaw, Chemistry of the Elements, Pergamon.		
6. W.W. Porterfiels, Inorganic Chemistry: A unified Approach, Elsevier		
7. A.G. Sharpe, Inorganic Chemistry, Pearson Education Ltd.		
8. G. L. Miessler and D.A Tarr, Inorganic Chemistry, Pearson Publications.		
9. G. Wulfsberg, Inorganic Chemistry, , University Science Books, Viva Book		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	-	3	1	-	1	-	-
CLO ₂	3	1	1	2	-	2	-	-	1	-	-
CLO ₃	3	1	1	2	-	2	1	2	1	-	-
CLO ₄	3	1	1	3	-	3	-	-	1	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours
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		Devoted
Employability/ Entrepreneurship	Transition metal nitrosyl, dinitrogen and dioxygen complexes; organometallic cross-coupling reactions (Stille, Negishi, Sonogashira, Kumada and Hiyama); crown ethers; boron compounds; carbon nanomaterials (fullerenes, carbon nanotubes); silicones and advanced inorganic materials with industrial, pharmaceutical and catalytic applications.	18
Skill Enhancement	Understanding synthesis, structure, bonding and reactivity of coordination compounds; application of electron counting and bonding concepts; interpretation of reaction mechanisms in cross-coupling reactions; analysis of nanomaterials and main-group compounds; problem-solving involving inorganic reaction pathways and structure–property relationships.	22
Communication Development	Interpretation and presentation of structural, bonding and reaction mechanisms of inorganic and organometallic compounds through assignments, seminars and scientific discussions.	5
Indian Knowledge System	Historical development of main-group chemistry and chemical sciences in India.	2
Environmental Awareness	Sustainable organometallic catalysis; environmentally benign cross-coupling reactions; applications of boron compounds, carbon nanomaterials and silicon-based materials in pollution control, renewable energy and environmental protection.	5
Current Issues and Social Awareness	Emerging applications of nanomaterials, organometallic catalysis, boron chemistry, phosphorus compounds, carbon nanotubes and advanced inorganic materials in energy, healthcare, electronics and sustainable technologies.	4
Women empowerment/ Gender issues	No direct content	0
Public policies	Chemical safety in handling reactive organometallic compounds and nanomaterials; environmental regulations governing hazardous inorganic chemicals; laboratory safety and responsible use of advanced materials.	4
Any Other	Transition metal nitrosyl, dinitrogen and dioxygen complexes; organometallic cross-coupling reactions (Stille, Negishi, Sonogashira, Kumada and Hiyama); crown ethers; boron compounds; carbon nanomaterials (fullerenes, carbon nanotubes); silicones and advanced inorganic materials with industrial, pharmaceutical and catalytic applications.	18

Session: 2025-26			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Organic Chemistry-III		
Course Code	26L6.5-CHE-402		
Course Type	CC-12		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To understand the role of Molecular Orbitals in analysing Pericyclic Reactions. CLO 2: To interpret the stereochemical course of a Pericyclic Reaction and identify the product. To understand the concepts of aromaticity, non-aromaticity, anti-aromaticity, homoaromaticity, and pseudo-aromaticity, aromaticity in charged rings, and the application of ¹H-NMR in determining the aromatic character of annulenes. CLO 3: To understand the mechanism and synthetic applications of the above listed name reactions CLO 4: To explore transition-metal reagents in organic synthesis, focusing on: Principles, Preparations, Mechanistic details in organic synthesis		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt

I	Pericyclic Reactions Molecular orbital symmetry, frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system classification of pericyclic reactions. Woodward-Hoffmann correlation diagram. FMO & PMO approach, Electrocyclic reaction - conrotatory and disrotatory motions. 4n, 4n+2, allyl systems, Ring opening of cyclopropyl halides and tosylates, cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheletropic reactions.	15/ CLO 1
II	Pericyclic Reactions Sigmatropic Rearrangements-suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, [3,3] and [5,5] sigmatropic rearrangements, Sommelet-Hauser, Claisen and Cope rearrangements. Introduction to ene reactions. Simple problems on Pericyclic reactions. Aromaticity Concept of aromaticity, non-aromaticity, anti-aromaticity, homoaromaticity, and pseudo-aromaticity. Aromaticity in charged rings and application of ¹ H-NMR in determining the aromatic character of annulenes.	15 CLO 2
III	Name Reactions in Organic Chemistry Mechanism and synthetic applications of Arndt-Eistert synthesis, Beckmann, Hofmann, Curtius, Lossen, Schmidt, Favorskii, Neber, Fritsch-Butenberg-Wiechell, Baeyer-Villiger, Benzil benzilic acid rearrangements, Darzens synthesis, Stork enamine reaction, Shapiro reaction, Sharpless asymmetric epoxidation reactions.	15 CLO 3
IV	Transition Metals in Organic Synthesis Preparations and applications of the reagents of the following metals in organic synthesis with mechanistic details: Pd, Ni, Fe, Co, Cr and Ti compounds.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test, etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.		
2. Pericyclic Reactions, S.M. Mukherji Macmilan India.		
3. The Conservation of Orbital Symmetry, R.B. Woodward and R. Hoffmann" Verlag Chemie Academic Press.		
4. Problem Solving approach to Orbital Symmetry, R.E. Lehr and A.P. Merchand.		
5. Organic Reactions and Orbital Symmetry, T.L. Gilchrist and R.C. Storr, Cambridge University Press, Cambridge, 2 nd Edn. 1979.		
6. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.		
7. Modern Synthetic Reactions, H.O. House, W. A. Benzamin.		
8. Advanced Organic Chemistry Reactions, Mechanisms and Structures, J. March, Wiley.		
9. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	-	2	-	2	-	-	2	-	-
CLO ₂	3	2	1	3	-	2	-	-	2	-	-
CLO ₃	3	2	1	3	-	2	1	-	2	-	-
CLO ₄	3	3	1	3	-	3	2	-	2	-	1

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Application of pericyclic reactions in organic synthesis, name reactions (Beckmann, Baeyer–Villiger, Claisen, Cope, Sharpless epoxidation), transition metal catalyzed organic transformations and industrial synthetic approaches	18
Skill Enhancement	Mechanistic understanding, FMO & PMO approaches, Woodward–Hoffmann rules, reaction prediction, problem solving in pericyclic reactions, synthetic planning using organic reagents and catalysts	20
Communication Development	Presentation and discussion of reaction mechanisms, interpretation of literature-based synthetic strategies, scientific writing related to organic transformations	4
Indian Knowledge System	Awareness of traditional organic compounds, natural product-based synthetic approaches and relevance of indigenous chemical knowledge in modern chemistry	2
Environmental Awareness	Green synthetic approaches using transition metal catalysts, atom-efficient rearrangements, catalytic transformations and sustainable organic synthesis	6
Current Issues and Social Awareness	Role of advanced organic synthesis in pharmaceuticals, agrochemicals and development of biologically active molecules	4
Women empowerment/ Gender issues	Contributions of women scientists in organic chemistry and chemical research	1
Public policies	Regulatory aspects, safe handling of chemicals, sustainable chemical practices and guidelines related to chemical industries	2
Any Other	Research-oriented understanding of modern synthetic methodologies, transition metal chemistry, computational approaches (FMO/PMO) and drug discovery applications	3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Inorganic Chemistry Special-III		
Course Code	26L6.5-CHE-403a		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To know about the concept of electroanalytical techniques and their applications CLO 2: To know about the atomic absorption spectroscopy and flame photometry CLO 3: To learn about the spectrophotometric techniques and about of ESR spectroscopy CLO 4: To learn about the concept and applications of NMR spectroscopy and about Nephelometry and Turbidimetric techniques		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Electro analytical methods of Analysis Current-voltage relationship during an electrolysis, decomposition potential, constant current electrolysis, constant cathode potential electrolysis, apparatus, electrodes, mercury cathode, physical properties of deposition, chemical factors of importance in electrodeposition. Applications of electrogravimetry. Coulometric analysis Coulometric methods of constant electrode potential and coulometric titrations. Apparatus and applications. Amperometric titrations Basic principle, types of curves with special reference to use of indicator and compensation reaction curve. Fundamental concept of Cyclic voltammetry		15 CLO 1

II	Flame photometry Theory of flame photometry, flame temperature, Emission Flame	15 CLO 2
	photometry - intensity of spectral lines, selection of optimum working conditions, application of flame photometry in trace metal analysis. Atomic Absorption Spectroscopy General principles, resonance line, its natural width, Doppler effect, broadening due to pressure, Hollow cathode lamp. Application to alkali and alkaline earth metals.	
III	Spectrophotometry and Colorimetry Fundamental concepts, instrumentation for absorption measurements, interferences, application of absorption spectroscopy and Colorimetry to analysis of inorganic substance. Electron Spin Resonance Spectroscopy Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensor, application to transition metal complexes (having one unpaired electron) and inorganic free radicals such as PH_4^- , F_2^- and $[\text{BH}_3]^-$. Double resonance in EPR.	15 CLO 3
IV	Nephelometry and Turbidimetry Theory - light scattering, choice and comparison between nephelometry and turbidimetry, factors affecting measurement, instrumentation, applications Nuclear magnetic Resonance Basic Principle of NMR, Nuclear relaxation, Factors affecting nuclear relaxation, effect of chemical exchange on spectrum and evaluation of reaction rate of fast reactions, Double resonance, Lanthanide shift reagents, an overview of NMR of other nuclides with emphasis on ^{31}P , ^{19}F , ^{195}Pt and ^{119}Sn NMR. Application in inorganic chemistry	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.		
2. Instrumental methods of Analysis; L.L. Merritt, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.		
3. Physical methods in Chemistry; R.S. Drago; Saunders.		
4. Introduction to Magnetic Resonance; McLachlan and Carrington; Chapman and Hall.		
5. NMR, NQR, EPR and MB Spectroscopy in inorganic Chemistry, R.V. Parish, Ellis Horwood.		
6. Instrumental Methods of Chemical Analysis, G. R. Chatwal and S. K. Anand, Himalaya Publishing House, Mumbai.		
7. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt Jr., J. A. Dean and F. A. Settle Jr., CBS Publishers & Distributors, New Delhi.		
8. Vogel's Qualitative Inorganic Analysis, G. Svehla, Orient Longman, New Delhi		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
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CLO ₁	3	2	-	2	-	3	3	-	1	-	-
CLO ₂	3	2	-	2	-	3	3	-	1	-	-
CLO ₃	3	2	-	2	-	3	3	-	1	-	-
CLO ₄	3	2	-	2	-	3	3	-	1	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Electroanalytical methods, flame photometry, atomic absorption spectroscopy (AAS), UV-Visible spectrophotometry, colorimetry, ESR, NMR, nephelometry and turbidimetry with applications in chemical, pharmaceutical, environmental, forensic and quality control laboratories.	18
Skill Enhancement	Electrogravimetry, coulometry, amperometric titrations, cyclic voltammetry, operation and interpretation of flame photometer, AAS, spectrophotometer, ESR and NMR instruments; quantitative analysis, spectral interpretation and analytical data evaluation.	24
Communication Development	Interpretation and presentation of analytical data, preparation of laboratory reports, spectral analysis, scientific writing, seminars and technical presentations on instrumental techniques.	4
Indian Knowledge System	Contributions of Indian scientists to analytical chemistry and spectroscopy; traditional methods of chemical analysis and their evolution into modern instrumental techniques.	2
Environmental Awareness	Application of electroanalytical and spectroscopic techniques in environmental monitoring, water and soil analysis, trace metal detection, pollution assessment and sustainable analytical practices.	5
Current Issues and Social Awareness	Modern applications of instrumental analysis in healthcare, food safety, environmental protection, nanotechnology, materials science and industrial quality assurance.	4
Women empowerment/ Gender issues	Contributions of women scientists in analytical chemistry, spectroscopy and instrumental analysis, promoting inclusivity and gender equity in scientific research.	2
Public policies	calibration standards, quality assurance (QA/QC) and environmental regulations governing analytical laboratories.	1
Any Other	Electroanalytical methods, flame photometry, atomic absorption spectroscopy (AAS), UV-Visible spectrophotometry, colorimetry, ESR, NMR, nephelometry and turbidimetry with applications in chemical, pharmaceutical, environmental, forensic and quality control laboratories.	18

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Physical Chemistry Special-III		
Course Code	26L6.5-CHE-403b		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Evaluate polymer molecular characteristics through sedimentation, light scattering, and chromatographic methods for accurate molecular weight determination. CLO 2: Investigate the kinetics of solution-phase reactions, including salt effects and catalytic mechanisms, and evaluate enzyme–substrate interactions using kinetic models. CLO 3: Interpret the behavior of electronically excited states through Jablonski diagrams and evaluate radiative and non-radiative processes in photochemical systems. CLO 4: Apply crystallographic principles to determine lattice parameters and crystal structures and explain the electronic behavior of solids based on band theory.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Determination of Molecular Weight of Polymers Molecular weight determination of polymers. Sedimentation or ultracentrifugation: Sedimentation velocity method, sedimentation equilibrium method. Light scattering: Debye and Zimm plot methods, comparison of Zimm and Debye methods, Determination of molecular weight by Gel Permeation Chromatography.		15 CLO 1

II	Chemical Dynamics Kinetics of reaction in solution, Debye Smoluchowski reaction, influence of pressure, ionic strength, solvent on reaction rates, salt effect, kinetics of catalytic reactions: acid base catalysis, enzyme catalysis, Michaelis-Menton treatment, evaluation of Michaelis's constant for enzyme- substrate binding by Line weaver - Burk plot).	15 CLO 2
III	Photochemistry: Laws of photochemistry: (Grothus-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law), quantum yield, quantum efficiency, singlet and triplet state, Jablonski diagram, photophysical processes: (radiative and non radiative) fluorescence, phosphorescence and chemiluminescence, Kinetics of photophysical processes, relaxation time, Kinetics of quenching: Stern Volmer equation.	15 CLO 3
IV	Solid-state Chemistry: Introduction: unit cell its classifications, lattice planes, Weiss indices, miller indices, d spacing formulae, interfacial angle, some ionic solid structures:- rock salt, zinc blende or sphalerite, fluorite, antiferite, wurtzite, cesium chloride, rutile structure, perovskite, carbide(CaC ₂). Electronic structure of solids– Band theory, Superconductivity, Theory of insulators, semiconductors, and metals.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. Principles of Polymer Chemistry, P.J. Flory, Cornell University Press. 2. Solid State Chemistry and its Applications by A.R. West, Wiley, 1989, 2nd edition, Singapore. 3. Principles of the Solid State by H.V. Keer, Wiley Eastern. Limited, 1993, New Delhi. 4. Fundamentals of Photochemistry by K. K. Rohatagi-Mukherjee. 5. Principles of Photochemistry by J.A. Baltrop& J.D. Coyle 6. Physical Chemistry, G.W. Castellan, Narosa. 7. Physical Chemistry by Levine Ira N., Tata McGraw Hill 8. Physical Chemistry by Atkins P.W and Paula J. De, W.H. Freeman 9. Crystallography made crystal clear: A guide for users of macromolecular models, Rhodes G., Elsevier, 2006. 10. M.P. Stevens, Polymer Chemistry: An Introduction (2nd Edition) Oxford University Press 91990). 11. F.W. Billmeyer, Jr., Textbook of Polymer Science (3rd Edition) Wiley-Inter Science (1984) paperback. 12. A. Ravve, Principles of Polymer Chemistry .		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	–	3	3	–	2	–	–
CLO ₂	3	3	1	3	–	3	2	1	2	–	–
CLO ₃	3	2	1	2	–	2	2	–	2	–	–
CLO ₄	3	3	1	3	–	3	3	1	2	–	–

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Advanced knowledge of polymer characterization, chemical dynamics, photochemistry, and solid-state chemistry prepares students for careers in polymer industries, pharmaceuticals, materials science, semiconductor technology, energy sectors, and research organizations.	14
Skill Enhancement	Develops analytical, computational, instrumental, and problem-solving skills through molecular weight determination, reaction kinetics, photochemical processes, and crystal structure analysis.	18
Communication Development	Graphical analysis (Debye, Zimm, Lineweaver–Burk, Stern–Volmer), scientific reporting and data interpretation.	6
Indian Knowledge System	Promotes scientific inquiry, logical reasoning, innovation, and understanding of fundamental principles that support advancements in modern science and technology.	3
Environmental Awareness	Applications of photochemistry in solar energy conversion, polymer science in sustainable materials, and solid-state chemistry in energy-efficient technologies and environmental remediation.	6
Current Issues and Social Awareness	Relevance to renewable energy, advanced materials, nanotechnology, semiconductor devices, sustainable polymers, catalysis, and modern healthcare technologies.	5
Women empowerment/ Gender issues	Encourages equal participation and opportunities in scientific education, research, innovation, and technology-driven careers.	1
Public policies	Supports scientific understanding relevant to energy policies, sustainable material development, environmental protection, technology innovation, and industrial quality standards.	2
Any Other	Research aptitude, scientific temper, critical thinking, innovation, computational proficiency, interdisciplinary learning, and lifelong learning.	5

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Organic Chemistry Special-III		
Course Code	26L6.5-CHE-403c		
Course Type	DEC-3		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Analyze terpenoid structure determination (general methods), synthesis (listed compounds). CLO 2: Study cholesterol: nomenclature, structural analysis, synthesis routes, stereochemistry; conversion into testosterone, progesterone, and cholic acids; Johnson's hydrochrysen approach for androsterone synthesis. CLO 3: Explore alkaloids: physiological roles, classification by nitrogen ring systems, isolation techniques, structural analysis methods; and detailed study of listed alkaloids (structure, and synthesis). CLO 4: To know nomenclature and general methods of structure determinations, isolation and synthesis of Cyanin, Quercetin, and Chrysin		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Terpenoids: Introduction, classification, essential oils, methods for extraction of essential oils, Isoprene and special isoprene rule. General aspects of structure determination of terpenoids. Synthesis of Geraniol, α-terpineol, α-pinene, camphor, farnesol and squalene.		15 CLO 1

II	Steroids: Introduction, nomenclature of steroids. Structure elucidation of cholesterol, synthesis (Woodward) and stereochemistry of cholesterol. Biological functions of cholesterol. Methods for the following conversions. (i) Cholesterol → Testosterone (ii) Cholesterol → Progesterone (iii) Cholesterol → 5- α and 5- β -cholic acids. Johnson's hydrochrysene approach for androsterone synthesis	15 CLO 2
III	Alkaloids Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, and synthesis, of the following: Ephedrine, Quinine and Reserpine.	15 CLO 3
IV	Natural Pigments: Occurrence nomenclature and general methods of structure determinations; Synthesis of Cyanin, Quercetin, myrcetin, hirsutidin and Chrysin.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test, etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Organic Chemistry, Vol. 2, I.L. Finar, ELBS.		
2. Natural Products: Chemistry and Biology Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.		
3. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.		
4. Biochemistry, A.L. Lehninger.		
5. Outlines of Biochemistry, Cohn & Stumpf.		
6. Enzymes, Biochemistry, Biotechnology, Clinical Chemistry, T. Palmer and P.L. Bonner		
7. Lehninger Principles of Biochemistry, D.L. Nelson, M.M. Cox		
8. Chemistry of alkaloids by Pelletier, S. W. Publisher: Van Nostrand Reinhold Inc.,U.S. (17 September 1970).		
9. Medicinal natural products: A biosynthetic approach. by Dewick, P. M. Publisher Wiley.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	-	3	1	-	2	-	-
CLO ₂	3	2	1	2	-	3	1	-	2	-	-
CLO ₃	3	3	1	2	-	3	2	-	2	-	-
CLO ₄	3	2	1	2	-	3	1	-	2	-	-

Content Mapping with NEP thrust areas

Field	Content/s	Hours devoted
Employability/ Entrepreneurship	Extraction of essential oils and their industrial applications; synthesis of terpenoids (Geraniol, α -terpineol, α -pinene, camphor, farnesol, squalene); pharmaceutical importance of steroids, alkaloids and natural pigments in drug, fragrance, cosmetic and nutraceutical industries.	20

Skill Enhancement	Isolation and extraction techniques for essential oils and alkaloids; structure elucidation of terpenoids, steroids, alkaloids and natural pigments; synthetic methodologies of natural products; conversion of cholesterol into biologically important steroids.	22
Communication Development	Scientific terminology, nomenclature, stereochemistry, structure determination, reaction mechanisms, interpretation of biosynthetic pathways, presentation and discussion of natural product chemistry.	4
Indian Knowledge System	Essential oils, medicinal plants, alkaloids and natural pigments used in Ayurveda, traditional medicine, herbal formulations and indigenous knowledge systems.	4
Environmental Awareness	Sustainable extraction of essential oils from plants, utilization of renewable natural resources, eco-friendly use of plant-derived pigments and bioactive natural products.	3
Current Issues and Social Awareness	Importance of natural products in healthcare, antimicrobial and therapeutic agents, steroid hormones in medicine, natural pigments as safer alternatives to synthetic dyes.	3
Women empowerment/ Gender issues	Steroid hormones (testosterone and progesterone), their biological functions, reproductive health, and applications in women's healthcare.	2
Public policies	Conservation of medicinal and aromatic plants, quality control of herbal products, pharmaceutical regulations for natural product-based drugs and nutraceuticals.	1
Any Other	Research trends in natural products, phytochemistry, drug discovery, medicinal chemistry and interdisciplinary applications of terpenoids, steroids, alkaloids and pigments.	1

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Inorganic Chemistry Special-IV		
Course Code	26L6.5-CHE-404a		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To evaluate nuclear models and radiochemical techniques for understanding nuclear structure and analytical applications. CLO 2: To analyze intermolecular interactions and molecular recognition processes involved in supramolecular assemblies. CLO 3: To assess the structure, synthesis, and applications of supramolecular host systems and their catalytic functions. CLO 4: To apply separation and purification techniques based on chromatography, ion exchange, and solvent extraction principles for chemical analysis.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Nuclear Models & Methods Liquid drop model, Shell model, Fermi gas model, collective model, optical model, concept of spin, parity electric and magnetic moments. Activation Analysis – Neutron Activation Analysis (NAA) NAA - Principle, Application and Limitation, Isotope Dilution Analysis (IDA) - Principle, Application and Limitation, Radiometric titrations. Uses of nuclear radiations.		15 CLO 1

II	Supramolecular chemistry-I Introduction of Supramolecular chemistry, Nature of binding interactions in Supramolecular structures: ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-p, anion-p, p-p, and van der Waals interaction. Molecular and chiral recognition- Self-Organization, Self-Assembly and Preorganization, lock and key analogy, Covalent self-assembly based on preorganization - inclusion complexes, host-guest chemistry, Utilisation of H-bonds to create Supramolecular structures, Use of H-bonds in crystal engineering and molecular recognition, Chelate and macrocyclic effects.	15 CLO 2
III	Supramolecular chemistry-II Binding of cationic, anionic, ion pair and neutral guest molecules. Synthesis and structure of crown ethers, coronads, cryptands, spherands, calixarenes, cyclodextrins, cyclophanes, cryptophanes, carcerands, hemicarcerands, metallomacrocycles, catenanes, rotaxanes and helicates Industrial Applications of Supramolecular Systems and Supramolecular catalysis.	15 CLO 3
IV	Chromatography General principles, types of chromatography, absorption chromatography, partition chromatography, vapour phase chromatography, paper and thin layer chromatography, retardation factor, retention volume, mechanism and efficiency of separations. Ion-Exchange General principles, ion exchangers-natural and synthetic, ion-exchange capacity, purification of water and other applications. Solvent Extraction General Principles, extraction coefficients, Batch, continuous, and counter current extractions, applications.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination: 70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Supramolecular Chemistry, J.M. Lehn, VCH.		
2. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.		
3. Perspectives in Supramolecular Chemistry, Vol. 2: Crystal Engineering and Molecular Recognition, G. R. Desiraju, Wiley: Chichester (199		
4. Supramolecular Chemistry: A Concise Introduction, J. L. Atwood and J.W. Steed, John Wiley & Sons (2000).		
5. Supramolecular Chemistry, F. Vogtle, John Wiley, (1991).		
6. Crystal Engineering. The Design of Organic Solids, G.R. Desiraju, Elsevier, (1989) Introduction to Supramolecular Chemistry, Helena Dodzuick, Springer, (2002)		
7. H. J. Arnika, Essentials of Nuclear Chemistry (1982).		
8. B. C. Harvey, Introduction to Nuclear Chemistry Prentice-Hall (1969).		
9. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.		
10. Dynamics of Chromatography Part I.; J.C. Gidding; Dekker, New York.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	-	2	-	3	2	1	1	-	-
CLO ₂	3	2	-	2	-	3	1	-	1	-	-
CLO ₃	3	2	-	3	-	3	1	1	1	-	-
CLO ₄	3	2	-	3	-	3	3	-	1	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Nuclear analytical methods (NAA, IDA, radiometric titrations); supramolecular systems and host–guest chemistry; industrial applications of supramolecular catalysis; chromatographic, ion-exchange and solvent extraction techniques used in pharmaceutical, chemical, environmental and research laboratories.	24
Skill Enhancement	Application of nuclear models; interpretation of nuclear analytical techniques; molecular recognition and self-assembly; synthesis and applications of crown ethers, cryptands, calixarenes and cyclodextrins; chromatographic separations, ion-exchange processes and solvent extraction methods for qualitative and quantitative analysis.	26
Communication Development	Interpretation and presentation of nuclear, supramolecular and chromatographic data through laboratory reports, assignments, seminars and scientific discussions.	4
Indian Knowledge System	Contributions of Indian scientists to nuclear chemistry, supramolecular chemistry and separation science; traditional purification and separation practices with relevance to modern chemistry.	1
Environmental Awareness	Safe handling and applications of radioisotopes; ion-exchange techniques for water purification; solvent extraction for environmental remediation; green supramolecular systems and sustainable separation technologies.	2
Current Issues and Social Awareness	No direct content	0
Women empowerment/ Gender issues	Contributions of women scientists in nuclear chemistry, supramolecular chemistry, analytical chemistry and separation science, encouraging gender equity in scientific research and innovation.	1
Public policies	Radiation safety regulations; handling and disposal of radioactive materials; Good Laboratory Practices (GLP); environmental regulations related to chromatographic solvents and hazardous chemicals; laboratory safety standards.	1
Any Other	Nuclear analytical methods (NAA, IDA, radiometric titrations); supramolecular systems and host–guest chemistry; industrial applications of supramolecular catalysis; chromatographic, ion-exchange and solvent extraction techniques used in pharmaceutical, chemical, environmental and research laboratories.	18

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Physical Chemistry Special-IV		
Course Code	26L6.5-CHE-404b		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Apply angular momentum operator formalism to analyze quantum systems by evaluating commutation relations, ladder operator operations, and eigenvalue–eigenfunction properties of orbital angular momentum. CLO 2: Apply first- and second-order perturbation theory and variational approaches to estimate the energy states of helium and other many-electron systems. CLO 3: Analyze chemical bonding in simple molecular systems using Valence Bond and Molecular Orbital theories, and evaluate the role of resonance, symmetry, and molecular orbitals in determining the stability of H_2 and H_2^+. CLO 4: Construct and solve Hückel secular determinant equations for conjugated systems and interpret the resulting molecular orbital diagrams and electronic properties.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt

I	Quantum Mechanics Angular momentum and expressions for angular momentum operators in Cartesian coordinates, commutation relation between orbital angular momentum operators $\hat{L}^2$, $\hat{L}_x$, $\hat{L}_y$, $\hat{L}_z$ commutation relation between components of total orbital angular momentum, Ladder operators for angular momentum, commutator of L^2 , $\hat{L}_+$, $\hat{L}_-$, application of $\hat{L}_+$ and $\hat{L}_-$ to an eigen function/eigen value of $\hat{L}_z$.	15 CLO 1
II	Variation Method Quantum mechanical treatment of Helium atom and the failure of rigorous quantum mechanical method, need of approximate methods, Approximate Methods: The variation theorem, Linear variation Principle, perturbation theory (first order, second order and non-degenerate), applications of variation method and perturbation theory to the Helium atom.	15 CLO 2
III	Methods to evaluate energy of Hydrogen system: Valance bond method, valance bond method to hydrogen molecule, hydrogen molecule ion (their symmetric and anti-symmetric solution without actual valuation of various integrals, energy of molecular hydrogen system, Concept of resonance and its role in the stability of hydrogen molecule ion, Molecular orbital methods.	15 CLO 3
IV	Molecular Orbital Theory: Huckel molecular orbital (HMO) theory of linear and cyclic conjugated systems, Applications of HMO theory (i) Set up and solve Huckel determinant equation (ii) Calculate resonance energy (iii) Wave functions for molecular orbitals (iv) Molecular diagrams of (a) Ethylene molecule (b) Butadiene (c) Cyclobutadiene (d) Allyl system(Allyl radical and related ions) (e) Cyclopropenyl system (cyclopropenyl radical and the related ions), (f) Benzene ring, Calculation of properties- Delocalization energy, electron density, bond order.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. Physical Chemistry, G.W. Castellan, Narosa 2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill. 3. Quantum Chemistry, I.M. Levine, Prentice Hall. 4. Quantum Chemistry, B. K. Sen, Kalyani Publishers 5. Quantum Chemistry, R. Prasad, New Age International. 6. Quantum Chemistry & Spectroscopy – Thomas Engel 7. Quantum Chemistry MC. Quarrie D.A. Viva 8. Physical Chemistry A molecular approach Univ. Science (2001) 9. The Chemical Bond: Fundamental Aspects of Chemical Bonding, Eds. Gernot Frenking, Sason Shaik; Wiley-VCH, 2014		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	–	3	2	–	2	–	–

CLO ₂	3	3	1	3	–	3	2	–	2	–	–
CLO ₃	3	3	1	3	–	3	2	–	2	–	–
CLO ₄	3	3	1	3	–	3	2	1	2	–	–

Content Mapping with NEP thrust areas

Field	Content/s	Hours devoted
Employability/ Entrepreneurship	Quantum mechanics, perturbation and variation methods, molecular orbital theory, Hückel MO calculations, computational chemistry concepts used in research, pharmaceuticals and materials science.	20
Skill Enhancement	Mathematical treatment of angular momentum, commutation relations, ladder operators, perturbation calculations, Hückel determinant, resonance energy, bond order and electron density calculations.	24
Communication Development	Interpretation of wave functions, molecular orbital diagrams, presentation of quantum mechanical concepts, numerical problem solving and scientific discussion.	4
Indian Knowledge System	No direct content related to Indian Knowledge Systems.	0
Environmental Awareness	Application of molecular orbital theory in understanding environmentally important molecules and development of sustainable materials (indirect).	3
Current Issues and Social Awareness	Quantum chemistry applications in nanotechnology, computational chemistry, spectroscopy, molecular modelling and modern scientific research.	4
Women empowerment/ Gender issues	No direct content.	0
Public policies	No direct content.	0
Any Other	Advanced theoretical foundation for higher education, research methodology, computational chemistry, molecular modelling and preparation for competitive examinations (NET/GATE/Ph.D.).	5

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Organic Chemistry Special-IV		
Course Code	26L6.5-CHE-404c		
Course Type	DEC-4		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To understand the basic concept of drug design CLO2: To understand the basic concept of development using the examples of penicillin and its modifications. CLO 3: To understand the synthesis, general mode of action, and medicinal uses of listed classes of drugs. CLO 4: To analyze the structures, reactivity, and applications of enolates and other carbanions in organic synthesis.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Drug Design Classification and discovery of new drugs, history and development of chemotherapeutic agents, therapeutic index, LD50 and ED50, naming of (new) drugs. Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control. Membrane bound enzymes-activation/deactivation. Chemical basis of messenger induced change of shape by the receptor. Design of agonists, antagonists and partial agonists.		15 CLO 1
II	Drug development Screening of natural products, isolation and purification, structure determination, SAR (structure-activity relationships) with reference to penicillins, synthetic analogues, isosteres and bioisosteres, concept of lead compounds (problems with penicillin G and solving the problems leading to		15 CLO 2

	the development of penicillin V, oxacillin, cloxacillin, ampicillin, amoxicillin, carbenicillin and carfecillin. Brief overview of pharmacokinetics and pharmacodynamics, concept of prodrug (sultampicillin) and synergism (β -lactamase inhibitors with pencillins).	
III	Synthetic Drugs: Structure, Synthesis and medicinal properties. Mechlorethamine, Chlorambucil, Cyclophosphamide, Chloroquine, Primaquine, Chloroguanide, Pyrimethamine, Aspirin, Acetaminophen, Indomethacin, Mefenamic acid, Ibuprofen, Celecoxib. Norethindrone, Estradiol, Sorbitrate, AZT (Zidovudine), Sulpha drugs: Sulphanilamide	15 CLO 3
IV	Alkylation of Enolates and Other Carbon Nucleophiles Introduction , Generation, and Properties of Enolates and Other Stabilized Carbanions, Generation of Enolates by Deprotonation, Regioselectivity and Stereoselectivity in Enolate Formation from Ketones and Esters, Other Means of Generating Enolates, Solvent Effects on Enolate Structure and Reactivity. Alkylation of Enolates: Alkylation of Highly Stabilized Enolates, Alkylation of Ketone Enolates, Generation and Alkylation of Dianions, Intramolecular Alkylation of Enolates, Control of Enantioselectivity in Alkylation Reactions. Nitrogen Analogs of Enols and Enolates: Enamines and Imine Anions	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test, etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resourcLes/MS:		
1. Carey, F. A., & Sundberg, R. J. (2007). Advanced organic chemistry: Part B: Reaction and synthesis (5th ed.). Springer.		
2. Carruthers, W., & Coldham, I. (2004). Modern methods of organic synthesis (4th ed.). Cambridge University Press.		
3. Rappoport, Z. (Ed.). (1990). The chemistry of enols. John Wiley & Sons.		
4. Smith, M. B. (2020). March's advanced organic chemistry: Reactions, mechanisms, and structure (8th ed.). Wiley.		
5. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.		
6. Burger's Medicinal Chemistry and Drug Discovery Vol-I Ed. M.E. Wolf, John Wiley.		
7. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.		
8. Organic Chemistry Vol.-2 I.L. Finar, ELBS.		
9. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific Technical.		
10. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergamon		
11. Handbook of Heterocyclic Chemistry, Alan Katritzky, Christopher Ramsden, John A. Joule and Viktor Zhdankin, 3rd Edition, Elsevier.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	-	2	-	2	1	-	2	-	-
CLO ₂	3	2	-	2	-	2	1	-	2	-	-
CLO ₃	3	2	1	3	-	2	1	1	2	1	-
CLO ₄	3	3	1	3	-	3	2	-	2	-	-

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Drug discovery and design, chemotherapeutic agents, therapeutic index, drug development process, screening of natural products, SAR studies, lead compound optimization, pharmacokinetics, pharmacodynamics, synthesis of medicinally important drugs (anticancer, antimalarial, analgesic, cardiovascular and anti-HIV drugs), industrial relevance of enolate alkylation in pharmaceutical synthesis.	28
Skill Enhancement	Drug design strategies, receptor–ligand interactions, SAR analysis, isolation and purification of natural products, structure determination, synthetic methodologies, enolate chemistry, stereoselective synthesis, retrosynthetic thinking and medicinal chemistry applications.	18
Communication Development	Scientific terminology, drug nomenclature, presentation and interpretation of drug discovery data, discussion of pharmacological concepts and medicinal chemistry case studies.	2
Indian Knowledge System	Screening and utilization of medicinal plants and natural products traditionally used in Indian systems of medicine as potential lead compounds for drug development.	3
Environmental Awareness	Sustainable drug development, responsible handling of pharmaceuticals, safer synthetic methods, waste minimization during synthesis of medicinal compounds.	2
Current Issues and Social Awareness	Drug resistance, emerging infectious diseases, HIV/AIDS treatment, malaria control, cancer chemotherapy, rational drug use, public health significance of modern medicines.	3
Women empowerment/ Gender issues	Role of medicines in improving women's health (pain management, infectious diseases, healthcare accessibility) and equal participation in pharmaceutical research.	1
Public policies	Drug regulation, approval process, ethical drug development, clinical evaluation, drug safety, essential medicines, intellectual property and pharmaceutical policies.	2
Any Other	Ethical aspects of medicinal chemistry, personalized medicine, interdisciplinary research and innovation in pharmaceutical sciences.	1

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Inorganic Chemistry Special-V		
Course Code	26L6.5-CHE-408a		
Course Type	DEC-5		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To describe the biochemical functions of essential metals, inorganic drugs, and metalloporphyrins in health and disease. CLO 2: To analyze the transport, storage, catalytic, and regulatory roles of metal ions in biological systems. CLO 3: To assess the medicinal applications and toxicity mechanisms of metal-based drugs and complexes. CLO 4: To evaluate the catalytic mechanisms and biological significance of metalloproteins, metalloenzymes, and coenzymes in living systems.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Basics of Bio-Inorganic Chemistry Biochemical basis of essential metal deficient diseases; Iron, copper and zinc deficiencies and their therapies; Different classes of Inorganic drugs, Inorganic compounds as antacids, Drugs in hypo and hyper activity of thyroids. Porphyrins, metalloporphyrins, structure and functions of hemoglobin and myoglobin.		15 CLO 1

II	Metal Ions in Biological Systems Fundamentals of inorganic biochemistry, essential, non-essential and trace elements in bio-systems, Role of alkali/alkaline earth metals in bio-systems; Bioinorganic chemistry of Na ⁺ , K ⁺ , Mg ²⁺ and Ca ²⁺ , Ionophores, active transport of cations across membranes, sodium pump, blood clotting, neurotransmitter. Metal Storage Transport and Bio-mineralization- Ferritin, transferrin, and siderophores. Metal ions as antioxidants, metal ion enhancing catalytic activity of enzymes (Biocatalysts). Inhibitions as competitive and non-competitive.	15 CLO 2
III	Metal in Medicine Carcinogens and Carcinostatic agents, Role of zinc in tumor growth and inhibition, Anticancer activity and mechanism of platinum complexes, anticancer activity of Rhodium, copper and gold complexes, anticancer activity of Selenium, alkylating agents as anticancer drugs. Antibacterial and antiviral properties of metal complexes and chelating drugs. Mechanism of metal ion induced toxicity, interaction between orally administered drugs and metal ions in gut. Ligand induced toxicity, interference with hemoglobin in oxygen transport system, interference with metallo-enzymes, beneficial effects of ligand chelation; Nuclear medicine Therapy.	15 CLO 3
IV	Metallo-protein and enzymes Zinc Enzymes –Carboxypeptidase, Carbonic anhydrase, alkaline phosphatase and alcohol dehydrogenase, Iron Enzymes –Catalase, Peroxidase and Cytochrome P- 450, Copper Enzymes –Superoxide dismutase, blue copper electron transfer enzyme, Molybdenumoxotransferase enzymes –Xanthine oxidase Coenzymes – Vitamin B12.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books. 2. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books. 3. S. J. Lippard, Progress in Inorganic Chemistry, Wiley-Inter science, 1991. 4. Fenton, Biocoordination Chemistry, Oxford Chemistry Print, 1995. 5. Kaim and Schwederski, Bioinorganic: Inorganic Perspective in the Chemistry of Life, 1994. 6. Advanced Inorganic Chemistry, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, Wiley India. 7. Concepts and Models of Bioinorganic Chemistry, B. E. Douglas, D. H. McDaniel and J. J. Alexander, John Wiley & Sons. 8. Principles of bioinorganic chemistry:Stephen J. Lippard, Jeremy Mark Berg,1994.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	1	-	2	-	2	1	2	1	-	-
CLO ₂	3	2	-	2	-	3	1	2	1	-	-
CLO ₃	3	2	-	3	-	3	1	3	1	2	-
CLO ₄	3	2	-	3	-	3	1	2	1	-	-

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Bioinorganic chemistry, inorganic pharmaceuticals, metal-based drugs, metalloproteins, metalloenzymes, nuclear medicine, anticancer metal complexes, and biomedical applications relevant to pharmaceutical, biotechnology, healthcare, and research industries.	19
Skill Enhancement	Understanding the biological roles of metal ions; mechanisms of metal-based drugs; structure and function of hemoglobin, myoglobin, metalloproteins and metalloenzymes; enzyme inhibition; ion transport; interpretation of bioinorganic reaction mechanisms and therapeutic applications.	20
Communication Development	Interpretation and presentation of biochemical, medicinal and enzymatic data through assignments, seminars, case studies and scientific discussions.	4
Indian Knowledge System	Traditional Indian knowledge related to minerals and metals in healthcare, historical use of metal-based medicines, and contributions of Indian scientists to bioinorganic and medicinal chemistry.	2
Environmental Awareness	Metal ion toxicity, metal pollution and its biological effects; safe use and disposal of metal-containing pharmaceuticals; sustainable approaches in medicinal inorganic chemistry and nuclear medicine.	5
Current Issues and Social Awareness	Metal-based therapeutics for cancer and infectious diseases, enzyme-based drug design, trace element nutrition, public health issues related to metal deficiencies and toxicities, and advances in nuclear medicine.	5
Women empowerment/ Gender issues	Contributions of women scientists in bioinorganic chemistry, medicinal chemistry, biochemistry and pharmaceutical sciences.	1
Public policies	Drug safety regulations, ethical use of metal-based pharmaceuticals, radiation safety in nuclear medicine, biomedical waste management, and healthcare policies related to essential trace elements and therapeutic agents.	4
Any Other	Bioinorganic chemistry, inorganic pharmaceuticals, metal-based drugs, metalloproteins, metalloenzymes, nuclear medicine, anticancer metal complexes, and biomedical applications relevant to pharmaceutical, biotechnology, healthcare, and research industries.	18

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Physical Chemistry Special-V		
Course Code	26L6.5-CHE-408b		
Course Type	DEC-5		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Analyze fabrication techniques and structure-dependent properties of nanomaterials and Langmuir–Blodgett films for advanced material applications. CLO 2: Interpret polymer chain behavior using freely jointed chain models and assess the effect of bond angle restrictions on chain dimensions and properties. CLO 3: Evaluate gas-phase and solution-phase reaction kinetics using modern techniques including flash photolysis, temperature/pressure jump methods, and shock tube studies. CLO 4: Interpret electrochemical processes using kinetic models and characterize electrode reactions through modern techniques such as cyclic voltammetry and AC impedance.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be a compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Material Chemistry Definition of nanomaterials, Various techniques for the preparation of nanomaterials, Thin Films and Langmuir-Blodgett films - Preparation techniques, evaporation/sputtering, chemical processes, MOCVD, sol-gel. Langmuir-Blodgett (LB) film, growth techniques, photolithography, properties and applications of thin and LB films. Electronic structure and properties of nanomaterials, optical, electrical and magnetic properties, applications of nanomaterials.		15 CLO 1

II	Thermodynamics of Polymer Solutions Poly-dispersity, Molecular mass distribution curves, Average end - to - end distance, average radius of gyration of polymer chains, statistical distribution of end - to - end dimensions, freely jointed chain in three dimensions, influence of bond angle restrictions. Flory Huggins' lattice theory, limitations of lattice models.	15 CLO 2
III	Kinetics of Fast Reactions General treatment of chain reaction, apparent activation energy of chain reactions, chain lengths, theories of branching chain and explosion (hydrogen-oxygen reaction). Modern techniques in gas phase and in solution, flash photolysis, flow methods, relaxation techniques (temperature jump, pressure jump) and shock tube technique.	15 CLO 3
IV	Advanced Electrochemistry Advanced concepts: Overpotential concept, Exchange current density, Butler-Volmer equation, Polarizable and non-polarizable interfaces. Electrochemical Processes: Difference between kinetically and mass transport controlled electrochemical processes, Difference between single step and multiple step electrode reactions, Brief introduction and applications of various electrochemical methods: Principle of electrochemical methods such as chronoamperometry, cyclic voltammetry, chronopotentiometry, coulometry, ac impedance.	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Chemical Kinetics, K.J. Laidler, McGraw Hill		
2. Theories of Chemical Reaction Rates, K.J. Laidler, McGraw Hill.		
3. Theory of Rate Processes, S. Glasstone, K.J. Laidler and H. Eyring, McGraw Hill.		
4. H.R. Allcock, F.W. Lampe and James Mark, Contemporary Polymer Chemistry, Prentice Hall, Inc. (1990).		
5. M.P. Stevens, Polymer Chemistry: An Introduction (2nd Edition) Oxford University Press (1990).		
6. F.W. Billmeyer, Jr., Textbook of Polymer Science (3rd Edition) Wiley-Inter Science (1984) paperback.		
7. A. Ravve, Principles of Polymer Chemistry.		
8. Modern Electrochemistry 1 : Ionics 2nd Ed., Springer (1998), J.O. M. Bockris & A.K. Reddy.		
9. Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science 2nd Ed., Springer (2001), J.O. M. Bockris & A.K. Reddy.		
10. Modern Electrochemistry 2A: Fundamentals of Electrodics 2nd Ed., Springer (2001), J. O. M. Bockris, A. K. N. Reddy and M. E. Gamboa-Aldeco.		
11. Crow, D.R. Principles and Applications of Electrochemistry, 4th Edition Chapman and Hall, London 1994.		
12. An Introduction to Nanoscience & Nanotechnology by A. Nouailhat, Wiley.		
13. Nano-The Essentials by T. Pradeep, Tata McGraw Hill.		
14. Nanotechnology Principles and Practices by S.K. Kulkarni.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	–	3	3	1	2	–	–
CLO ₂	3	3	1	3	–	3	2	–	2	–	–
CLO ₃	3	3	1	3	–	3	3	–	2	–	–
CLO ₄	3	3	1	3	–	3	3	1	2	1	–

Content Mapping with NEP thrust areas

Field	Content/s	Hours devoted
Employability/ Entrepreneurship	Knowledge of nanomaterials, thin films, polymer solution thermodynamics, fast reaction kinetics, and advanced electrochemical techniques enhances employability in nanotechnology, materials science, polymer industries, energy storage, semiconductor industries, and research organizations.	16
Skill Enhancement	Develops analytical, computational, instrumental, and problem-solving skills through synthesis of nanomaterials, electrochemical techniques, polymer characterization, and study of fast reaction mechanisms.	16
Communication Development	Scientific presentation and interpretation of advanced materials, polymer characterization data, reaction kinetics data analysis, electrochemical results and research communication.	6
Indian Knowledge System	Application of advanced materials, polymers, and electrochemical technologies in traditional material development and indigenous technologies.	3
Environmental Awareness	Applications of nanomaterials and electrochemical methods in pollution control, renewable energy, sensors, water purification, sustainable materials, and green technologies.	6
Current Issues and Social Awareness	Relevant to emerging fields such as nanotechnology, advanced materials, energy storage devices, fuel cells, sensors, sustainable polymers, and clean energy technologies.	5
Women empowerment/ Gender issues	Encourages equal participation and opportunities in scientific education, research, entrepreneurship, and technology-driven careers.	1
Public policies	National initiatives related to nanotechnology, advanced materials, sustainable technologies, energy policies and scientific innovation programmes.	1
Any Other	Research aptitude, scientific temper, innovation, interdisciplinary learning, quantitative reasoning, computational proficiency, and lifelong learning.	6

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Organic Chemistry Special-V		
Course Code	26L6.5-CHE-408c		
Course Type	DEC-5		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To understand chemical and biological catalysis, nomenclature and classification, of enzymes, extraction and purification of enzymes, Fischer's lock and key and Koshland's induced fit hypothesis. To understand kinetics of Enzyme catalyzed reactions, Michaelis-Menten and Lineweaver-Burk plots and kinetics of reversible and irreversible inhibition. CLO 2: To get knowledge about Cofactors, knowledge of coenzymes, prosthetic groups, apoenzymes. structure and biological functions and mechanisms of reactions catalyzed by different coenzyme CLO 3: To understand application of aliphatic nitro compounds in organic synthesis. CLO 4: To understand the Systematic nomenclature, General synthesis and reactions of Five- membered heterocycles: pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole, General reactivity of purines and pyrimidines.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics		Contact Hours/ CLO Attempt

I	Amino Acids, Peptides and Proteins: Introduction, classification and structure, Isoelectric point with numerical problems. General methods of preparation, Ninhydrin reaction. Peptide bond, protein structure, Chemical and enzymatic hydrolysis of proteins to peptides. Enzymes: Remarkable properties of enzymes like catalytic power, specificity and regulation. 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, affinity labelling. Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.	15 CLO 1
II	Coenzyme Chemistry: Biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD ⁺ , NADP ⁺ , FMN, FAD. Carbohydrates: Introduction, nomenclature, monosaccharide & their configuration with the determination of the size of sugar rings, basic elementary idea of structure of starch, cellulose, sucrose, maltose. Fatty Acids: Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerol phosphor lipids, sphingolipids	15 CLO 2
III	Nomenclature of heterocyclic compounds: Replacement and Systematic (Hantzsch-Widman) nomenclature for monocyclic, fused ring and bridged heterocyclic systems. Aromatic heterocycles: Classification (structural type) Aromaticity, bond lengths, ¹ H NMR, resonance energy, charge distribution, reactivity, tautomerism. Non-aromatic heterocycles: Bond angle and torsional strains and their consequences in small ring heterocycles. Small ring heterocycles: Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, azetidines.	15 CLO 3
IV	Five membered heterocycles: Methods of synthesis and reactions including mechanism (addition on nitrogen: protonation, Nalkylation, N-acylation; reactions with electrophilic and nucleophilic reagents) of the following five -membered 1,2-and 1,3-heterocycles: pyrazole, isoxazole, isothiazole, imidazole, oxazole, thiazole; their basic character. Reactions with oxidizing and reducing agents. Six membered heterocycles: Methods of synthesis and reactions including mechanism of the following six-membered heterocycles: purines and pyrimidines	15 CLO 4
Total Contact Hours		60
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
● Class Participation:	5	Written Examination:70
● Seminar/presentation/assignment/quiz/class test, etc.:	10	
● Mid-Term Exam:	15	
Part C-Learning Resources		
Recommended Books/e-resources/LMS: 1. Dugas, H., Bioorganic Chemistry. A Chemical approach to enzyme action, Springer-Verlag, 2nd Edition (1989). 2. Metzler, D.E., Biochemistry- The Chemical Reactions of a Living Cell, Academic Press, (1977). 3. Ed. Dugas, H., Bioorganic Chemistry Frontiers Vol.2, Springer-Verlag (1990). 4. Lehninger, A.L. et al., Lehninger Principles of Biochemistry, W.H. Freeman (2005). 5. Voet, D., Voet, J.G., Pratt, C.W., Principles of Biochemistry, Wiley, 3rd Edition (2008).		

6. Outlines of Biochemistry, Cohn & Stumpf.
7. Enzymes, Biochemistry, Biotechnology, Clinical Chemistry, T. Palmer and P.L. Bonner
8. Gilchrist, T.L., Heterocyclic Chemistry, Prentice Hall (1997).
9. Paquette, L.A., Principles of Modern Heterocyclic Chemistry, W.B. Benjamin, Inc. (1978).
10. Joule, J.A. & Mills, K., Heterocyclic Chemistry, Wiley, Fifth Edition (2010).

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	-	2	1	-	2	-	-
CLO ₂	3	2	1	2	-	2	-	-	2	-	-
CLO ₃	3	2	-	3	-	2	1	-	1	-	-
CLO ₄	3	2	1	3	-	2	-	-	2	-	-

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Amino acids, proteins, enzymes, coenzymes, carbohydrates, fatty acids, heterocyclic compounds used in pharmaceuticals, biotechnology, food, and chemical industries.	18
Skill Enhancement	Numerical problems on isoelectric point, enzyme kinetics (Michaelis-Menten & Lineweaver-Burk plots), reaction mechanisms, heterocyclic synthesis, nomenclature, biochemical structure analysis.	20
Communication Development	Scientific terminology, IUPAC/Hantzsch-Widman nomenclature, interpretation of biochemical and heterocyclic chemistry concepts, technical presentations and discussions.	3
Indian Knowledge System	Traditional knowledge related to carbohydrates, proteins, enzymes, fatty acids, medicinal heterocycles, and their relevance in Ayurveda and natural products.	3
Environmental Awareness	Enzyme catalysis as green catalysts, biodegradable biomolecules, sustainable biochemical processes, environmentally benign heterocyclic synthesis concepts.	4
Current Issues and Social Awareness	Role of enzymes, proteins, carbohydrates and lipids in healthcare, metabolic disorders, drug discovery, antimicrobial agents, and public health.	5
Women empowerment/ Gender issues	Application of biomolecules and heterocyclic drugs in women's health, nutrition, hormonal disorders, and healthcare awareness.	2
Public policies	Relevance of biotechnology, pharmaceutical regulations, food safety, nutritional standards, and healthcare policies involving biomolecules and drugs.	2
Any Other	Research orientation, interdisciplinary applications, medicinal chemistry, pharmaceutical sciences, computational biology, and innovation in heterocyclic chemistry.	3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Practical		
Name of the Course	Inorganic Chemistry Special Practical-III		
Course Code	26L6.5-CHE-405a		
Course Type	PC-9		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To apply spectrophotometric techniques to verify Beer- Lambert's law and quantify metal ions in unknown samples. CLO 2: To utilize flame photometry for the estimation of sodium and potassium ions in samples. CLO 3: To employ turbidimetric methods for quantitative determination of chloride and sulphate ions and evaluate the analytical data obtained. CLO 4: To utilize volumetric methods for metal ion determinations.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time		3 hours	
Part B- Contents of the Course			
Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics		Contact Hours\ CLO Attempt
I	Spectrophotometric analysis i) To validate the Beer's Lambert law spectrophotometrically ii) To determine the unknown amount of following metal ions present in the given sample spectrophotometrically Fe; Ni, Mo, V, Cu iii) To find out the stoichiometry of the complex by Job's Method.		30 CLO 1
II	Flame photometric analysis i) To determine the unknown amount of Na/K ions present in the given water sample by Flame photometry. ii) Determination of Na, Ca, Li, in cold drinks and fruit juices using Flame photometry Any other experiments related to this technique.		30 CLO 2

III	Turbidimetric analysis To determine the unknown amount of Cl ⁻ and sulphate ions present in the given sample by turbidimetry method Any other experiments related to this technique.	30 CLO 3
IV	Volumetric analysis A) Acid -base Titrations i) Estimation of free alkali present in different soaps/ detergents/ shampoos ii) Estimation of total alkalinity in water samples from different sources B) Redox titration involving Iodine i.e. iodometric and iodimetric titration	30 CLO 4
Total Contact Hours		120
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
➤ Practical	30	➤ Practical: 70
● Class Participation:	5	Lab record 10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva-voce 20
● Mid-Term Exam:	15	Write-up and execution of the practical 40
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London. 2. Practical Chemistry, A.M. James and F.E. Prichard, Longman. 3. Instrumental Methods of Chemical Analysis, G. R. Chatwal and S. K. Anand, Himalaya Publishing House, Mumbai. 4. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt Jr., J. A. Dean and F. A. Settle Jr., CBS Publishers & Distributors, New Delhi. 5. Experimental Methods in Inorganic Chemistry, W. G. Palmer, Cambridge University Press, Cambridge. 6. A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, Longman, London. 7. Experimental Methods in Inorganic Chemistry, W. G. Palmer, Cambridge University Press, Cambridge 8. Advanced Practical Inorganic Chemistry, D. M. Adams and J. B. Raynor, John Wiley & Sons, New York. 9. Practical Inorganic Chemistry, D. Amita, M. Navneet, Manakin Press		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	2	2	-	3	-	3	3	-	1	2	-
CLO ₂	2	2	-	3	-	3	3	-	1	2	-
CLO ₃	2	1	-	2	-	3	3	-	1	2	-
CLO ₄	2	2	-	3	-	3	3	-	1	2	-

Content Mapping with NEP thrust areas

Field	Content	Hours
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		Devoted
Employability/ Entrepreneurship	Spectrophotometric determination of metal ions; flame photometric analysis of sodium and potassium; turbidimetric estimation of chloride and sulphate ions; volumetric estimation of metal ions; operation of analytical instruments relevant to chemical, pharmaceutical, food, environmental and quality control laboratories.	40
Skill Enhancement	Validation of Beer–Lambert law; quantitative estimation of metal ions; determination of complex stoichiometry by Job's method; operation and calibration of spectrophotometer and flame photometer; turbidimetric analysis; volumetric estimation; data analysis, calculations, error analysis and laboratory record maintenance.	55
Communication Development	Preparation of laboratory records, calculation sheets, interpretation of analytical results, graphical presentation of calibration curves, viva-voce and presentation of experimental observations.	8
Indian Knowledge System	Traditional analytical practices, historical contributions of Indian scientists to analytical chemistry and chemical instrumentation, and indigenous approaches to quality assessment of materials.	1
Environmental Awareness	Analysis of environmentally significant ions (chloride and sulphate); safe handling and disposal of laboratory chemicals; green analytical chemistry practices; waste minimization and environmental monitoring using instrumental techniques.	8
Current Issues and Social Awareness	Applications of instrumental analytical techniques in water quality assessment, environmental monitoring, food analysis, pharmaceutical quality control and public health.	5
Women empowerment/ Gender issues	Contributions of women scientists in analytical chemistry, spectroscopy and instrumental analysis, encouraging gender equity in scientific research and laboratory sciences.	1
Public policies	No direct content	0
Any Other	Spectrophotometric determination of metal ions; flame photometric analysis of sodium and potassium; turbidimetric estimation of chloride and sulphate ions; volumetric estimation of metal ions; operation of analytical instruments relevant to chemical, pharmaceutical, food, environmental and quality control laboratories.	35

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Practical		
Name of the Course	Physical Chemistry Special Practical-III		
Course Code	26L6.5-CHE-405b		
Course Type	PC-9		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Perform pH-metric titrations of acid–base systems to determine dissociation constants and investigate the influence of substituents on acid strength using the Hammett equation. CLO 2: Analyze the kinetics of ester hydrolysis and saponification reactions to determine relative acid strengths and reaction velocity constants. CLO 3: Evaluate the kinetic parameters of chemical reactions, including rate constants and activation energy, through temperature-dependent studies of reaction rates. CLO 4: Perform experiments to construct the phase diagram of a binary system and study micelle formation to analyze the principles of phase equilibria and surface chemistry.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	
Part B- Contents of the Course			
Instructions for the examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics		Contact Hours\ CLO Attempt
I	1. pH-Metry (i) pH-titrations of: (a) Acetic acid vs. NaOH, (b) acetic acid vs. NH ₄ OH (iv) HCl vs. NH ₄ OH (v) NaOH vs. H ₃ PO ₄ (ii) To find dissociation constants of weak acids. (iii) Determine the hydrolysis constant of aniline hydrochloride. (iv) Determine the Hammett constant of a given substituted benzoic acid by pH measurements.		40 CLO 1
II	1. Chemical Kinetics (i) Determination of velocity constant of the reaction of ethyl acetate with NaOH.		30 CLO 2

	(ii) Determination of the velocity constant and energy of activation of the reactions between H ₂ O ₂ and HI. Determine the relative strength of the acids by studying the hydrolysis of methyl acetate.		
III	Chemical Kinetics (i) Determination of activation energy and temperature coefficient of hydrolysis of ester by an acid. (ii) Investigate the muta rotation of Glucose catalyzed by (a) an acid (b) base. (iii) Investigation of the reaction between hydrogen peroxide and hydrogen iodide. Investigate the reaction between acetone and iodine.	30 CLO 3	
IV	2. Phase equilibria (i) Construct the phase diagram of binary (Two component) system. (ii) Construct the phase diagram of three component system containing ethanol, benzene and water system. (iii) Study the boiling point composition curves for binary liquid mixtures. 3. Surface Chemistry (i) Experiments on formation and study of micelles. Note: Any experiment may be introduced/deleted in the practical class based on the availability / non-availability of the instruments / chemicals.	20 CLO 4	
Total Contact Hours		120	
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
➤ Practical	30	➤ Practical:	70
● Class Participation:	5	Lab record	10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce	20
● Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/e-resources/LMS: 1. Practical Chemistry, A.M. James and F.E. Pricherd, Longman. 2. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman. 3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency. 4. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill. 5. Experiments in Physical Chemistry, Shoemaker and Garland, McGraw Hill. 6. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj. 7. Experimental Physical Chemistry, V.D. Athawale and Parul Mathur, New Age International. 8. Senior Practical Physical Chemistry, B. D. Khosla, V. C. Garg, A. Gulati, R. Chand & Co.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	1	3	3	–	2	1	–
CLO ₂	3	3	1	3	1	3	2	–	2	1	–

CLO ₃	3	3	1	3	1	3	2	–	2	1	–
CLO ₄	3	2	1	3	1	3	3	–	2	1	–

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Practical training in pH-metry, chemical kinetics, and dipolemetry develops skills required in analytical laboratories, pharmaceuticals, chemical industries, quality control, environmental testing, and research institutions.	30
Skill Enhancement	Enhances laboratory competency in pH measurements, kinetic studies, determination of dissociation constants, activation energy calculations, dielectric constant measurements, and data analysis.	34
Communication Development	Strengthens scientific report writing, laboratory record maintenance, graphical representation of data, result interpretation, and technical presentation skills.	12
Indian Knowledge System	Promotes scientific inquiry, experimental learning, logical reasoning, and evidence-based understanding of physicochemical principles.	6
Environmental Awareness	Applications of pH measurements and kinetic studies in water quality assessment, environmental monitoring, and sustainable chemical processes.	10
Current Issues and Social Awareness	Supports analytical techniques widely used in healthcare, pharmaceuticals, environmental analysis, industrial quality control, and modern research.	10
Women empowerment/ Gender issues	Encourages equal participation and skill development in scientific experimentation, higher education, and research activities.	3
Public policies	Provides scientific understanding relevant to laboratory safety standards, environmental regulations, industrial quality assurance, and analytical testing protocols.	5
Any Other	Scientific temper, research aptitude, critical thinking, quantitative analysis, precision in experimentation, problem-solving ability, teamwork, and lifelong learning.	10

Part A - Introduction

Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Practical		
Name of the Course	Organic Chemistry Special Practical-III		
Course Code	26L6.5-CHE-405c		
Course Type	PC-9		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: Demonstrate the synthesis of selected organic compounds involving two-step reaction sequences, applying appropriate laboratory techniques, purification methods, and reaction mechanisms CLO 2: Perform multistep (three-step) organic syntheses, interpret reaction pathways, and evaluate the transformation of starting materials into target compounds using standard experimental procedures CLO 3: Utilize chemistry software for drawing chemical structures, predicting molecular properties, and performing basic computational studies of small organic molecules. CLO 4: Apply IUPAC nomenclature, predict ¹H NMR spectra of organic compounds, and systematically record, analyze, and present experimental observations and results in a well-organized laboratory record.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	

Part B- Contents of the Course

Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.

Unit	Topics	Content Hours\ CLO Attempt
I	All the students must acquire the knowledge of the preparation of organic compounds in two steps. Preparations of organic compounds involving two steps: (Any three) 1. Synthesis of Benzalacetophenone (Chalcone) from Acetophenone and its Conversion to Epoxide 2. Synthesis of Cyclohexanone Oxime from Cyclohexanone	40 CLO 1

	and Beckmann Rearrangement to Caprolactam 3. Preparation of Anthraquinone from Phthalic Anhydride via o-Benzoylbenzoic Acid 4. Preparation of Acridone from o-Chlorobenzoic Acid via N-Phenylanthranilic Acid 5. Preparation of 2,4-Dinitrophenol from Chlorobenzene via 2,4-Dinitrochlorobenzene 6. Preparation of Trityl Chloride from Bromobenzene via Triphenylcarbinol 7. Phenol — salicylaldehyde — coumarin 8. Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene		
II	All the students must acquire the knowledge of the preparation of organic compounds in three steps. Preparations of organic compounds involving three steps: (Any two) 1. Toluene - p-nitrotoluene — p-nitrobenzoic acid — p-amino benzoic acid 2. Hydroquinone — Benzoquinone — 5-Hydroxy benzoxathiole-2-one — 5-Acetoxy benzoxathiol-2-one 3. Acetophenone — Acetophenone oxime — Acetanilide - p-Nitroacetanilide 4. Benzaldehyde — Benzoin — Benzil — Benzillic acid 5. Acetylacetone — 4,6-dimethylpyridine-2-mercaptopyrimidine — 4,6-dimethyl-2-hydrazinpyrimidine — 1-(4'-6'-dimethylpyridine-2'yl)-3,5- dimethylpyrazole 6. Nitrobenzene — m-dinitrobenzene — m-nitroaniline — m-nitrophenol Phthalic acid — phthalic anhydride – phthalimide —Anthranilic acid	40 CLO 2	
III	Demonstration of different software useful in chemistry for drawing the structure of organic compounds as well as for the computational studies of small organic molecules.	16 CLO 3	
IV	Finding IUPAC nomenclature, 1H NMR prediction, etc and to develop the ability to compile the obtained results in the form of a lab record.	24 CLO 4	
Total Contact Hours		120	
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
Practical	30	Practical:	70
● Class Participation:	5	Lab record	10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce	20
● Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			

Recommended Books/e-resources/LMS:

1. Mohrig, J. R., Hammond, C. N., & Schatz, P. F. (2025). Techniques in organic chemistry: Advanced laboratory course (5th ed.). W.H. Freeman.
2. Zweifel, G. S., & Nantz, M. H. (2023). Modern organic synthesis: An introduction (2nd ed.). University Science Books.
3. Jensen, F. (2022). Molecular modeling basics: Computational tools for chemical discovery. CRC Press.
4. Kürti, L., & Czakó, B. (2025). Strategic applications of named reactions in multi-step synthesis. Elsevier.
5. Loudon, G. M., & Parise, J. (2021). Organic chemistry: Structure and function with spectroscopy guide (8th ed.). Macmillan.
6. Bachrach, S. M. (2014). Computational organic chemistry (2nd ed.). Wiley.
7. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (1996). Vogel's textbook of practical organic chemistry (6th ed.). Prentice Hall.
8. Leonard, J., Lygo, B., & Procter, G. (2013). Advanced practical organic chemistry (3rd ed.). CRC Press.
9. Roy, K., & Gramatica, P. (2015). QSAR and molecular modeling in drug design. Springer.
10. Schlick, T. (2010). Molecular modeling and simulation: An interdisciplinary guide (2nd ed.). Springer.

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	–	3	–	2	1	–	1	–	–
CLO ₂	3	3	–	3	1	3	3	–	1	2	–
CLO ₃	2	1	2	2	–	1	3	–	2	–	–
CLO ₄	3	2	3	2	–	2	2	–	2	3	–

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Training in multi-step organic synthesis, purification, characterization, reaction handling, and laboratory practices develops skills required for employment in pharmaceutical, chemical, and research industries. Software-based molecular drawing and computational chemistry skills enhance career opportunities in chemical research and industry.	25
Skill Enhancement	Practical skills related to preparation of organic compounds through two-step and three-step synthetic routes, reaction monitoring, isolation techniques, yield calculation, IUPAC nomenclature, spectral prediction (¹ H NMR), and preparation of scientific laboratory records.	45
Communication Development	Development of scientific communication skills through preparation of laboratory records, interpretation of experimental results, presentation of synthetic procedures, and reporting of observations and conclusions using scientific terminology.	15
Indian Knowledge System	Understanding the role of organic compounds, natural product-based molecules, traditional chemical practices, and indigenous knowledge related to organic materials and their applications in chemistry.	5
Environmental Awareness	Awareness about sustainable organic synthesis, solvent selection, waste minimization, safe handling of chemicals, and environmentally responsible laboratory practices during organic preparations.	10
Current Issues and Social Awareness	Understanding the relevance of organic synthesis, computational chemistry, and molecular design in modern drug discovery, healthcare,	5

	material science, and industrial development.	
Women empowerment/ Gender issues	Equal participation and opportunities in laboratory training, research activities, and skill development for all students irrespective of gender, promoting inclusive scientific education.	3
Public policies	Awareness of chemical safety regulations, laboratory ethics, responsible chemical management, and guidelines related to environmental protection and industrial chemical practices.	5
Any Other	Use of chemistry software for molecular structure drawing and computational studies; development of digital literacy, problem-solving ability, and research-oriented thinking in chemistry.	7

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Practical		
Name of the Course	Inorganic Chemistry Special Practical-IV		
Course Code	26L6.5-CHE-406a		
Course Type	PC-10		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able:	CLO 1: To demonstrate proficiency in quantitative analysis using volumetric, gravimetric, and instrumental methods. CLO 2: To determine the concentration of inorganic constituents through direct complexometric titration CLO 3: To apply back complexometric titrations for the estimation of metal ions and assessment of water quality parameters. CLO 4: To estimate the composition of chloride ions argentometry titration methods.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time (Spread over two sessions)		3 hours	
Part B- Contents of the Course			
Instructions for Examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics		Contact Hours\ CLO Attempt
I	Quantitative analysis: Determination of triple elements in the mixtures, ores, alloys etc. by available analytical techniques. i) Volumetrically ii) Gravimetrically iii) Instrumentation methods		40 CLO 1

II	Volumetric “Complexometric” Titration A) Direct Titration Using EDTA i) Estimation of calcium content in chalk sample as calcium oxalate by permanganometry ii) Estimation of Hardness (Temporary as well as permanent) of water sample by EDTA iii)To determine the strength of ZnSO ₄ and MgSO ₄ present in the given solution by complexometric titration	30 CLO 2	
III	Volumetric “Complexometric” Titration B) Back Titrations i) Basic concept of back Titration ii) Determination of alkali content- present in the given antacid sample using HCl iii)Determination of acetic acid in commercial vinegar using NaOH Any other experiments related to these techniques	25 CLO 3	
IV	Volumetric “Precipitation” Titration [Argentometry] i) Estimation of chloride ions in NaCl solution using silver nitrate solution by Mohr’s method ii) Estimation of chloride ions in HCl solution using ammonium thiocyanate by Volhard’s method iii) Estimation of Chloride ions in NaCl solution using silver nitrate solution by Fajan’s Method iv) Any other experiments related to these techniques	25 CLO 4	
Total Contact Hours		120	
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
➤ Practical	30	➤ Practical:	70
● Class Participation:	5	Lab record	10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva-voce	20
● Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/e-resources/LMS: 1. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London. 2. Practical Chemistry, A.M. James and F.E. Pricherd, Longman. 3. Practical Chemistry, A.M. James and F.E. Prichard, Longman. 4. Instrumental Methods of Chemical Analysis, G. R. Chatwal and S. K. Anand, Himalaya Publishing House, Mumbai. 5. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt Jr., J. A. Dean and F. A. Settle Jr., CBS Publishers & Distributors, New Delhi. 6. Experimental Methods in Inorganic Chemistry, W. G. Palmer, Cambridge University Press, Cambridge. 7. A Vogel’s Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, Longman, London. 8. Experimental Methods in Inorganic Chemistry, W. G. Palmer, Cambridge University Press, Cambridge 9. Advanced Practical Inorganic Chemistry, D. M. Adams and J. B. Raynor, John Wiley & Sons, 10. Practical Inorganic Chemistry, D. Amita, M. Navneet, Manakin Press			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	2	2	1	3	-	3	3	-	1	2	-
CLO ₂	2	1	1	3	-	3	2	-	1	2	-
CLO ₃	2	2	1	3	-	3	2	1	1	2	-
CLO ₄	2	2	1	3	-	3	2	1	1	2	1

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Quantitative analysis of mixtures, ores and alloys using volumetric, gravimetric and instrumental methods; estimation of commercial products (antacid, vinegar); analytical techniques used in quality control, pharmaceutical, environmental and industrial laboratories.	38
Skill Enhancement	Practical training in volumetric, gravimetric, complexometric and back titrations; preparation and standardization of solutions; analytical calculations; handling of laboratory instruments and interpretation of experimental results.	55
Communication Development	Maintenance of laboratory records, presentation and interpretation of analytical data, discussion of experimental observations and viva-voce.	5
Indian Knowledge System	Study of water quality analysis and analytical practices supporting traditional and sustainable water resource management in India.	2
Environmental Awareness	Determination of temporary and permanent hardness of water using EDTA; environmental significance of water quality monitoring and safe disposal of laboratory chemicals.	10
Current Issues and Social Awareness	Analysis of drinking water quality and commercial products (antacids and vinegar); importance of analytical chemistry in public health, food quality and environmental monitoring.	5
Women empowerment/ Gender issues	Equal participation of all learners in laboratory activities, collaborative learning and promotion of gender equity in scientific education.	1
Public policies	Relevance of analytical techniques in water quality standards, food safety, pharmaceutical quality control and environmental regulations.	1
Any Other	Laboratory ethics, safety practices, precision, accuracy, teamwork and professional conduct during practical work.	3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Practical		
Name of the Course	Physical Chemistry Special Practical-IV		
Course Code	26L6.5-CHE-406b		
Course Type	PC-10		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Utilize polarimetric methods to study optical activity, acid-catalyzed sucrose inversion, and factors influencing reaction kinetics. CLO 2: Analyze water and juice samples for Na^+, K^+, Ca^{2+}, and Mg^{2+} content and interpret the results in terms of sample composition and quality. CLO 3: Determine the concentration of sulphate ions in a given solution using turbidimetric analysis and interpret the results based on turbidity measurements. CLO 4: Apply interferometric methods to measure the speed of sound in liquids and calculate their isentropic compressibility.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time		3 hours	
Part B- Contents of the Course			
Instructions for the examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics		Contact Hours
	Polarimetry - Determine the percentage of two optically active substances in a mixture polarimetrically. - Determination of relative strength of acids by the study of inversion of sucrose. - Investigate the effect of substitution of chloride ions on rate constant of inversion of cane sugar by using mono- and tri-chloroacetic acids as catalysts. Flame Photometry - Determination of Na^+, K^+, Ca^{2+} and Mg^{2+} in water, juice, etc. Turbidimetry - Determine the concentration of sulphate ions in the given solution. Interferometry - Determination of speed of sound and isentropic compressibility of		120

pure liquids using interferometer. Synthesis of nanoparticles (i) Synthesize metal nanoparticles by sol-gel method. (ii) Synthesize metal nanoparticles by co-precipitation method. (iii) Synthesize metal nanoparticles by micro emulsion method. Note: Any experiment may be introduced/deleted in the practical class based on the availability / non-availability of the instruments / chemicals.			
Total Contact Hours			120
Evaluation Methods			
Internal Assessment: 30		End Term Examination: 70	
➤ Practical	30	➤ Practical:	70
● Class Participation:	5	Lab Record	10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce	20
● Mid-Term Exam:	15	Write-up and execution of the practical	40
Part C-Learning Resources			
Recommended Books/e-resources/LMS: 1. Practical Chemistry, A.M. James and F.E. Prichard, Longman. 2. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman. 3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency. 4. Experimental Physical Chemistry, R.C. Das and B. Behra, McGraw Hill. 5. Experiments in Physical Chemistry, Shoemaker and Gailand, McGraw Hill. 6. Systematic experimental Physical Chemistry, T.K. Chandrasekhar & S.K. Rajbhoj. 7. Experimental Physical Chemistry, V.D. Athawale and Parul Mathur, New Age International. 8. Senior Practical Physical Chemistry, B. D. Khosla, V. C. Garg, A. Gulati, R Chand & Co. 9. https://gaussian.com/basissets/ 10. https://gaussian.com/man/			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	3	1	3	1	3	3	—	2	1	—
CLO ₂	3	3	1	3	1	3	3	1	2	1	—
CLO ₃	3	2	1	3	1	3	3	1	2	1	—
CLO ₄	3	3	1	3	1	3	3	—	2	1	—

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Practical exposure to polarimetry, flame photometry, turbidimetry, interferometry, and nanoparticle synthesis enhances employability in analytical laboratories, nanotechnology industries, pharmaceuticals, environmental testing laboratories, food industries, and research organizations.	28
Skill Enhancement	Develops laboratory skills in instrumental analysis, quantitative estimation, kinetic studies, optical measurements, nanoparticle synthesis, data interpretation,	36

	and advanced experimental techniques.	
Communication Development	Strengthens scientific report writing, presentation of experimental findings, interpretation of analytical results, and technical communication skills.	12
Indian Knowledge System	Promotes scientific inquiry, experimental learning, innovation, and evidence-based understanding of physicochemical and nanomaterial systems.	6
Environmental Awareness	Applications in water quality analysis, environmental monitoring, pollutant determination, green synthesis approaches, and sustainable nanomaterial development.	10
Current Issues and Social Awareness	Relevance to nanotechnology, environmental sustainability, water quality assessment, healthcare diagnostics, food quality analysis, and advanced material development.	10
Women empowerment/ Gender issues	Encourages equal participation and capacity building in scientific experimentation, research, innovation, and technology-driven careers.	3
Public policies	Supports scientific understanding related to environmental regulations, water quality standards, nanotechnology development, laboratory safety, and quality assurance protocols.	5
Any Other	Scientific temper, research aptitude, innovation, critical thinking, precision in experimentation, interdisciplinary learning, and lifelong learning.	10

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Practical		
Name of the Course	Organic Chemistry Special Practical-IV		
Course Code	26L6.5-CHE-406c		
Course Type	PC-10		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Perform the isolation and extraction of natural products such as caffeine, curcumin, casein, and lactose using appropriate laboratory techniques, and evaluate their extraction efficiency, percentage yield, and purity. CLO 2: Investigate the effect of solvent polarity on the rate of an SN2 reaction, analyze experimental observations, and explain the relationship between solvent properties and reaction kinetics. CLO 3: Determine the vitamin C content in pharmaceutical formulations and fruit juices using iodometric redox titration, perform quantitative analysis accurately, and interpret analytical results. CLO 4: Record, analyze, and present experimental procedures, observations, calculations, results, and conclusions in a well-structured laboratory report following accepted scientific writing standards.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time		3 hours	
Part B- Contents of the Course			
Instructions for the examiner: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40.			
Unit	Topics		Contact Hours\ CLO Attempt
I	1.Isolation of Caffeine from Tea Leaves and Evaluation of Extraction Efficiency, Purity, and Recovery 2.Comparative Extraction of Curcumin from Turmeric Using Ethanol, Acetone, and Ethyl Acetate		30 CLO 1

II	Effect of Solvent Polarity on the Rate of an SN ₂ Reaction: Reaction of 1-Bromobutane with Sodium Iodide in Different Solvents	30 CLO 2
III	1. Determination of Vitamin C Content in Commercial Tablets by Iodometric Redox Titration Determination of Vitamin C Content in Fruit Juices by Iodometric Redox Titration	30 CLO 3
IV	1. To isolate casein from milk by isoelectric precipitation, determine the percentage yield, and evaluate its purity using qualitative tests. 2. To isolate lactose from milk by removing proteins and concentrating the whey, and to determine the percentage yield and purity of lactose. Prepare a file record experimental procedures, results, and conclusions in a structured lab report adhering to scientific writing standards.	30 CLO 4
Total Contact Hours		120
Evaluation Methods		
Internal Assessment: 30		End Term Examination: 70
➤ Practical	30	➤ Practical: 70
● Class Participation:	5	Lab record 10
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	10	Viva Voce 20
● Mid-Term Exam:	15	Write-up and execution of the practical 40
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (2023). Vogel's textbook of practical organic chemistry (6th ed.). Pearson Education. 2. Mann, F. G., & Saunders, B. C. (2018). Practical organic chemistry (3rd ed.). Wiley. 3. Harris, D. C., & Lucy, C. A. (2020). Quantitative chemical analysis (10th ed.). W. H. Freeman. 4. Ahluwalia, V. K., & Dhingra, S. (2019). Advanced practical chemistry (2nd ed.). CRC Press. 5. Mohrig, J. R., Hammond, C. N., & Schatz, P. F. (2020). Modern Projects and Experiments in Organic Chemistry (2nd ed.). W.H. Freeman. New York, NY. 6. Doxsee, K. M., & Hutchison, J. E. (2021). Green Organic Chemistry: Strategies, Tools, and Laboratory Experiments (1st ed.). Cengage Learning. Boston, MA. 7. Leonard, J., Lygo, B., & Procter, G. (2019). Advanced Practical Organic Chemistry (3rd ed.). CRC Press. Boca Raton, FL. 8. Harwood, L. M., & Moody, C. J. (2020). Experimental Organic Chemistry (2nd ed.). Oxford University Press. Oxford, UK. 9. Lehman, J. W., & Morrill, T. B. (2021). Techniques in Organic Chemistry (4th ed.). Springer. Chem, Switzerland.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	1	3	3	—	1	2	—
CLO ₂	2	3	2	3	1	3	2	—	1	2	—

CLO ₃	3	2	1	3	2	3	3	1	1	2	1
CLO ₄	2	1	3	1	1	2	1	–	2	3	1

Content Mapping with NEP thrust areas

Field	Content/s	Hours Devoted
Employability/ Entrepreneurship	Isolation and purification of caffeine, curcumin, casein, and lactose; extraction efficiency, purity analysis, yield calculations; analytical techniques applicable to pharmaceutical, food, and herbal industries.	25
Skill Enhancement	Solvent extraction, recrystallization, filtration, SN2 reaction studies, iodometric redox titration, qualitative analysis, calculation of percentage yield and purity, scientific laboratory practices and instrumentation.	45
Communication Development	Preparation of laboratory records, scientific writing of experimental procedures, observations, calculations, results, discussions, and conclusions following standard laboratory report format.	15
Indian Knowledge System	Extraction and analysis of bioactive compounds from traditional Indian natural products such as tea and turmeric; relevance of natural products in Ayurveda and indigenous knowledge.	10
Environmental Awareness	Selection of suitable solvents, solvent polarity, safe chemical handling, laboratory waste management, and sustainable extraction practices.	8
Current Issues and Social Awareness	Quality assessment of commercial vitamin C tablets and fruit juices; importance of food quality, nutritional analysis, and public health awareness.	7
Women empowerment/ Gender issues	Equal participation in laboratory activities, collaborative practical work, and promotion of gender-inclusive scientific education.	3
Public policies	Good Laboratory Practices (GLP), laboratory safety regulations, quality assurance, and standards related to food and pharmaceutical analysis.	4
Any Other	Data interpretation, statistical analysis of experimental results, ethical scientific practices, and teamwork.	3

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory + Practical		
Name of the Course	Skills in Chemistry		
Course Code	26L6.5-CHE-407a		
Course Type	EEC		
Level of the course	500-599		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To know about the Safety aspects of Handling the Chemicals and gases in chemical laboratories & industries. To know how the most commonly used products are manufactured in industries. CLO 2*: To perform entrepreneurship-oriented practicals		
Credits	Theory	Practical	Total
	1	1	2
Teaching Hours per week	1	2	3
Internal Assessment Marks	5	5	10
End Term Exam Marks	20	20	40
Max. Marks	25	25	50
Examination Time	2 hours	2 hours	
Part B- Contents of the Course			
<u>Instructions for Theory Paper-Setter</u>			
The paper setter shall prepare 4 questions from unit 01 with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question comprising 6 short answer type questions carrying one mark each (total 06 marks). The remaining questions will be carrying 07 marks each. Examinees will be required to attempt three questions: the compulsory question no. 1 and 02 questions from other 03 questions.			
<u>Instructions for Practical Examiner</u>			
Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Handling of Chemicals: Safety aspects in chemical laboratories & industries, emergency procedures, safe handling of glassware, Safety in storage and handling of chemicals & precautions. Large scale production, uses, storage & hazards in handling gases like oxygen, nitrogen, dry-ice, hydrogen, acetylene etc. Industrial Product Chemistry Chemistry in manufacture of paper, sugar, fertilizers, daily use products (Soap, detergent, disinfectant, cosmetics etc), distillery.		15 CLO 1

II*	Practicals 1. Extract essential oils from natural sources. 2. Determination of total active content in detergent. 3. Preparation of cosmetic cream or lip balm naturally. 4. To measure the acidity / alkalinity of a soil sample. 5. To estimate total organic content / total organic carbon in soil. 6. To prepare a low-cost adsorbent from organic waste (e.g., orange peel, banana peel, sugarcane bagasse, or sawdust) and evaluate its	30*	
	potential for removing pollutants (like dyes or heavy metals) from aqueous solutions. 7. To construct a simple solar cell using black tea or hibiscus extract as a natural dye, Titanium dioxide (TiO ₂) as a semiconductor, and simple kitchen materials to understand solar energy conversion. Note: Any experiment may be introduced/deleted in the practical class based on the availability / non-availability of the instruments / chemicals.		
Total Contact Hours		45 (15+30*)	
Evaluation Methods			
Internal Assessment:		End Term Examination:	
➤ Theory	5	➤ Theory:	20
● Class Participation:	5	Written Examination:20	
● Seminar/presentation/assignment/quiz/class test etc.:	--		
● Mid-Term Exam:	--		
➤ Practical*	5	➤ Practical*	20
● Class Participation:	NA	Lab record	5
● Seminar/Demonstration/Viva-Voce/Lab Record, etc.:	5	Viva-Voce	5
● Mid-Term Exam:	NA	Write-up and execution of the practical	10
Part C-Learning Resources			
Recommended Books/e-resources/LMS: 1. Chemical Laboratory: Safety and Techniques, Mohamed Elzagheid; Walter de Gruyter GmbH & Co KG. 2. Safety in the Chemical Laboratory and Industry by Muhammad Raza Shah. 3. Surfactants, Disinfectants, Cleaners, Toiletries, Personal Care Products Manufacturing and Formulations by <u>NPCS Board of Consultants & Engineers</u> . 4. Soaps, Detergents and Disinfectants Technology Handbook (3rd Revised Edition) by <u>Ajay Kumar Gupta</u> . 5. Industrial Chemistry, B. K. Sharma.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	1	1	2	1	2	2	3	2	3	2
CLO ₂	2	2	2	3	2	2	3	2	3	2	3

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Safety practices in chemical industries; industrial production of paper, sugar, fertilizers, soaps, detergents, cosmetics and distillery products; preparation of essential oils, cosmetic cream/lip balm; development of low-cost adsorbents and natural dye-sensitized solar cells with entrepreneurial potential.	12
Skill Enhancement	Safe handling of chemicals and laboratory glassware; extraction of essential oils; determination of detergent active content; preparation of cosmetic products; soil analysis; preparation and evaluation of low-cost adsorbents; fabrication of natural dye-based solar cells.	20
Communication Development	Maintenance of laboratory records, presentation of experimental results, teamwork during practicals, scientific reporting and viva-voce.	2
Indian Knowledge System	Extraction of natural essential oils; preparation of herbal cosmetic products and renewable energy applications.	1
Environmental Awareness	Soil acidity/alkalinity and organic carbon analysis; preparation of bio-adsorbents from agricultural waste; wastewater pollutant removal; renewable energy through natural dye-sensitized solar cells; safe disposal of chemicals.	5
Current Issues and Social Awareness	Green chemistry, waste valorization, renewable energy, sustainable consumer products, environmental pollution control, and soil health monitoring.	3
Women empowerment/ Gender issues	No direct content	0
Public policies	Industrial safety regulations, environmental protection, soil health initiatives, waste management, renewable energy promotion, and quality standards for consumer products.	1
Any Other	Laboratory ethics, professional conduct, chemical hygiene, teamwork, and innovation in sustainable product development.	1

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of Course/Course Composition	Theory		
Name of the Course	Computational Chemistry		
Course Code	26L6.5-CHE-407b		
Course Type	EEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1 : Explain the fundamental principles of computational chemistry, including the Born–Oppenheimer approximation, Hartree–Fock theory, semi-empirical methods, and Density Functional Theory (DFT), and evaluate their applications in molecular structure and electronic property calculations. CLO 2 : Apply appropriate basis sets and potential energy surface concepts to perform molecular modeling studies, including geometry optimization, single-point energy calculations, transition state identification, and reaction pathway analysis of polyatomic molecules.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	2 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 5 questions selecting two questions from each of the two units with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question comprising 07 short answer type questions carrying one mark each (total 07 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt three questions: the compulsory question no. 1 and 1 question from the each of the two units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	INTRODUCTION TO COMPUTATIONAL CHEMISTRY Scope of computational chemistry, Born-Oppenheimer approximation, Hartree-Fock theory, restricted HF calculations; open shell systems, ROHF and UHF calculations, HF limit and electron correlation, semi empirical methods. DENSITY FUNCTIONAL THEORY Electron density, exchange-correlation functional, local Density		10 CLO 1

	approximation, generalized gradient approximation, hybrid density functional methods, self-Interaction corrections.	
II	BASIS SETS Definition of basis sets, Slater and Gaussian type orbitals, minimal, double-zeta, split-valence, core valence, Pople style basis Sets, polarization and diffuse functions, determination of basis functions, pseudopotentials or effective core potentials, choice of basis bets. BASIC CONCEPTS OF POTENTIAL ENERGY SURFACES Z-matrix construction, Stationary Points, geometry optimization, local and global minima, and transition state theory. Computations of single point energy, optimizations and transition states of polyatomic molecules, intrinsic reaction coordinate analysis.	20 CLO 2
Total Contact Hours		30
Evaluation Methods		
Internal Assessment: 15		End Term Examination: 35
• Class Participation:	05	Written Examination:35
• Seminar/presentation/assignment/quiz/class test etc.:	05	
• Mid-Term Exam:	05	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. J. B. Foresman and A. Frisch, Exploring Chemistry with Electronic Structure Methods, 2ndEdition.Gaussian Inc., 2015.		
2. F. Jensen, Introduction to Computational Chemistry, John Wiley & Sons, 2007		
3. C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2ndEdition.John Wiley & Sons Ltd, 2004.		
4. C. J. Cramer, Essentials of Computational Chemistry: Theories and Models, 2ndEdition.John Wiley & Sons Ltd, 2002.		
5. D. A. McQuarrie, Physical Chemistry: A molecular Approach, 1stEdition.University Science Books, 1997.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	-	2	2	1	2	1	-
CLO ₂	3	3	1	3	1	3	3	1	2	1	2

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Applications of computational chemistry in molecular modelling, drug design, materials science, catalysis, and chemical industries.	6
Skill Enhancement	Hartree-Fock theory, Density Functional Theory (DFT), basis sets, potential energy surfaces, geometry optimization, transition state calculations, and computational analysis of molecular systems.	12

Communication Development	Scientific interpretation, presentation, and reporting of computational results using appropriate chemical terminology and visualization tools.	2
Indian Knowledge System	Computational studies of naturally occurring molecules and bioactive compounds of Indian origin.	1
Environmental Awareness	Green computational approaches that reduce chemical usage, laboratory waste, and energy consumption through predictive modelling.	2
Current Issues and Social Awareness	Applications of computational chemistry in sustainable development, renewable energy materials, environmental chemistry, and modern drug discovery.	2
Women empowerment/ Gender issues	Promotion of equal participation and opportunities in computational science and interdisciplinary research.	1
Public policies	Role of computational chemistry in supporting national initiatives on digital research, innovation, and scientific advancement.	2
Any Other	Research ethics, responsible use of computational software, and data integrity in scientific investigations.	2

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Applied Chemistry		
Course Code	26L6.5-CHE-307a		
Course Type	OEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Explain the principles of water treatment and conditioning processes, and apply methods for the determination and control of water quality parameters such as hardness and alkalinity for domestic and industrial applications. CLO 2: Analyze the mechanisms of corrosion and protective coating techniques, and evaluate the manufacturing processes, properties, and applications of Portland cement and refractory materials in engineering and industrial systems.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	2 hours		
Part B- Contents of the Course			
<u>Instructions for Paper- Setter:</u> The paper setter shall prepare 5 questions selecting two questions from each of the two units with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question comprising 07 short answer type questions carrying one mark each (total 07 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt three questions: the compulsory question no. 1 and 1 question from the each of the two units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	Technology of water: Standards for drinking water, Methods of Treatment of water for domestic and industrial purposes: Sedimentation, Coagulation, Filtration, Sterilization, Break point chlorination. Determination of alkalinity of water, Hardness of water: Units, determination. Demineralization of water. Softening of water: Lime-soda Process, Ion exchange process, Zeolite process. Internal treatment of water: Carbonate conditioning, Phosphate conditioning, Colloidal conditioning, Calgon conditioning. Determination of alkalinity and hardness of water.		10 CLO 1
II	Corrosion and Protective Coatings: Corrosion and its Control: Nernst Theory, Standard Electrode Potential, Galvanic Series, Concentration cell, Types of corrosion: Uniform and		20 CLO 2

	Galvanic, Erosion, Crevice, Pitting, Exfoliation and Selective leaching, Inter-angular Stress, Waterline, Soil, Microbiological. Theories of corrosion: Acid, Direct Chemical attack, Electrochemical, Corrosion reactions, Factors affecting corrosion, Protective measures against corrosion, Sacrificial anode, Impressed current cathode protection. Protective Coatings: Paints: Constituents, functions & mechanism of drying. Varnishes and Lacquers; surface preparation for metallic coatings, electroplating (gold) and electrodeless plating (Nickel), anodizing, phosphate coating, powder coating & antifouling coating. Portland Cement & Refractories: Portland Cement: Manufacture of cement, Dry and Wet process, Important process parameters for manufacturing a good cement clinker. Characteristics of the constitutional compounds of cement. Additives for cement, Properties, General composition, Testing of cement, Chemical & physical requirement. Refractories: Definition, Classification with Examples; Criteria of a Good Refractory Material; Causes for the failure of a Refractory Material.	
Total Contact Hours		30
Evaluation Methods		
Internal Assessment: 15		End Term Examination: 35
● Class Participation:	05	Written Examination:35
● Seminar/presentation/assignment/quiz/class test etc.:	05	
● Mid-Term Exam:	05	
Part C-Learning Resources		
Recommended Books/e-resources/LMS:		
1. A text book of Engineering Chemistry by S. S. Dara, S. Chand & Co. New Delhi.		
2. Engineering Chemistry by M. M. Uppal & S.C. Bhatia, Khanna Publishers. New Delhi.		
3. Chemistry of Engineering Materials by C.P. Murthy, C. V. Agarwal and A. Naidu B. S. Publication Hyderabad		
4. Engineering Chemistry by J. C. Kuriacose and J. Rajaram, Tata McGraw-Hill Co. New-Delhi.		

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	3	-	2	2	2	2	1	1
CLO ₂	3	2	1	3	1	3	2	2	2	1	2

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Water treatment technologies, corrosion control, protective coatings, cement manufacturing, and refractory materials with applications in water treatment plants, construction, chemical, and metallurgical industries.	8
Skill Enhancement	Determination of water hardness and alkalinity; understanding water softening methods, corrosion mechanisms, protective coatings, cement manufacturing, and refractory selection for industrial applications.	10

Communication Development	Interpretation of water quality data, corrosion studies, technical report writing, and presentation of industrial processes.	2
Indian Knowledge System	Sustainable water conservation and traditional practices of water management integrated with modern treatment technologies.	1
Environmental Awareness	Drinking water standards, wastewater treatment, corrosion prevention for resource conservation, eco-friendly coatings, and sustainable use of construction materials.	4
Current Issues and Social Awareness	Safe drinking water, infrastructure durability, environmental pollution due to corrosion, sustainable construction materials, and industrial waste management.	2
Women empowerment/ Gender issues	No direct content	0
Public policies	Drinking water quality standards, environmental regulations, corrosion control in public infrastructure, and quality standards for cement and construction materials.	2
Any Other	Industrial safety, professional ethics, quality assurance, and sustainable engineering practices.	1

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	III		
Nature of Course/Course Composition	Theory		
Name of the Course	Introduction to Nanomaterials		
Course Code	26L6.5-CHE-307b		
Course Type	OEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Explain the fundamental concepts, classification, properties, and synthesis approaches of nanomaterials, and compare various top-down and bottom-up techniques used for the preparation of nanoparticles and nanocomposites. CLO 2: Apply characterization techniques for nanomaterials and analyze the structure, properties, synthesis, and applications of one-dimensional nanostructures such as nanotubes, nanorods, nanoplates, graphene, and carbon nanotubes.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	2 hours		
Part B- Contents of the Course			
Instructions for Paper- Setter: The paper setter shall prepare 5 questions selecting two questions from each of the two units with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory question comprising 07 short answer type questions carrying one mark each (total 07 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt three questions: the compulsory question no. 1 and 1 question from the each of the two units.			
Unit	Topics		Contact Hours/ CLO Attempt
I	INTRODUCTION: An Introduction to Nanomaterials with Historical Perspectives. Nanomaterials and Nanocomposites. Elementary Consequences of Small Particle Size - Surface of Nanoparticles. Classification of nanomaterials - zero dimensional (0D), one dimensional (1D) and two dimensional (2D) nanomaterials. SYNTHESIS OF NANOMATERIALS: Top-Down and Bottom-Up Approach of Synthesis of Nanomaterials. Gas-Phase Synthesis of Nanoparticles - Physical and Chemical Vapor Synthesis Processes. Radio- and Microwave Plasma Processes. Flame Aerosol Process. Synthesis of Coated Particles.		15 CLO 1
II	CHARACTERIZATION OF NANOMATERIALS: Characterization of Nanomaterials: Global Methods for Characterization, X-Ray and		15 CLO 2

Electron Diffraction, Electron Microscopy, Scanning Transmission Electron Microscopy. NANOTUBES, NANORODS, AND NANOPATES: Introduction of Nanotubes, Nanorods, and Nanoplates, One-Dimensional Crystals, Carbon Nanotubes and Graphene, Nanotubes and Nanorods from Materials other than Carbon, Synthesis of Nanotubes and Nanorods.			
Total Contact Hours			30
Suggested Evaluation Methods			
Internal Assessment: 15		End Term Examination: 35	
➤ Theory	15	➤ Theory:	35
● Class Participation:	05	Written Examination:35	
●Seminar/presentation/assignment/quiz/class test etc.:	05		
● Mid-Term Exam:	05		
Part C-Learning Resources			
Recommended Books/e-resources/LMS:			
1.D. Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Edition. Wiley-VCH, 2013.			
2.D. C. Agarwal, Introduction to Nanoscience and Nanomaterials. World Scientific, 2013.			

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	3	2	1	2	—	2	2	1	2	1	1
CLO ₂	3	3	1	3	1	3	3	1	2	1	2

Content Mapping with NEP thrust areas

Field	Content	Hours Devoted
Employability/ Entrepreneurship	Applications of nanomaterials and nanocomposites in electronics, healthcare, energy, environmental remediation, and advanced manufacturing; synthesis techniques relevant to research and industry.	7
Skill Enhancement	Classification, synthesis (Top-Down and Bottom-Up), characterization techniques (XRD, Electron Microscopy, STEM), and synthesis of nanotubes, nanorods, nanoplates, graphene, and related nanostructures.	10
Communication Development	Scientific interpretation of characterization data, technical presentations, and preparation of reports on nanomaterials and their applications.	2
Indian Knowledge System	Emerging applications of nanotechnology in traditional medicines, agriculture, water purification, and indigenous materials research.	1
Environmental Awareness	Green synthesis of nanomaterials, environmental applications of nanotechnology, sustainable nanomaterials, and pollution remediation.	3
Current Issues and Social Awareness	Role of nanotechnology in renewable energy, healthcare, clean water, sustainable development, and emerging technologies.	2
Women empowerment/ Gender issues	Promotion of equal participation and opportunities in nanoscience and interdisciplinary research.	1

Public policies	National nanotechnology initiatives, research and innovation policies, and regulations related to the safe use of nanomaterials.	2
Any Other	Research ethics, laboratory safety, and responsible development and application of nanotechnology.	2

Session: 2025-26			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	IV		
Nature of the Course	Dissertation Work or Project Work		
Name of the Course	Dissertation Work or Project Work		
Course Code	26L6.5-CHE-409		
Course Type	Dissertation Work or Project Work		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG Level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: Improved skills to design, perform, report and present research outcomes. CLO2: Improved skills in writing the research outcomes in the form of thesis dissertation. CLO3: Acquiring skills to work independently as well as in group in order to solve are search based problem.		
Credits	Theory	Practical	Total
	12	0	12
Max. Marks	300 300 (Report of dissertation- 200 marks + Open Viva Voce- 100	0	300
(as per university rules) The total number of students' projects offered will be one per faculty member in accordance with the ordinance, and allotment will be made on the basis of merit cum preference of the students. Students opting for the project will be exempted from the corresponding theory course. The work can be carried out in any thrust area of _____ under the guidance of the allotted supervisor of the department. The students must submit their project report to the department as per the date announced for the submission. External assessment of the project work will be carried out by an external examiner nominated by the Vice-Chancellor from a panel approved by the Board of Studies. - Field Project /Research Project/Master's Dissertation will contain a cover page, a certificate signed by the student and supervisor, a table of contents, an introduction, Objectives, Literature review, methodology, results and discussion conclusion, and references. ✓ The paper size to be used should be A-4 size. ✓ The font size should be 12 with Times New Roman. ✓ The text of the report may be typed in 1.5 (one and a half) space. ✓ The printout of the report shall be done on both sides of the paper (instead of ✓ single-side printing) ✓ The total no. of written pages should be between 80 to 100 for the report. - The candidate shall be required to submit two soft-bound copies of the report along with a CD/ email			

in the department as per the date announced. It must be submitted with a plagiarism report in accordance with the rules of the University/UGC.

3. The candidate will defend her/his project work through presentation and viva voce examination before the External examiner at the end of the semester and will be awarded marks. The dissertation/project work will be evaluated as per university rules/policy/guidelines.

In case, a student is not able to score passing marks in the research project exam, he/she will have to resubmit her/his report after making all corrections/improvements & this report shall be evaluated as above. The candidate is required to submit the corrected copy of the report in hardbound within one month after the viva-voce. In case of any confusion regarding rules and its interpretation, the rules of examination branch will be final and applicable.

FORMAT OF DISSERTATION/PROJECT WORK

- General Introduction to the Study and Theoretical Framework
- Review of Literature
- Research Gap
- Statement of the problem
- Significance of the Study
- Formulation of Research Questions /Issues
- Research objectives
- Hypotheses
- Data source (Primary/Secondary)
- Methodology
- Analysis of Data
- Discussion of the Results
- Major findings, Summary, Recommendations (if any) and Conclusion
- Bibliography /References &Webliography
- Appendices

Mapping of Course Learning Outcomes (CLOs) to Program Outcomes & Program Specific Outcomes

CLOs	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁
CLO ₁	2	3	3	2	2	3	2	1	2	2	2
CLO ₂	2	3	3	1	1	3	2	1	2	3	1
CLO ₃	1	3	2	3	3	3	2	2	2	2	2