Sardar Patel University
Vallabh Vidyanagar
NAAC 'A' Grade (10-01-2023 To 09-01-2028)
NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Chemistry Semester I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S01NCCHE01**	Inorganic Chemistry-I	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Explain and correlate the role of metal ions in biological systems, including structure–function relationships of metalloproteins, heme proteins, and metalloenzymes.

CLO2: Analyze and evaluate biochemical processes involving metal centers such as electron transfer, nitrogen fixation, and enzyme catalysis, along with the role of Vitamin B□□ and coenzymes.

CLO3: Assess and justify the application of metal complexes in medicine and toxicology, including anticancer drugs (cisplatin and analogs), mechanisms of metal toxicity, and chelation therapy.

CLO4: Apply and interpret advanced concepts of coordination chemistry, including CFT/LFT, orbital splitting, term symbols, correlation diagrams, and Tanabe–Sugano diagrams for predicting properties of complexes.

CLO5: Examine and differentiate magnetic properties of coordination compounds, including paramagnetism, ferromagnetism, antiferromagnetism, and spin crossover phenomena using theoretical models.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Traditional Inorganic Medicinal Chemistry and Bio-Inorganic Chemistry-I** Traditional Inorganic Medicinal Chemistry: metal-based medicines (mercury, gold, silver), their preparation methods, and mode of action. Bio-Inorganic Chemistry-I: The biological roles of metal ions, Structure of heme, Photosystem-II, Hemoglobin and Myoglobin, Cytochromes of the electron transport chain, Cytochrome P-450, Methane monooxygenase, Cytochrome C oxidase, Iron-sulfur proteins (Rubredoxin, [2Fe-2S] and [4Fe-4S]), Bohr effect	Classroom Lectures Seminars Problem-Based Learning Self-Directed Learning ICT-Enabled Learning (Digital Resources)	CLO1, CLO2

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II	**Bio-Inorganic Chemistry-II** Carbonic anhydrase, Carboxy peptidase, Superoxide dismutase, Vitamin B12, Coenzyme B12, Roles of Vitamin B12, Anti-cancer drugs; cisplatin and its mechanism of action, the analogues of cisplatin, Metal Toxicity & chelation: Toxic metals: Hg^{2+} , Pb^{2+} , Cd^{2+} , As^{3+} , Mechanism of toxicity (binding to –SH groups), Chelating agents (EDTA, BAL, penicillamine).	Classroom Lectures Seminars Problem-Based Learning Self-Directed Learning ICT-Enabled Learning (Digital Resources)	CLO2, CLO3
III	**Coordination Chemistry, and Coordination Chemistry in Traditional Systems** Concept of crystal field theory (CFT) and ligand field theory (LFT), Splitting of d-orbitals in various stereochemistry, Tetragonal elongation and compression in octahedral complexes, Nephelauxetic series, derivation of terms for closed subshell, derivation of terms for f2 configurations, Correlation diagrams for octahedral and tetrahedral stereochemistry of d1, d2, d8, and d9 systems. Tanabe-Sugano diagram for octahedral and tetrahedral stereochemistry of d1 , d2 , d8 and d9 systems, Determination of Crystal Field Splitting Energy Coordination Chemistry in Traditional Systems: Metal-ligand interactions in Ayurvedic formulations, Stability and chelation, Comparison with modern coordination chemistry.	Classroom Lectures Seminars Problem-Based Learning Self-Directed Learning ICT-Enabled Learning (Digital Resources)	CLO4
IV	**Magneto Chemistry** Magnetic susceptibility: Sources of paramagnetism, diamagnetic susceptibility, antiferromagnetism, Types of antiferromagnetism, antiferromagnetic exchange pathways, Ferromagnetism and magnetic domains, molecular field theory of ferromagnetism, magnetic sublattice, ferrimagnetism and canting, Spin pairing: spin pairing in octahedral complexes; spin pairing in non-octahedral complexes; some aspects of spin pairing and crossover region	Classroom Lectures, Seminars, Problem-Based Learning, Self-Directed Learning ICT-Enabled Learning (Digital Resources)	CLO5

(A) Assessment Methodologies/Tools

(A) Internal Assessment

(a) Formative assessment (30 Marks)

- Quiz
- Assignment, Self-learning, and Term work
- Seminar/Presentation
- Regularity

(b) Summative Assessment (20 Marks)

- Mid Term Examination: 20 Marks

(B) External Assessment

- Term End Examination: 50 Marks

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyze & above (A)	
I	CLO1 CLO2	30	1	1	11	13
II	CLO2 CLO3	32	0	1	11	12
III	CLO4	28	0	1	11	12
IV	CLO5	30	1	1	11	13
		120	**02**	**04**	**44**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

(B) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO 1	3	2	2	3	3	1	-	3	2	1
CLO 2	3	2	2	3	3	1	-	3	2	1
CLO 3	3	2	2	3	3	1	-	3	2	1
CLO 4	3	1	3	1	-	-	-	2	1	2
CLO 5	3	2	1	-	1	-	-	1	1	1

Values to the CLO-PLO matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Metal Ions in Biochemistry	P. K. Bhattacharya, P. B. Samnani	2nd edition, 2020	Taylor & Francis
2	Inorganic Chemistry	Shriver and Atkins	5th edition, 2010	New York : W. H. Freeman and Co.

3	Concise Inorganic Chemistry	J.D. Lee	5th edition, 1996	Blackwell Science Ltd.
4	Electronic absorption spectroscopy and related techniques	D.N. Sathyanarayana	2001	Universities Press
5	Introduction to ligand fields	B.N. Figgis	1967	Krieger Pub Co
6	Introduction to Magnetochemistry	Alan Earshaw	1968	Elsevier
7	Elements of Magnetochemistry	Dutta and Syamal	2nd edition, 2004	Affiliated East-West Press Pvt Ltd, New Delhi
8	Advanced Inorganic Chemistry	F.A. Cotton, Wilkinson, Murillo and Bochmann	3rd edition, 1999	Interscience Publishers, New York
9	Inorganic Chemistry	James E. Huheey, Eilen A. Keiter, Richard L. Keiter	4th edition, 1993	Harper Collins College Publishers
10	A History of Hindu Chemistry: from the Earliest Times to the Middle of the Sixteenth Century A.D.	Prafulla Chandra Ray	Volume I: 1902 Volume II: 1909	Williams and Norgate, London & Chuckervertty, Chatterjee & Co., Ltd., Calcutta
11	Rasaratna Samucchaya of Vagbhattacharya (Hindi)	Indra Dev Tripathi		Chaukhambhas Sanskrit Sansthan

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Chemistry in India, by B. N. Sharma, Source: Academia.edu	https://www.academia.edu/49089007/Chemistry_in_India

M.Sc. Chemistry Semester I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S01NCCHE02**	Organic Chemistry-I	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Evaluate and design reaction mechanisms for elimination, addition, and substitution reactions using experimental evidence, mechanistic tools, and scientific reasoning.

CLO2: Illustrate fundamental concepts of organic chemistry from an Indian Knowledge Systems perspective and interpret elimination, addition and aromatic substitution reactions, including their mechanisms, orientation, and reactivity patterns, using suitable chemical representations and reasoning skills.

CLO3: Justify principles of reactive intermediates and named rearrangement reactions to predict reaction pathways, mechanisms, and products in diverse chemical contexts.

CLO4: Demonstrate a comprehensive understanding of stereochemistry, including chirality, stereoisomerism, and projection systems, and interpret molecular structures using established nomenclature and symmetry principles.

CLO5: Evaluate stereochemical and mechanistic aspects of organic reactions, including stereoselectivity, stereospecificity, topicity, and prostereoisomerism, to draw logical and evidence-based conclusions.

Unit	Course Content	Learning Pedagogies	CLO(s)
I	**Fundamental Concepts of Organic Chemistry** Organic Chemistry Concepts with an Indian Knowledge Systems Perspective. Aromatic substitution reactions (Electrophilic and Nucleophilic): Mono-substituted benzenes - Reactivity and Orientations, Orientation in Benzene Rings with more than One Substituent, ipso substitution, Orientation in Other Ring Systems, Primary Kinetic Isotope Effect and Mechanisms of Friedel-Crafts reactions, Nitration, Sulphonation, Halogenation, Diazocoupling and Formylation. Benzyne Mechanisms for Aromatic Nucleophilic Substitution Reactions. Addition – Elimination mechanism.	Interactive Lectures, Problem-Based Learning, ICT-Enabled Learning, Micro-Projects	CLO1, CLO2

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II	**Reactive Intermediates in Molecular Rearrangements:** 1 Molecular Rearrangement involving Non-Classical Carbocation:Neighbouring group participation by π(pi) and σ(sigma) bonds. 2.2 Molecular Rearrangement involving Carbocation: Wagner-Meerwein, Pinacol-Pinacolone, Demjanov, and Beckmann Rearrangement. 2.3 Molecular Rearrangement involving Carbanion: Baker Venkataraman, Favorskii, Benzil-Benzilic Acid, Stevens, and Sommelet-Hauser Rearrangement. 2.4 Molecular Rearrangement involving Free Radical: Barton and Fries Rearrangement 2.5 Molecular Rearrangement involving Nitrene: Curtius, Schmidt, Lossen and Hoffmann Rearrangement 2.6 Molecular Rearrangement involving Carbene: Riemer-Tiemann and Wolf Rearrangement [Emphasizing Various Techniques for Determination of Mechanism]	Interactive Lectures, Tutorial, Industrial Visit, Experiential Learning	CLO3
III	**Elimination and Addition Reactions:** 3.1 Elimination Reactions: Mechanisms and Orientation, E1, E1cb, E2, Ei spectrum, Effects of changes in substrate, Base, leaving group, and medium on reactivity, Hoffman and Saytzef eliminations, Bredt's rule, Pyrolytic eliminations- Cope and Chugaev eliminations. 3.2 Addition reactions: Mechanisms, Orientation and Reactivity, Markonikoff and anti-Markonikoff additions, Reactions including Hydro-Halo, Hydro-Hydroxy, Hydro-Alkoxy, Dihydro, Dihydroxy, dihalo, ozonolysis, Woodward-Prevost hydroxylation.	Interactive Lectures, Collaborative Learning, Experiential Learning	CLO2
IV	**Stereochemistry:** Concept of Chirality, Chirality and symmetry, Sawhorse, Newman and Fischer Projections, Interconversion of projection formula, Elements of chirality including chiral centre, Chiral axis, Chiral plane and Helicity, Geometrical isomerism, CIP Nomenclature, Molecules with more than one chiral centre, Total number of stereoisomer in such molecules, Enantiomeric and diastereomeric relationship, Chirogenicity and Stereogenecity, Pseudochirality, Topicity and Prostereoisomerism, Determination of Topic relationship between homomorphic ligands in intact molecules, Concept of stereoselective and stereospecific reactions, Optical purity with examples.	Interactive Lectures, Problem-Based Learning	CLO4 CLO5

- **Weightage of Learning Efforts for Assessment**

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	CLO1, CLO2	32	1	1	11	13
II	CLO3	32	1	1	11	13
III	CLO2	28	0	1	11	12
IV	CLO4, CLO5	28	0	1	11	12
		120	02	04	44	50

- **Assessment Methodologies/Tools**

(A) Internal Assessment

(a) Formative assessment (30 Marks)

- Quiz
- Assignment, Self-learning, and Term work
- Seminar/Presentation
- Regularity

(b) Summative Assessment (20 Marks)

- Mid Term Examination: 20 Marks

(B) External Assessment

- Term End Examination: 50 Marks

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

- **CLOs – PLOs Matrix**

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	3	3	1	1	1	1	3	1	1
CLO2	3	2	3	3	1	1	2	3	1	1
CLO3	3	2	3	1	-	1	-	3	1	1
CLO4	3	-	3	1	-	1	-	2	1	1
CLO5	3	1	3	1	-	1	-	3	1	1

Values to the CLO-PLO matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Organic Reactions, Stereochemistry and Mechanism	P. S. Kalsi	3rd Revised Ed., 2017	New Age International
2	Principles of Organic Synthesis	R. O. C. Norman & J. M. Coxon	3rd Ed., 1993	Nelson Thornes / ELBS
3	A Guidebook to Mechanism in Organic Chemistry	Peter Sykes	6th Ed., 1999	Pearson / Orient Longman
4	Modern Methods of Organic Synthesis	W. Carruthers & Iain Coldham	4th Ed., 2004	Cambridge University Press
5	Organic Reaction Mechanisms	V. K. Ahluwalia & R. K. Parashar	4th Ed., 2010	Narosa Publishing House
6	Organic Chemistry	Jonathan Clayden, Nick Greeves & Stuart Warren	2nd Ed., 2012	Oxford University Press
7	March's Advanced Organic Chemistry	Jerry March (rev. by M. B. Smith)	6th Ed., 2007	Wiley

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	MIT OpenCourseWare – Organic Chemistry (Lecture notes, assignments, and exams covering stereochemistry and reaction mechanisms)	https://ocw.mit.edu/courses/5-13-organic-chemistry-ii-fall-2003/
2	LibreTexts – Open-access Organic Chemistry textbook (Chirality, stereochemistry, elimination, addition, aromatic substitution)	https://chem.libretexts.org/Bookshelves/Organic_Chemistry
3	Master Organic Chemistry – Reaction mechanism guide (Detailed explanation of E1, E2, addition, and aromatic substitution reactions)	https://www.masterorganicchemistry.com/reaction-guide/

M.Sc. Chemistry Semester I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S01NCCHE03**	Physical Chemistry - I	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Analyze and evaluate thermodynamic principles, Gibbs free energy, entropy, chemical potential, and chemical kinetics principles, including rate laws and factors influencing reaction rates.

CLO2: Relate chemical kinetics to industrial processes and environmental systems reactions.

CLO3: Analyze kinetic data using graphs e.g., concentration vs time.

CLO4: Solve problems using integrated rate laws for different reaction orders.

CLO5: Demonstrate and apply electrochemistry of solutions and electrified interfaces; analyze interface structures and evaluate electrochemical kinetics.

CLO6: Illustrate and apply surface chemistry concepts, including micellar systems, surfactant behavior, and surface phenomena; analyze their thermodynamics and interactions.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Chemical Thermodynamics: Thermodynamic Potentials: concepts of laws of thermodynamics, Energy, Entropy, Free energies, Applications of Thermodynamics: Free energy, chemical potential. Partial molar properties: partial molar free energy, partial molar volume, and partial molar heat content, and their significance. Determinations of these quantities. Concept of fugacity and determination of fugacity, Non-ideal systems: Excess functions for non-ideal solutions, Activity, activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength. **Heat and Energy in Vedic Traditions, Concepts of energy balance in ayurveda, Second Law of Thermodynamics, and Natural Processes**	Classroom Lecture(CL), ICT-Enabled Learning(ICT) Problem-Based Learning (PBL), Seminar(S)	CLO1 CLO2
II	Chemical Kinetics: Fundamentals of Chemical Kinetics, Arrhenius equation, concept of activation energy, reaction mechanisms and examples; unimolecular reactions, bi-molecular reactions, trimolecular reactions, polymerization reactions.	Classroom Lecture, ICT-Enabled Learning,	CLO3 CLO4

	Kinetics of Complex reactions:- Opposing reactions, Consecutive reactions, Parallel reactions, Reactions in flow systems, Chain reactions, Ionic reactions and salt effect, enzyme-catalyzed reactions, kinetics of fast reactions, Kinetically and thermodynamically controlled products. **Fermentation techniques in ancient India: The Importance of Reaction Rates in Ayurvedic Preparations**	Problem-Based Learning, Seminar	
III	Electrochemistry: Electrochemistry of solutions, Debye-Hückel-Onsager treatment and its extension, ion solvent interactions, Thermodynamics of electrified interface equation, Derivation of electro-capillary, Lippmann equations (surface excess), Structure of electrified interfaces, Perrin, Guoy-Chapman and Stern models, Over potentials, exchange current density, derivation of Butler-Volmer equation, Tafel plot. **Ancient Electrochemical Cells (Agastya Samhita), Corrosion Resistance in Ancient Metallurgy, Electroplating-like Techniques in Ancient India**	Classroom Lecture, ICT-Enabled Learning, Problem-Based Learning, Seminar	CLO5
IV	Surface Chemistry: Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Surface active agents, classification of surface active agents, micellization, critical micellar concentration (CMC), methods of determination of CMC, factors affecting the CMC of surfactants, reverse micelles, thermodynamics of micellization - phase separation and mass action models, emulsions, micro-emulsion, micellar catalysis An ancient process for water purification. **Adsorption in Medicinal Clay and Ash (Bhasma), Ancient polishing of metals, stones, and sculptures**	Classroom Lecture, ICT-Enabled Learning, Problem-Based Learning, Seminar	CLO6

(A) Assessment Methodologies/Tools

(A) Internal Assessment

(a) Formative assessment (30 Marks)

(a) Quiz
(b) Assignment, Self-learning, and Term work
(c) Seminar/Presentation
(d) Regularity

(b) Summative Assessment (20 Marks)

- Mid Term Examination: 20 Marks

(B) External Assessment

- Term End Examination: Marks 50

M.Sc. Chemistry Semester I

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyze & above (A)	
I	CLO1	30	3	7	4	14
II	CLO2, CLO3, CLO4	32	3	3	4	10
III	CLO5	28	2	7	3	12
IV	CLO6	30	2	8	4	14
		120	**10**	**25**	**15**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity, written Internal Exam	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

(B) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**2**
CLO2	**3**	**3**	**2**	**1**	**2**	**1**	**2**	**2**	**1**	**1**
CLO3	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**
CLO4	**2**	**2**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**2**
CLO5	**3**	**2**	**3**	**2**	**1**	**1**	**1**	**1**	**3**	**3**
CLO6	**2**	**3**	**2**	**2**	**1**	**2**	**2**	**3**	**1**	**2**

Values to the **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Physical Chemistry	P. Atkins and J. de Paula, Atkins	8th edition, 2006.	Oxford University Press,
2	Physical Chemistry	I. N. Levine	5th edition, 2002	Tata McGraw-Hill, New Delhi
3	Physical Chemistry - a molecular approach	D. A. McQuarrie and J.D. Simon	1998	Viva Books Pvt. Ltd.
4.	An Introduction to Chemical Thermodynamics	R. P. Rastogi and P. R. Misra	1995	Vikas Publishing House Pvt.Ltd.
5.	Thermodynamics	P. C. Rakshit	1983	The New Book Stall, Calcutta
6.	Thermodynamics for Chemists	S. Glasstone	2006 (Digital)	East-West Edition, Third Edition
7.	Chemical Kinetics	K. J. Laidler	1987	McGraw-Hill Publisher
8.	Modern Electrochemistry, Vol. I and Vol. II	J. O. M. Bockris and A. K. N. Reddy	1998	Plenum press
9.	Surfactants and Interfacial Phenomena	Milton J. Rosen	2004	Wiley Interscience, Third Edition
10.	Colloid and Interface Science	Pallab Ghosh	2009	PHI Learning Private Limited

M.Sc. Chemistry Semester I

*** The latest edition of the textbooks should be used**

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Web link
1	**Video lectures.**	**www.swayam.gov.in,**
2	**Specially prepared reading material that**	**www.epgp.inflibnet.ac.in,**
3	**can be downloaded/printed.**	**www.ndl.iitkgp.ac.in,**
4	**Self-assessment tests through tests and quizzes.** **An online discussion forum for clearing doubts**	**www.nptel.ac.in**

M.Sc. Chemistry Semester I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
SKILL	**P2S01NSCHE01**	Polymer Chemistry	2-0-0	**60**	02

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Explain fundamental concepts of polymer science and structure–property relationships

CLO2: Apply molecular weight concepts and relevant working equations for polymer characterization

CLO3: Analyze mechanisms and factors affecting different types of polymerization

CLO4: Evaluate polymer solubility behavior and the role of additives in modifying properties

CLO5: Design suitable polymer processing and compounding strategies for specific industrial Applications

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Fundamentals of Polymer Science: Molecular Weight and Polymerization** Historical development in polymeric materials, Basic concepts: Oligomer, Monomer, Polymer, Polymerization and Functionality, Repeating Unit, Degree of Polymerization, Bonding in Polymers, Notation and Nomenclature of Polymers, Classification of Polymers, Glass Transition Temperature (Tg) and Factors Influencing the Glass Transition Temperature, Structure–property relationships, Molecular Weight Concepts, Molar Mass and Molecular Weight Distribution, Calculation of Molecular Weights, Practical Significance of Molecular Weight, Methods of molecular weight determination: End group analysis, osmometry, viscosity method, light scattering and Gel Permeation Chromatography (GPC) (principles along with relevant working equations for molecular weight determination, without detailed derivations), Free Radical Polymerization (Mechanism: initiation, propagation, termination; Basic kinetics (introductory), Factors affecting polymerization: Temperature, initiator concentration,	Classroom Lecture**,** Problem-Based Learning, Case-Based Learning, Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises), ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)	**CLO 1-CLO5**

	monomer concentration, pressure and Concept of equilibrium), Ionic Polymerization (General features, Cationic and anionic mechanisms and Living polymers), Coordination Polymerization (Ziegler–Natta catalysis (basic concept), Copolymerization (Types: random, alternating, block, graft, Reactivity ratio and Industrial significance), Step-growth polymerization (basic mechanism and conceptual understanding of polyesterification)		
II	**Polymer Solubility, Additives, Processing, and Compounding** Polymer solubility and solutions: Introduction, General rules for polymer solubility, Thermodynamic basis of Polymer Solubility, Prediction of Solubility, Examples based on the calculation of the solubility parameter for solvent & polymer. Additives for Polymers title for this course: Polymer Solubility, Solutions, and Polymer Additives and their applications, Introduction to polymer processing, Classification of polymer processing, Rheological states of polymers, Mixing and compounding of polymers, Important factors of feedstock, Blenders and mixers for polymer processing	Classroom Lecture, Problem-Based Learning, Case-Based Learning, Collaborative Learning, Self-Directed Learning (Guided Readings, Concept Exploration Tasks), ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)	**CLO1-5**

(A) Assessment Methodologies/Tools

(A) Internal Assessment

(a) Formative assessment (15 Marks)

- Quiz
- Assignment, Self-learning, and Term work
- Seminar/Presentation
- Regularity

(b) Summative Assessment (10 Marks)

- Mid Term Examination: 10 Marks

(B) External Assessment

- Term End Examination: Marks:25 Marks

M.Sc. Chemistry Semester I

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyze & above (A)	
I	**CO1.1 CO1.2,CO1.3, CO1.4, CO1.5**	30	**5**	**10**	**10**	25
II	**CO2.1, CO2.2, CO2.3, CO2.4, CO2.5**	30	**4**	**9**	**12**	25
		60	**9**	**19**	**22**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

(B) CLOs – PLOs Matrix

CLO	PLO/PSO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PSO1**	**PSO2**
CLO1	3	3	2	2	2	2	2	2	2	2
CLO2	3	2	3	2	2	2	2	2	3	2
CLO3	2	3	2	2	3	2	2	2	3	3
CLO4	3	2	3	2	3	2	3	2	3	2
CLO5	3	3	3	3	3	2	3	2	2	3

Values to the **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Principles of Polymerization	George Odian	4th Ed., 2004	Wiley
2	Polymer Science and Technology	Joel R. Fried	3rd Ed., 2014	Pearson
3	Polymer Processing: Principles and Design	Donald G. Baird, Dimitris I. Collias	3rd Ed., 2014	Wiley

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL lectures on Polymer Chemistry, Polymer Processing, and Materials Science	https://nptel.ac.in/
2	SWAYAM online courses on polymer science and industrial chemistry	https://swayam.gov.in/
3	MIT Open Course Ware – Polymer Science and Materials Engineering	https://ocw.mit.edu/
4	e-PG Pathshala (UGC) – Chemistry and Polymer Science modules	https://epgp.inflibnet.ac.in/
5	National Digital Library of India (NDLI) – e-books and lecture notes	https://ndl.iitkgp.ac.in/
6	Polymer Database – Material properties and polymer data	https://polymerdatabase.com/

M.Sc. Chemistry Semester I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			P		
DSC	**P2S01NCCHE05**	Chemistry Practical-I	0-8-0	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Apply systematic qualitative analysis techniques through the integration of classical wet chemistry and modern logical deduction, resolving contradictions in experimental data, to identify cationic and anionic radicals in unknown samples

CLO2: Demonstrate analytical reasoning and problem-solving skills in interpreting experimental observations and confirming the presence of radicals.

CLO3: Perform laboratory experiments safely and accurately while recording observations, analyzing results, and reporting findings with scientific clarity and ethical practices.

CLO4: Perform **purification of solids** via crystallization and validate compound purity through the precise determination of **melting points, boiling points, and mixed melting points**

CLO5:Execute complex **multi-step organic syntheses** based on named reactions (e.g., Claisen-Schmidt, Cannizzaro, Sandmeyer, and Diels-Alder) and heterocyclic formations (Fischer-Indole and Knorr Quinoline).

CLO6: Demonstrate mastery in spectral interpretation (FT-IR, ^{1}H, ^{13}C NMR, and mass Spectrometry) to authenticate synthesized compounds, identifying subtle structural nuances such as isomers or rearrangement products from Beckmann or Kolbe-Schmitt processes.

CLO7: Critically evaluate the thermodynamic stability of systems by determining **Critical Solution Temperature (CST)** and **Heat of Solution**, using these parameters to predict the behavior of complex mixtures under varying industrial or environmental conditions.

CLO8: Evaluate dissociation constants of dibasic acids and hydrolysis constants of aniline hydrochloride using distribution methods, and interpret the results in terms of molecular inter

CLO9:Correlate their laboratory findings with contemporary chemical literature, comparing their experimental results against published models and peer-reviewed data

CLO10: Communicate their experimental findings say complex chemical phenomena and synthetic pathways into high-quality technical reports or manuscripts, with the clarity and depth

M.Sc. Chemistry Semester I

Subject		Learning Pedagogies	CLO(s)
Ino-I	Problem-Based Learning (Students are given unknown samples and required to identify the radicals using logical and stepwise analytical approaches)	Experiential Learning, Research-Oriented Learning, Collaborative Learning, Case-Based Learning	CLO1, CLO2, CLO3, CLO9, CLO10
Org-I	1. Method of Crystallization. Determination Of Melting Point, Boiling Point, and Mixed Melting Point 2. Preparation Based On Some Name Reactions: Claisen-Schmidt reaction, Cannizzaro reaction, Sandmeyer/Gattermann-Koch reaction. Fischer-Indol synthesis, Mannich reaction, Diels-Alder reaction, Beckmann rearrangement, Kolbe-Schmitt reaction, Leibensperger-Haloform reaction, Knorr Quinoline synthesis, Spectral Characterization Of Compounds Synthesized And Related Example	Case-Based Learning, Research-Oriented Learning, Experiential Learning	CLO4, CLO5, CLO6, CLO9, CLO10
Phy-I	1. To determine the heat of solution of the given acid by solubility method 2. Determination of hydrolysis constant of aniline hydrochloride by distribution method 3. Determination of the critical solution temperature (CST) of the phenol/water system and to study the effect of additive on CST 4. To determine the surface tension of methyl acetate, ethyl acetate, hexane and chloroform and hence calculate the atomic parachors of C, H,Cl etc 5. To determine partial molar volume of sodium chloride in aqueous solution at room temperature	Experiential Learning,Reflective Practices (Learning Journals, Reflective Notes)	CLO7, CLO8, CLO9, CLO10

- **Assessment Methodologies/Tools**

(A) Internal Assessment

(a) Formative assessment (30 Marks)

(a) Quiz
(b) Assignment, Self-learning, and Term work
(c) Seminar/Presentation
(d) Regularity

(b) Summative Assessment (20 Marks)

- Mid Term Examination: 20 Marks

(B) External Assessment

- Term End Examination: 50 Marks

Subjects	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyze & above (A)	
Inorg-I	CLO1,CLO2, CLO3, CLO9, CLO10	40	**5**	**10**	**35**	**50**
Org-I	CLO4,CLO6, CLO9,CLO10	40				
Phy-I	CLO7, CLO8	40				
		120	**15**	**30**	**35**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Journal/record book, oral quiz, Periodic tests, Laboratory Regularity	50
2	End-Semester Examination	Practical Exam/ Project Evaluation (Report, Presentation, Viva)	50

(A) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	3	1	1	1	2	3	2	1
CLO2	3	2	3	1	1	1	1	3	2	1
CLO3	3	3	1	2	2	1	3	2	2	2
CLO4	1	3	2	1	1	1	2	2	1	1
CLO5	3	3	3	1	2	1	2	2	2	2
CLO6	3	3	2	2	1	2	1	3	2	1
CLO7	3	2	2	1	1	2	2	2	2	3
CLO8	3	2	2	1	1	1	2	2	1	1
CLO9	2	3	2	2	1	3	1	3	3	2
CLO10	1	2	2	3	1	2	2	1	2	2

Values to the **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Elementary Practical Organic Chemistry	A. I. Vogel	Part-1 to 3	CBS publication
2	Advanced Physical Chemistry Experiments	Gurtu and Gurtu	7th Edition	Pragati Prakashan, Meerut
3	Advanced Physico-Chemical Experiments	J. Rose	1964	Sir Isaac Pitman & Sons Ltd.,London
4	Experimental Physical Chemistry	V. D. Athawale and Parul Mathur	1st Edition	New Age International Publishers, New Delhi
5	Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis	A.I. Vogel Revised by G. Svehla	5th Edition, 1979	Longman Group Ltd. London

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Web link
1	IGNOU eGyanKosh – Qualitative Inorganic Analysis	http://egyankosh.ac.in//handle/123456789/79535
2	IGNOU Block Resources (Cation & Anion Detection Modules)	https://egyankosh.ac.in/handle/123456789/24825?utm_source

M.Sc. Chemistry Semester I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2S01NCCHE06**	Chemistry Practical-II	0-8-0	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1:Synthesize a variety of **coordination complexes and double salts** applying specific techniques for ligand exchange, chelation, and stabilization of metal oxidation states

CLO2: Execute stereospecific syntheses and explain the geometric or optical isomerism inherent in octahedral and tetrahedral coordination environments.

CLO3: Apply **gravimetric and volumetric techniques** to determine the composition of synthesized salts and the concentration of organic functional groups (Hydroxyl, Phenol, Aniline) with high analytical precision

CLO4: Evaluate the degree of unsaturation and the concentration of bioactive molecules using redox and addition reaction stoichiometries, correlating chemical reactivity with molecular structure.

CLO5: Design and perform varied titrations to estimate binary mixtures, such as Acid + Amide or Acid + Ester, utilizing differences in hydrolysis rates and acidity constants.

CLO6: Determine the dissociation constants k1 and k2 of dibasic acids and the Ksp of sparingly soluble salts AgCl by integrating the Nernst equation with pH-metric/potentiometric data.

CLO7: Execute conductivity measurement experiments to identify the Critical Micelle Concentration (CMC) of ionic surfactants, interpreting the results in the context of molecular self-assembly and equilibrium.

CLO8: Verify the Law of Additive Absorbance using multi-component systems (e.g., $KMnO_4$ and $K_2Cr_2O_7$), demonstrating mastery in wavelength selection and the mathematical resolution of overlapping electronic spectra.

CLO9: Utilize polarimetric measurements to determine the concentration of optically active substances, applying the specific rotation formula and understanding the relationship between molecular chirality and light-matter interaction.

CLO10: Critically analyze experimental errors across diverse instrumental techniques, maintaining meticulous laboratory records and communicating findings through structured technical reports that meet professional scientific standards.

M.Sc. Chemistry Semester I

Subject	Course Content	Learning Pedagogies*	CLO(s)
Inor-II	Synthesis of metal complexes, double salts, and estimation by gravimetry. 1. Hexaamminenickel(II) chloride 2. Cis-potassium dioxalatodiaquachromate(III) dihydrate 3. Mercury(II) tetrathiocyanatocobaltate(II) 4. Tris(acetylacetonato)manganese(III) chelate 5. Potasiumtrioxalatoferrate(III) trihydrate 6. Prussian blue 7. Hexaurea chromium(III) chloride 8. Tetraamminecopper(II) sulphate 9. Ferrous ammonium sulfate	Experiential learning, Problem-Based Learning, Research-Oriented Learning, Collaborative Learning	CLO1 CLO2
Org-II	Estimations: 1. Hydroxyl Group Estimation 2. Unsaturation Estimation 3. Phenol/ Aniline Estimation 4. Ascorbic Acid (Vitamin-C) Estimation 5. Acid + Amide / Acid + Ester Estimation	Experiential Learning, Seminar, Mini Research Tasks, Industrial Visit, Problem-Based Learning, Research-Oriented Learning	CLO3 CLO4 CLO5
Phy-II	1. To determine the dissociation constants (k1 and k2) of a dibasic acid pH metrically. 2. To find out the (a) cell constant of a given conductivity cell, (b) to determine the critical micelle concentration (CMC) of an ionic surfactant. 3. To determine the solubility and solubility product of silver chloride by the potentiometry technique. 4. To verify the law of additive absorbance for a mixture of colored substances in solution using potassium permanganate and potassium dichromate solutions. 5. To determine the concentration of a given solution of an optically active substance by polarimetric measurements.	Experiential Learning, Mini Research Task, Research-Oriented Learning, Collaborative Learning	CLO6 CLO7

Weightage of Learning Efforts for External Assessment

Subjects	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyze & above (A)	
Inorg-II	CLO1 CLO2	40	0	0	50	50
Org-II	CLO3 CLO4 CLO5	40	0	0		
Phy-II	CLO6 CLO7	40	0	0		
		120	0	0	50	50

- **Assessment Methodologies**

(A) Internal Assessment

(a) Formative assessment (20 Marks)

- Method of Working
- Viva
- Regularity
- Journal Writing

(b) Summative Assessment (30 Marks)

- Mid Term Practical Examination: 30 Marks

(B) External Assessment

- Term End Practical Examination: 50 Marks

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Journal/record book, oral quiz, Periodic tests, Laboratory Regularity	50
2	End-Semester Examination	Practical Exam/ Project Evaluation (Report, Presentation, Viva)	50

(A) CLOs – PLOs Matrix

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CLO2	3	1	3	1	1	1	1	2	2	1
CLO3	2	3	2	1	2	1	2	2	1	1
CLO4	2	2	3	1	1	2	1	2	2	2
CLO5	2	2	3	1	2	1	1	3	1	1

CLO6	3	3	2	1	1	2	1	2	1	1
CLO7	3	3	2	1	1	1	1	2	2	2
CLO8	2	3	2	2	2	2	1	3	2	1
CLO9	2	3	2	1	1	1	1	2	1	1
CLO10	1	2	1	3	2	2	3	2	3	2

Values to the **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	A Laboratory Manual of Experiments in Physical Chemistry	D. Brennan and C. F. H. Tipper	1967	McGraw-Hill Publishing Company Ltd., London
2	Systematic Experimental Physical Chemistry	S. W. Rajbhoj and T. K. Chondhekar,	2nd Edition	Anjali Publication, Aurangabad
3	Elementary Practical Organic Chemistry Part 3	A. I. Vogel	2nd Edition	Pearson
4	Practical Organic Chemistry	F.G. Mann and B.C. Saunders	4th Edition	Pearson
5	Vogel's Textbook of Quantitative Chemical Analysis	G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney	5th Edition	Longman Group Ltd. London
6	Advanced Practical Inorganic Chemistry	Gurdeep Raj	1st Edition, 2013	Goel Publishing House, Meerut.

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Comprehensive Coordination Chemistry Lab Manual	https://doi.org/10.13140/RG.2.2.15072.05123
2	LibreTexts – Synthesis of Coordination Compounds	https://chem.libretexts.org/Ancillary_Materials/Laboratory_Experiments/Wet_Lab_Experiments/MIT_Labs/Lab_16%3A_Synthesis_of_%28Co%28NH_3%29_4%28CO_3%29NO_3?utm_source=chatgpt.com