



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. (Advanced Organic Chemistry) Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2TNC01AOC01	Conceptual Inorganic Chemistry	4-0-1	120	04

• Course Learning Outcomes (CLOs)

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

CLO 1: Apply the fundamental properties of transition elements, and apply Crystal Field Theory (CFT), Ligand Field Theory (LFT), and Molecular Orbital Theory (MOT) to analyse and evaluate the structure, bonding, and stability of coordination complexes.

CLO 2: Analyse crystal field splitting, Crystal Field Stabilisation Energy (CFSE), spectrochemical series, and Jahn–Teller distortion, and critically analyse their effects to evaluate the properties of coordination complexes with different geometries.

CLO 3: Understand the classification, bonding, and synthesis of organometallic compounds, apply the 18-electron rule to analyse their stability, and evaluate key reaction types such as oxidative addition and reductive elimination.

CLO 4: Analyse and critically analyse the chemistry of metal carbonyls and related complexes, and evaluate their preparation, structure, bonding, properties, and reactivity, including carbonyls, nitrosyls, hydrides, and cyanides.

CLO 5: Apply the principles of symmetry to identify symmetry elements and assign point groups, and apply group theory concepts to analyse and evaluate molecular structure, bonding, and spectroscopic properties.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Chemistry of Transition: Elements General characteristics and properties of transition elements, Coordination chemistry of transition metal ions, Crystal field theory (CFT) for tetrahedral, octahedral, square pyramidal, square planar, and trigonal bipyramidal fields, Crystal field stabilization energy (CFSE), Factors affecting the crystal field splitting parameters, Strong and weak field complexes, Spectrochemical series, Jahn-Teller Distortion, Ligand Field Theory (LFT), and Molecular Orbital Theory (MOT)	Classroom lecture, Seminar, Problem-Based Learning	CLO 1, CLO 2
II	Organometallic Chemistry: Definition and criteria of organometallic compounds, Classification of organometallic compounds based on hapticity and polarity of M-C bond, Nomenclature and general characteristics, 18 electron rule-applications and exceptions, Synthesis, bonding, properties and reactivity of representative organometallic compounds (-CO, -NO, -alkene, -alkyne), Reactions of organometallic compounds: Oxidative addition, reductive elimination, Insertion and elimination,	Classroom lecture, Seminar, Problem-Based Learning	CLO 3



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	Organometallics in homogeneous catalysis: Hydrogenation of olefins, hydroformylation reaction, Monsanto Acetic Acid, and polymerization of olefins		
III	Transition Metal Carbonyls and Related Compounds: Introduction, Preparation, structure, physical and chemical properties of metal carbonyls, Anionic and cationic carbonyl complexes, Lewis base derivatives of carbonyls, Carbonyl hydrides, Carbonyl halides, Nitrosyl complexes of transition metals, complexes of molecular nitrogen, Cyanide complexes of transition metals.	Classroom lecture, Seminar, Problem-Based Learning	CLO 4
IV	Concepts of Symmetry and Group theory: Symmetry elements and symmetry operations, Center of symmetry (i), Axis of symmetry (C_n), Plane of symmetry (σ_v , σ_h , σ_d), Rotation reflection axis of symmetry (S_n), Identity (E), point groups, classifications of point groups, Identification of point group of various molecules, Applications of point group	Classroom lecture, Seminar, Problem-Based Learning, Collaborative Learning	CLO 5

- (*) **Learning Pedagogies/Methods**

- (a) Classroom lecture
- (b) Seminars (Student-led and Faculty-moderated)
- (c) Case-Based Learning (CBL)
- (d) Micro-Projects/Mini Research Tasks
- (e) Industrial Visit/Field Visit/Institutional Visit
- (f) Problem-Based Learning (PBL)
- (g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (j) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- (k) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (l) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (m) Inquiry-Based Learning
- (n) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (30 Marks)

- (a) Quiz
- (b) Seminar
- (c) Assignment
- (d) Group Task
- (e) Attendance

b. Internal Summative Assessment (20 Marks)

Mid-term

(B) Weightage of Learning Efforts for External



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M.Sc. (Advanced Organic Chemistry) Semester-I

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	CLO 1, CLO 2	30	1	3	7	11
II	CLO 3	30	1	3	8	12
III	CLO 4	30	1	4	5	10
IV	CLO 5	30	2	5	10	17
		120	5	15	30	50

• Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity, and Group tasks	50
2	End-Semester Examination	Written Exam	50

• CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	1	3	3	1	1	1	2	-	-	2	-
CLO2	3	1	2	2	2	1	-	2	-	-	2	-
CLO3	3	2	3	3	1	2	1	2	1	2	2	2
CLO4	3	2	3	3	1	2	1	2	1	2	2	2
CLO5	3	1	3	3	2	1	-	2	-	-	2	-

Values to 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	Inorganic Chemistry	Shriver & Atkins	5 th Edition 2009	Oxford Press
2	Concise Inorganic Chemistry	J. D. Lee	-	-
3	Electronic Absorption	D. N.	1 st Edition	University Press



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	Spectroscopy and Related Techniques	Sathyanarayana	2001	
4	Advanced Inorganic Chemistry	Cotton, Wilkinson, Murillo & Bochmann	6 th Edition. 2007	Wiley & Sons
5	Mechanism of Inorganic Reactions	F. Basolo & R. G. Pearson	2 nd Edition 1967	Wiley Publication
6	Reaction Mechanism of Coordination Compounds	C. H. Langford & H. B. Gray	1 st Edition 1966	W. A. Benjamin
7	Fundamental Principles of Inorganic Chemistry	D. Banerjee	3 rd Edition 1993	Sultan Chand & Sons

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL (Transition Metal Organometallic Chemistry, Co-ordination Chemistry)	http://www.nptel.ac.in
2	SWAYAM (Inorganic Chemistry)	http://www.swayam.gov.in
3	e-PG Pathshala (Inorganic Chemistry-I, Inorganic Chemistry-II, Inorganic Chemistry-III)	http://www.epgp.inflibnet.ac.in
4	National Digital Library (Video lecture on symmetry in achiral molecule-I)	http://www.ndl.iitkgp.ac.in

Course Type	Course Code	Course Title	Teaching-Learning	Total Notional	Course credits
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M.Sc. (Advanced Organic Chemistry) Semester-I

			Scheme	Hours	
			L-P-T		
DSC	P2TNC01AOC02	Principal of Organic Chemistry	4-0-1	120	04

• Course Learning Outcomes (CLOs)

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

CLO1: Analyze the nature of bonding, aromaticity, and supramolecular assemblies (crown ethers, rotaxanes) in complex organic molecules.

CLO2: Apply the mechanistic pathways (Addition, Elimination, Substitution) and predict regioselectivity using Markovnikov and Ipso rules.

CLO3: Evaluate the spatial arrangement of molecules through conformational analysis and assign absolute configurations (R/S, E/Z) to chiral and achiral systems.

CLO4: Differentiate between the generation, stability, and reactivity of short-lived intermediates like carbocations, nitrenes, and arynes.

CLO5: Apply stereochemical principles to predict the outcomes of stereospecific and stereoselective organic transformations.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Introduction of Stereochemistry Elements of symmetry, chirality, different projections and their interconversion, CIP Nomenclature, Molecules with more than one Chiral centre, Total number of Stereoisomer, Enantiomeric and Diastereomeric Relationship, Chirogenicity and Stereogenecity, Pseudochirality, Topicity and Prostereoisomerism, chirality due to chiral axis, plane, and helical shape, Determination of Topic relationship between Homomorphic ligands in Intact Molecules, Concept of stereoselective and stereospecific reactions, Optical Purity.	Classroom Lecture, Concept Mapping	CLO1
II	Methods of resolution and conformational analysis of organic compounds Methods of resolution, conformational analysis of acyclic compounds (ethane, n-butane, haloalkanes, vicinal dihydroxy, etc.), Conformational analysis of cycloalkanes, Mono and disubstituted cyclohexane, decalins, effect of conformation on reactivity	Classroom Lecture, Problem-Based Learning (PBL), Collaborative Learning	CLO2
III	Addition, Elimination and Substitution reactions Orientation of Addition reactions, reactivity and mechanism, Markovnikov and anti-Markovnikov addition reactions, Addition reactions (hydro-halo, hydro-hydroxy, and hydro-alkoxy), Elimination mechanism and orientation, E1-E2-E1cB, mechanistic spectrum, various factors affecting elimination reactions, Pyrolytic Eliminations, Aliphatic substitution, S _N 1, S _N 2, S _N i mechanism, Neighbouring-Group participation, Aromatic Substitution, S _N Ar, Ipso substitution	Classroom Lecture, Seminars, Flipped Classroom	CLO3, CLO5
IV	Reactive intermediates in organic chemistry Carbocation: Structure, geometry and generation of carbocations, Carbocation stability, Reactions involving non-classical	Classroom Lecture, Research-	CLO4



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M.Sc. (Advanced Organic Chemistry) Semester-I

carbocations Carbanions: Structure, geometry and generation of carbanions, Stability and reactions of carbanions Free Radicals: Structure and generation of free radicals, Stability and reactions of free radicals Carbenes: Structure, geometry and generation of carbenes, Reactions of carbenes Nitrenes: Structure, reactivity and generation of nitrenes, Reactions of nitrenes Benzynes: Structure, reactivity, generation and reactions of benzyne	Oriented Learning, Problem-Based Learning, Reflective Practices	
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• (*) Learning Pedagogies/Methods

- (o) Classroom Lecture (CL)
- (p) Seminars (Student-led and Faculty-moderated)
- (q) Case-Based Learning (CBL)
- (r) Micro-Projects/Mini Research Tasks
- (s) Industrial Visit/Field Visit/Institutional Visit
- (t) Problem-Based Learning (PBL)
- (u) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (v) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (w) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (x) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- (y) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (z) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (aa) Inquiry-Based Learning
- (bb) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies/Tools

(C) Formative assessment (Assessment for Learning)

a. Internal Formative assessment (30 Marks)

- (f) Quiz
- (g) Seminar
- (h) Assignment
- (i) Group Task
- (j) Attendance

b. Internal Summative Assessment (20 Marks)

Mid-term test

(D) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning	Approximate weightage (Marks) to Learning levels (BT)	Total Marks
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M.Sc. (Advanced Organic Chemistry) Semester-I

		Hours	Remember (R)	Understanding (U)	Analyse & above (A)	
I	CLO 1, CLO 2	30	1	3	6	10
II	CLO 3	30	1	3	8	12
III	CLO 4	30	2	4	9	15
IV	CLO 5	30	1	5	7	13
		120	5	15	30	50

• Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity, and Group task	50%
2	End-Semester Examination	Written Exam	50%

(E) CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	2	2	1	2	1	-	1	1	-	1	2	-
CLO2	2	1	3	2	1	-	1	1	-	1	2	1
CLO3	3	3	2	3	1	2	1	2	1	1	2	1
CLO4	2	1	2	2	1	-	1	1	-	1	2	-
CLO5	3	2	3	3	1	1	1	2	1	1	2	1

Values to 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	Advanced Organic Chemistry, Part-A: Structure and Mechanisms	F.A. Carey & R. J. Sundberg	5 th Edition, 2007	Springer
2	Text book of Organic Chemistry (Vol. I & II)	I. L. Finar	Vol. I, 6 th Edition, 2022; Vol. II, 5 th Edition, 2018	Pearson Education
3	Organic Chemistry	R. T. Morrison & R. N. Boyd	7 th Edition, 2010	Pearson
4	Advanced Organic Chemistry: Reaction Mechanism and	Jerry March	6 th Edition, 2007	John Wiley



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M.Sc. (Advanced Organic Chemistry) Semester-I

	Structure			
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- Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL - Principles of Organic Synthesis	https://nptel.ac.in/
2	MIT Open Course Ware - Organic Chemistry	https://ocw.mit.edu/
3	Virtual Textbook of Organic Chemistry	Michigan State University

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
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M.Sc. (Advanced Organic Chemistry) Semester-I

			L-P-T		
DSC	P2TNC01AOC03	Selected topics of Physical Chemistry	4-0-1	120	04

• Course Learning Outcomes (CLOs)

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

CLO1: Apply the laws of thermodynamics to analyze chemical systems, including concepts of free energy, entropy, and chemical potential.

CLO2: Interpret thermodynamic relationships such as Maxwell relations, Gibbs-Duhem equation, and their applications in evaluating partial molar properties.

CLO3: Apply the principles of statistical thermodynamics, including distribution laws, partition functions, and their role in determining thermodynamic properties.

CLO4: Analyse phase equilibria and chemical equilibria in one-, two-, and three-component systems, including ideal and non-ideal behaviour.

CLO5: Evaluate electrochemical systems using concepts such as Debye-Hückel theory, activity coefficients, and interionic interactions in electrolyte solutions.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Chemical Thermodynamics Introduction, revision of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Extensive and intensive properties, Gibbs-Duhem equation and its application to study the partial molar quantities and their significance. Maxwell relations, thermodynamic equation of state, variation of chemical potential with temperature and pressure	Classroom Lecture, Seminars, Problem-Based Learning, Research-Oriented Learning, Collaborative Learning, Reflective Practices, Self-Directed Learning	CLO1, CLO2
II	Statistical Thermodynamics: Limitation of classical thermodynamics, statistical thermodynamics, Energy states and energy levels, macrostate and microstate, thermodynamic probability, the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distributions, Molecular partition function and their significance, thermodynamics properties in terms of partition function, Rotational, translational, vibrational and electronic partition function, the statistical interpretation of entropy, Sackur-Tetrode equation, comparison of distribution function for indistinguishable particles	Classroom Lecture, Seminars, Problem-Based Learning, Reflective Practices, Self-Directed Learning.	CLO3
III	Phase Equilibria and Chemical Equilibria Elementary description of phase transitions, phase equilibria and phase rule, One-component, two components and three components system. Thermodynamics of ideal and non-ideal gases and solutions.	Classroom Lecture, Seminars, Problem-Based Learning, Research-Oriented Learning, Self-Directed Learning	CLO4
IV	Electrochemistry: Electrochemistry of solutions, Debye-Huckel theory of inter-ionic attraction, atmosphere, time of relaxation,	Classroom Lecture, Seminars, Problem-Based Learning,	CLO5



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M.Sc. (Advanced Organic Chemistry) Semester-I

	relaxation and electro-phoretic effects, Dye-Huckel-Onsager equation and its validity for dilute solution and at appreciable concentrated solutions. Activity coefficients: forms of activity coefficients and their interrelationship. Dye-Huckel limiting law for osmotic and activity coefficients of dilute electrolyte solutions and its application to concentrated solutions. Debye-Huckel-Bronsted equations, quantitative and qualitative verification of DyeHuckel limiting law, Industrial applications of Electrochemistry.	Research-Oriented Learning, Collaborative Learning,	
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• (*) Learning Pedagogies/Methods

- (cc) Classroom Lecture (CL)
- (dd) Seminars (Student-led and Faculty-moderated)
- (ee) Case-Based Learning (CBL)
- (ff) Micro-Projects/Mini Research Tasks
- (gg) Industrial Visit/Field Visit/Institutional Visit
- (hh) Problem-Based Learning (PBL)
- (ii) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (jj) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (kk) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (ll) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- (mm) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (nn) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (oo) Inquiry-Based Learning
- (pp) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies

(F) Internal Assessment

a. Internal Formative assessment (30 Marks)

- (k) Quiz
- (l) Seminar
- (m) Assignment
- (n) Group Task
- (o) Attendance

b. Internal Summative Assessment (20 Marks)

Mid-term tests

(G) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total	Approximate weightage (Marks) to	Total
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M.Sc. (Advanced Organic Chemistry) Semester-I

		Learning Hours	Learning levels (BT)			Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	30	1	4	8	13
II	CLO3	30	1	3	7	11
III	CLO4	30	2	3	6	11
IV	CLO5	30	1	5	9	15
		120	05	15	30	50

Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity, and Group tasks	50%
2	End-Semester Examination	Written Exam	50%

(H)CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	1	-	1	3	2	-	1	3	1	1	-	1
CLO2	2	-	1	3	2	-	2	3	1	1	-	1
CLO3	1	-	1	3	1	-	1	3	1	1	-	1
CLO4	1	1	1	3	2	-	2	3	2	2	-	1
CLO5	2	2	3	3	3	-	1	3	2	3	2	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	Elements of Physical Chemistry	Peter Atkins, Julio De Paula, James Keeler	11 th edition, 2018	Oxford University Press
2	Physical Chemistry	Ira N. Levine	6 th edition, 2009	McGraw-Hill Publishing House
3	Modern Electrochemistry (Vol. I & II)	J. O. M. Bockris, A. K. N. Reddy	2 nd edition, 2004	Kluwer Academic Publishers
4	An Introduction to Electrochemistry	S. Glasstone	4 th reprint, 2006	Affiliated East-West Press Pvt. Ltd.



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5	Electrolytic Solutions	R. A. Robinson, R. H. Stokes	2 nd edition, 2002	Dover Publication
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- Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Elementary Electrochemistry, IISER Mohali Prof. Angshuman Roy Choudhury	https://nptel.ac.in/courses/104106137
2	Basic thermodynamics: Classical and Statistical Approaches, IISER Pune Prof. Arnab Mukherjee	https://nptel.ac.in/courses/104106107
3	Physical_and_Theoretical_Chemistry online content	https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps
4	classical/ macroscopic and statistical thermodynamics and kinetics	https://nptel.ac.in/courses/104106089

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		



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M.Sc. (Advanced Organic Chemistry) Semester-I

DSC	P2TNC01AOC04	Organic and Inorganic Practical	0-8-0	120	04
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• Course Learning Outcomes (CLOs)

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

CLO1: Execute laboratory techniques for the synthesis, purification, and characterization of organic and inorganic compounds with advanced safety protocols.

CLO2: Perform precise quantitative analysis, including direct and indirect titrations (Cu^{2+} , Ni^{2+} , Fe^{3+}), and estimate metal contents in synthesized complexes.

CLO3: Identify and Separate two-component organic mixtures using systematic chemical and physical methods.

CLO4: Determine various organic functional groups and estimate parameters such as unsaturation, esters, acids, and reducing sugars through titrimetric methods.

CLO5: Analyze reaction mechanisms in catalysis by investigating acid-catalyzed and base-catalyzed synthesis reactions.

Course Content	Learning Pedagogies*	CO(s)
Inorganic Chemistry: Quantitative Analysis: Direct Titration (Cu^{2+} , Ni^{2+} , Ca^{2+} , Mg^{2+} and Fe^{3+}) Indirect Titration of Calcium By Back Titration and Replacement titration Synthesis of metal complexes, double salts and estimation by gravimetry. Chrome alum K_2SO_4 , $\text{Cr}_2(\text{SO}_4)_3 \cdot 24 \text{H}_2\text{O}$ Ferrous ammonium sulphate $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ Tris ethylene diamine $\text{Ni}(\text{II})$ sulphate Tetrammine $\text{Cu}(\text{II})$ sulphate Sodium trioxalato ferrate trihydrate Potassium trioxalatochromate (III) Hexa-ammine nickel (II) chloride Hexa-ammine cobalt (III) chloride	Experiential Learning, Peer Discussion, Collaborative Learning	CLO1, CLO2
Organic Chemistry: 1. Separation and identification of the three-component mixtures using Chemical and physical methods. 2. Estimation of reducing sugars, phenols, and aniline.	Problem-Based Learning (PBL), Reflective Practices, Research-Oriented Learning, Inquiry-Based Learning	CLO3, CLO4, CLO5

• (*) Learning Pedagogies/Methods

- (qq) Seminars (Student-led and Faculty-moderated)
- (rr) Case-Based Learning (CBL)
- (ss) Micro-Projects/Mini Research Tasks
- (tt) Industrial Visit/Field Visit/Institutional Visit



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M.Sc. (Advanced Organic Chemistry) Semester-I

- (uu) Problem-Based Learning (PBL)
- (vv) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (ww) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (xx) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (yy) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- (zz) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (aaa) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (bbb) Flipped Classroom Approach
- (ccc) Inquiry-Based Learning
- (ddd) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies

(I) Internal Assessment

a. Internal Formative Assessment (30 Marks)

- (p) Journal
- (q) Method of working
- (r) Viva
- (s) Attendance

b. Internal Summative Assessment (20 Marks)

- (a) Mid-Term Examination
- (b) Viva-voce

(J) Weightage of Learning Efforts for External Assessment

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Journal Evaluation, Method of working, Attendance, Mid-Term Examination, Viva-voce	50%
2	End-Semester Examination	Practical Exam	50%

• CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	2	3	3	3	2	2	1	2	1	1	2	-
CLO2	2	3	3	3	3	2	1	2	1	1	2	-
CLO3	3	3	3	3	2	3	1	2	1	2	2	2
CLO4	3	3	2	3	2	2	1	2	1	2	2	2
CLO5	3	3	3	3	2	2	1	2	1	1	2	-
CLO6	3	3	3	3	2	2	1	2	1	2	2	2

Values to 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



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Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Qualitative Chemical semi micro analysis	V. N. Alexeyev	2 nd Ed. 1979	Mir Publishers Moscow
2	Vogel's Qualitative Inorganic Analysis	G. Svehla	7 th Ed. 1996	Orent Longman
3	Vogel's Textbook of Quantitative Chemical Analysis	G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney	5 th Ed. 1989	ELBS Publication
4	A Textbook of Practical Organic Chemistry	A. I. Vogel	5 th Ed. 1989	Pearson edu.
5	Elementary Practical Organic Chemistry – Part 3 Quantitative Organic Analysis	A. I. Vogel	2 nd Ed. 1978	Pearson edu.

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	LibreTexts (Coordination compounds lab, Organic chemistry lab)	https://chem.libretexts.org
2	NPTEL (Analytical chemistry course/Direct titration)	https://nptel.ac.in

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		



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DSC	P2TNC01AOC05	Physical and Analytical Practical	0-8-0	120	04
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• Course Learning Outcomes (CLOs)

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

CLO1: Perform precise potentiometric measurements to determine the normality and composition of various halide and electrolyte solutions.

CLO2: Analyze solubility and calculate the solubility product of silver halides through established experimental methodologies.

CLO3: Utilize conductometric titrations to determine the exact composition of acid mixtures and establish the critical micelle concentration (CMC) of surfactants.

CLO4: Investigate the molecular composition of complexes and evaluate reaction kinetics using advanced analytical techniques.

CLO5: Calculate fundamental kinetic parameters, including reaction rate constants and activation energies, for chemical transformations.

Course Content	Learning Pedagogies*	CO(s)
Physical and Analytical Chemistry: 1. Determination of normality, amount of chloride/bromide/iodide using Potentiometry. 2. Determination of solubility and solubility product of silver halides. 3. Determination the composition of a mixture of acetic acid and Hydrochloric acid by Conductometric titration. 4. Determination of CMC of anionic surfactant by Conductometry. 5. Determination of mixture of acids and relative strength of weak acids using Conductometry. 6. Investigate the molecular composition of a ferric-salicylate complex by Job's method. 7. To determine the rate constant of the saponification of ethyl acetate at different temperatures and calculate the energy of activation of the reaction. 8. To study the variation of refractive index with composition of mixtures of glycol and water. 9. To find out the amount of Borax in given solution by titrating it against hydrochloric acid pH metrically. 10. Kinetics of inversion of cane sugar in presence of strong acid. 11. Determination of partial molar volume by intercept method, density measurements. 12. Determine the pK_1 and pK_2 value of phosphoric acid by pH metry. 13. Determine the indicator constant of given indicator by colorimetric measurements. 14. Study of kinetics of inversion of cane sugar. 15. To study the effect of surfactants (sodium chloride) on surface tension of given liquid.	Collaborative Learning, Research-Oriented Learning, Problem-Based Learning	CLO1 to CLO5



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- (*) **Learning Pedagogies/Methods**
 - Classroom Lecture (CL)
 - Seminars (Student-led and Faculty-moderated)
 - Case-Based Learning (CBL)
 - Micro-Projects/Mini Research Tasks
 - Industrial Visit/Field Visit/Institutional Visit
 - Problem-Based Learning (PBL)
 - Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
 - Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
 - Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
 - Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
 - ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
 - Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
 - Inquiry-Based Learning
 - Self-Directed Learning (Guided Reading, Concept Exploration Tasks)

Assessment Methodologies

(K) Internal Assessment

a. Internal Formative assessment (30 Marks)

- Journal Evolution
- Method of Working
- Attendance

b. Internal Summative Assessment (20 Marks)

- Mid-term test
- Viva-voce

(L) Weightage of Learning Efforts for Assessment

Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
		Remember (R)	Understanding (U)	Analyse & above (A)	
CLO1 to CLO6	120	5	10	35	50
	120	5	10	35	50

Assessment and Evaluation

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Journal Evolution, Method of Working, Attendance, Mid-term exam, Viva-voce	50%
2	End-Semester Examination	Practical Exam and Viva-voce	50%

(c) CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	2	3	2	2	2	2	2	1	-	-



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

Values to 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	Experiments in Physical Chemistry	J. M. Wilson, R. J. Newcombe, A. R. Denaro, R. M. W. Rickett	2 nd revised and enlarged ed. 2013	Pergamon Press, Oxford.
2	Advanced Physico-Chemical Experiments: A Textbook of Practical Physical Chemistry and Calculations.	James Spicer Rose	1 st ed. 1964	Sir Isaac Pitman & Sons Ltd., London
3	Experimental Physical Chemistry,	R. C. Das, B. Behera,	1 st ed. 1983	Tata McGraw-Hill Publishing Company Ltd., New Delhi.
4	A Laboratory Manual of Experiments in Physical Chemistry	D. Brennan, C. F. H. Tipper	1 st ed. 1967	McGraw-Hill Publishing Company Ltd., London.
5	Practical Physical Chemistry	Renu Gupta	1 st ed. 2017	New Age International Private Limited

• Online Resources (Open Source)

Sr.No.	Description of Resource(s)	Weblink
1	Virtual labs simulation of physical chemistry practical concept	https://chemcollective.org/vlabs
2	Physical chemistry practical video	https://chemagic.org/home/Index.html
3	e-PG Pathshala (INFLIBNET)	http://www.epgp.inflibnet.ac.in
4	Libretexts Physical chemistry practical concepts	https://commons.libretexts.org/book/chem-332621



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2TNC01AOC06	Analytical Chemistry	2-0-1	60	02

• Course Learning Outcomes (CLOs)

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

CLO1: Critically evaluate the role of analytical chemistry, including qualitative and quantitative analysis, analytical processes, and method validation, along with fundamental concepts of errors, accuracy, precision, and significant figures.

CLO2: Apply statistical tools such as confidence limits, F-test, Student's t-test, and Q-test for the interpretation, validation, and rejection of analytical data.

CLO3: Analyze and evaluate the principles and classifications of chromatographic techniques, including adsorption, partition, gas chromatography, ion exchange chromatography, TLC, and HPLC, and evaluate their applications in chemical analysis.

CLO4: Evaluate and formulate the principles and operational theories of distillation methods, including classical, fractional, and vacuum distillation, with emphasis on phase equilibrium.

CLO5: Apply and critically assess the concepts of solvent extraction and solid-phase extraction, including partition coefficient, distribution ratio, and various extraction techniques, to solve numerical problems and analyze separation processes.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Basic concepts of analytical chemistry The role of analytical chemistry, qualitative and quantitative analysis, analytical process, and validation of a method, introduction of statistical treatment of analytical data, types of errors, significant figures, precision and accuracy, methods of expressing accuracy, methods of expressing precision, the confidence limit, tests of significance- the F test, the student T test, rejection of results - the Q test, numerical. Separation Methods Principle, classification of chromatographic methods, adsorption and partition chromatography, gas chromatography, ion exchange chromatography, thin layer chromatography (TLC), high-performance liquid chromatography (HPLC)	Classroom Lecture, Seminars, Collaborative Learning, Experiential Learning	CLO1, CLO2, CLO3
II	Basic Separation Techniques Distillation: Classical distillation, fractional distillation, distillation under vacuum, theory of operation of distillation methods Solvent and Solid Phase Extraction: Phase equilibrium, partition coefficient, distribution ratio, theory of phase contact methods, single equilibrations, repeated equilibrations, counter-current distribution, extraction of metals, extraction of molecular species, ion-pair extractions, accelerated	Classroom Lecture, Seminars, Problem-Based Learning, Collaborative Learning, Experiential Learning	CLO4, CLO5



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	and microwave-assisted extraction, solid phase extraction, numerical		
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- (*) Learning Pedagogies/Methods**

- (eee) Classroom Lecture (CL)
- (fff) Seminars (Student-led and Faculty-moderated)
- (ggg) Case-Based Learning (CBL)
- (hhh) Micro-Projects/Mini Research Tasks
- (iii) Industrial Visit/Field Visit/Institutional Visit
- (jjj) Problem-Based Learning (PBL)
- (kkk) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (lll) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (mmm) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (nnn) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- (ooo) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (ppp) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (qqq) Inquiry-Based Learning
- (rrr) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- Assessment Methodologies**

- (M) Internal Assessment**

- a. Internal Formative assessment (30 Marks)**

- (w) Quiz
- (x) Seminar
- (y) Assignment
- (z) Group Task
- (aa) Attendance

- b. Internal Summative Assessment (20 Marks)**

Mid-term test

(N) Weightage of Learning Efforts for Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	CLO1, CLO2, CLO3	30	1	3	7	11
II	CLO4, CLO5	30	1	4	9	14
		60	2	7	16	25

- Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity and Group task	25%
2	End-Semester Examination	Written Exam	25%



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(O)CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	-	2	-	3	2	2	-	1	2	1	2	-
CLO2	-	2	-	3	3	2	-	1	1	-	2	-
CLO3	1	3	-	3	2	2	-	1	2	1	2	-
CLO4	-	2	1	3	1	2	-	1	2	2	2	1
CLO5	-	3	-	3	2	3	1	1	2	2	2	-

Values to 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	Fundamental of Analytical Chemistry	Douglas A. Skoog, Donald M. West	10 th edition 2021-2022	Cengage Learning
2	Analytical Chemistry	Gary D. Christian	6 th edition 2007	John Wiley & Sons
3	Statistics and Chemometrics for Analytical Chemistry	James N. Miller, Jane C. Miller	6 th edition 2010	Pearson Education
4	Gas Chromatography and Mass Spectrometry	O. David Sparkman, Zlatkis A.	2 nd edition 2011	Elsevier
5	Introduction to Modern Liquid Chromatography	Lloyd R. Snyder, Joseph J. Kirkland, John W. Dolan	3 rd edition 2010	John Wiley & Sons

• Online Resources (Open Source)

Sr.No.	Description of Resource(s)	Weblink
1	MIT Open Course Ware- Analytical Chemistry	https://www.ocw.mit.edu/search/?t=Analytical%20Chemistry
2	Libre Texts- Analytical Chemistry	https://chem.libretexts.org/Bookshelves/Analytical_Chemistry
3	Agilent Technologies Learning Centre- Chromatography	https://www.agilent.com/en/training-events/events/agilent-ducation
4	Chem Collective- Separation Methods	https://chemcollective.org/