



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. (Applied Chemistry) Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCACH01	Applied Inorganic and Quantum Chemistry	4-0-1	120	04

• Course Learning Outcomes (CLOs)

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

CLO1: Understand and apply the fundamental principles of wave mechanics, including particle models, operators, and quantum systems to explain atomic and molecular behavior.

CLO2: Analyze different types of magnetic properties (diamagnetism, paramagnetism, ferro-, antiferro-, and ferrimagnetism) and evaluate magnetic behavior of transition metal, lanthanide, and actinide compounds.

CLO3: Explain the structure and function of biologically important metal-containing systems such as metalloproteins, enzymes, and metal-based drugs in bioinorganic chemistry.

CLO4: Interpret the mechanisms and types of corrosion processes and assess various factors affecting corrosion along with appropriate prevention and control methods.

CLO5: Integrate concepts from quantum chemistry, magnetochemistry, bioinorganic chemistry, and corrosion to solve theoretical and applied problems in inorganic chemistry.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Wave mechanics Operator algebra, Free particle; particle in a box; quantization; symmetry of the wave functions; use of the box model; cubical box; Particle on a sphere; normalization of the wave functions; rotation of a diatomic molecule, One dimensional harmonic oscillator	Classroom Lecture, Problem-Based Learning, Inquiry-Based Learning, Self-Directed Learning.	CLO1
II	Magnetochemistry Magnetic susceptibility; sources of paramagnetism; diamagnetic susceptibility; Pascal constants and constitutive corrections; antiferromagnetism; types of antiferromagnetism; Ferromagnetism; ferrimagnetism; quenching of orbital magnetic moment by crystal field; Term symbols, magnetic properties of the compounds of lanthanides and actinides	Classroom Lecture, Seminars, Problem-Based Learning, Research-Oriented Learning, Collaborative Learning	CLO2
III	Bioinorganic Chemistry Introduction to Bio-Inorganic chemistry, Iron-Sulphur proteins, Cytochromes of the electron transport chain, Cytochrome P-450 enzymes, Coenzyme B12, Blue copper proteins Metals in medicine: Antibiotic and related compounds, Metal deficiency and diseases, chelation therapy for metal ion detoxification, Metal ions in clinical diagnosis	Classroom Lecture, Seminars, Micro-Projects/Mini Research Tasks, Industrial Visit, Collaborative Learning, Experiential Learning	CLO3



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IV	Corrosion Introduction, Dry or chemical corrosion, wet or electrochemical Corrosion, mechanism, pilling Bed worth rule, Types of corrosion galvanic corrosion, concentration cell corrosion, Differential aeration corrosion, soil corrosion, Pitting corrosion, Intergranular corrosion, Microbial corrosion, Stress corrosion, Waterline corrosion, Erosion corrosion, Factors influencing corrosion, Corrosion Control: Proper designing, using pure metal, using metal alloys, cathodic protection, modifying the environment, use of Inhibitors.	Classroom Lecture, Seminars, Problem-Based Learning, Research-Oriented Learning, Reflective Practices, Self-Directed Learning	CLO4, 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**

(A) Internal Assessment

a. Internal Formative assessment (30 Marks)

- Quiz
- Seminar
- Assignment
- Group Task
- Attendance

b. Internal Summative Assessment (20 Marks)

Mid-term test



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(B) Weightage of Learning Efforts for External Assessment

• 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	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	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

• 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	2	2	1	–	–	1	–	1	1	–
CLO2	3	1	2	2	1	–	–	1	–	–	1	–
CLO3	3	2	3	2	2	–	–	1	–	1	1	–
CLO4	3	2	3	2	1	1	–	2	1	2	1	1
CLO5	3	2	3	3	1	1	–	1	1	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	Introductory Quantum Chemistry	A. K. Chandra	4 th edition, 2004	Tata McGraw-Hill



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2	Quantum Chemistry	R. K. Prasad	4 th edition, 2010	New Age International
3	Quantum Chemistry	Ira N. Levine	7 th edition, 2016	Pearson India
4	Introduction to Magnetochemistry	Alan Earnshaw	1 st edition, 2013	Academic Press
5	Bioinorganic Chemistry: An Introduction	J. A. Cowan	2 nd edition, 1997	Wiley-VCH

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL	http://www.nptel.ac.in
2	SWAYAM	http://www.swayam.gov.in
3	e-PG Pathshala (INFLIBNET)	http://www.epgp.inflibnet.ac.in
4	National Digital Library (IIT Kharagpur)	http://www.ndl.iitkgp.ac.in



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M.Sc. (Applied Chemistry) Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCACH02	Organic Reactions and Photochemical Processes	4-0-1	120	04

• Course Learning Outcomes (CLOs)

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

CLO1: Critically analyze the concept of aromaticity and predict the mechanisms of electrophilic and nucleophilic substitution reactions in various aromatic systems.

CLO2: Design and formulate multi-step synthetic pathways for complex bioactive molecules by integrating modern name reactions (e.g., Cross-coupling, Annulations) with high atom economy.

CLO3: Evaluate and compare the role and selectivity of different reagents used in oxidation, reduction, and functional group transformations in organic synthesis.

CLO4: Explain the principles of photochemistry, including excited states, energy transfer, and photochemical reaction mechanisms of organic compounds.

CLO5: Integrate concepts of aromatic reactions, name reactions, reagents, and photochemistry to solve complex problems and propose synthetic strategies in organic chemistry.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Aromaticity and Aromatic Substitution Reactions Introduction of Aromaticity: Concept of aromaticity, Annulenes, aromaticity in charged rings, homo-aromaticity, fused ring systems, heterocyclic rings. Aromatic Substitution Reactions: Introduction to aromatic/electrophilic substitution reactions, reaction mechanism of Friedel-Crafts alkylation and acylation reactions, nitration, sulfonation, and halogenation of aromatic compounds. Reactivity of substrates, Orientation of electrophilic substitution reactions in various aromatic substrates. Nucleophilic aromatic substitution reactions.	Classroom Lecture, Case-Based Learning, Problem-Based Learning	CLO1
II	Organic Name Reactions and their Applications Aldol reaction, Henry reaction, contribution of Indian scientist V. K. Singh in asymmetric Henry reaction (Singh's catalyst), Michael Addition, Mannich reaction, Robinson ring annulation, Wittig reaction and its modifications; Peterson olefination, Baeyer-Villiger Oxidation, Stork Enamine reaction, Shapiro reaction, Bamford Steven's reaction, Julia olefination, Stork Enamine reaction, Vilsmeier-Haack reaction, Darzen condensation, Brown's Hydroboration, Applications of hindered boron reagents, Carbonylation of organoboranes, Stobbe condensation, K. Venkataraman's contribution in flavone synthesis (Baker-Venkataraman Rearrangement)	Classroom Lecture, Seminars, Micro-Projects, Problem-Based Learning, Research-Oriented Learning, Collaborative Learning	CLO2



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III	Reagents in Organic Synthesis Oxidising Reagents: CrO ₃ , PDC, PCC, modification of PDC by S. Chandrasekaran, MnO ₂ , SeO ₂ , Pb(OAc) ₄ , HIO ₄ , DMSO, HgO, K ₃ Fe(CN) ₆ Reducing Reagents: Al(O ^t Bu) ₃ , Na/NH ₃ , Zn/HCl, N ₂ H ₄ /OH ⁻ , NaBH ₄ , LiAlH ₄ , TBTH. Miscellaneous Reagents: Wilkinson catalyst, alkyl lithium, Grignard reagent, Gilman reagent, NBS, DCC	Classroom Lecture, Case-Based Learning, Problem-Based Learning, Research-Oriented Learning, Self-Directed Learning	CLO3
IV	Organic Photochemical Reactions Basic principles, Jablonski diagram; photochemistry of olefinic compounds, cis-trans isomerization; photochemistry of carbonyl compounds (Norrish type-I and type-II reactions), Paterno-Buchi reaction, Photorearrangement reactions: di-π methane rearrangement, rearrangement of cyclohexadienes, Barton reaction; photo-Fries reaction, reactions and synthetic applications of singlet oxygen, Hoffman-Löffler rearrangement	Classroom Lecture, Case-Based Learning, Research-Oriented Learning, Reflective Practices, Inquiry-Based Learning	CLO4 CLO5

- (*) 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 Readings, Concept Exploration Tasks)

- Assessment Methodologies**

- (C) Internal Assessment**

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

- Quiz
- Seminar
- Assignment
- Group Task
- Attendance

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

Mid-term test



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M.Sc. (Applied Chemistry) Semester-II

(D) 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	30	1	3	6	10
II	CLO2	30	1	5	9	15
III	CLO3	30	2	4	8	14
IV	CLO4, CLO5	30	1	3	7	11
		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

• 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	1	1	-	-	-	1	-	-	1	-
CLO2	3	2	3	2	1	1	-	1	1	2	1	1
CLO3	3	2	3	2	1	1	-	1	1	3	1	-
CLO4	3	1	2	2	-	-	-	1	-	2	1	-
CLO5	3	3	3	3	2	3	2	2	2	3	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	Advanced Organic Chemistry (Part-A)	F. A. Carey, R. J. Sundberg	5th Edition / 2007	Springer / Plenum
2	Advanced Organic Chemistry	Jerry March	8th Edition / 2020	John Wiley



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3	A Guidebook to Mechanism in Organic Chemistry	Peter Sykes	6th Edition / 2003	Pearson
4	Organic Synthesis	M. B. Smith	5th Edition / 2020	Academic Press
5	Organic Chemistry	Clayden, Greeves, Warren	2nd Edition / 2012	Oxford University Press

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL (Pericyclic Reactions and Organic Photochemistry)	https://onlinecourses.nptel.ac.in/noc26_cy37/preview
2	SWAYAM (Introductory Organic Chemistry I)	Introductory Organic Chemistry I - Course
3	e-PG Pathshala (INFLIBNET; Chemistry (Organic Chemistry II))	e-PGPathshala
4	National Digital Library (Higher education, Post graduation content in Chemistry)	NDLI: Browse



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M.Sc. (Applied Chemistry) Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCACH03	Advances in Physical Chemistry	4-0-1	120	04

• Course Learning Outcomes (CLOs)

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

CLO1: Understand and apply the principles of chemical kinetics, including rate laws, reaction mechanisms, and factors affecting reaction rates.

CLO2: Analyze different types of reactions such as consecutive, parallel, chain, and enzyme-catalyzed reactions, and interpret their kinetic behavior.

CLO3: Critically evaluate the structural principles of solid-state chemistry, including crystal structures, defects, band theory, and methods of structure determination.

CLO4: Apply nuclear chemistry concepts such as radioactive decay, nuclear reactions, fission, fusion, and isotope separation techniques.

CLO5: Apply the concepts of molecular symmetry and group theory to identify point groups, construct character tables, and predict molecular properties and spectra.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Chemical Kinetics and Reaction Mechanism Basics of chemical kinetics: rate of reaction, factors influencing the rate of reaction, rate laws, rate law, consecutive reactions, chain reaction, parallel reactions, opposing reactions, Arrhenius equation, concept of activation energy	Classroom Lecture, Seminars, Problem-Based Learning, Research-Oriented Learning	CLO1, CLO2
II	Solid State Chemistry Contribution of Indian scientist C. N. R. Rao in solid state chemistry, Structural principle in solid state chemistry, types of solids based on bonding, nature of packing, conductivity. Preparation of solids, Solid state reactions, Perfect and imperfect crystals, types of defects, intrinsic and extrinsic defects, point defects, Band structure of metals, insulators and semiconductors, Rao's synthesis for 2D oxide materials, X-ray diffraction for structure determination of solids, Bragg methods, Powder methods, Miller indices, Neutron diffraction, Symmetry in solids, types of symmetry in cubic crystal system.	Classroom Lecture, Seminars, Collaborative Learning, Self-Directed Learning	CLO3
III	Nuclear Chemistry Contribution of Indian scientist Homi J. Bhabha in nuclear chemistry, Radioactive decay, nuclear reactions, Q value, cross sections, types of reactions, chemical effects of nuclear transformation, equilibrium, Nuclear	Classroom Lecture, Seminars, Reflective Practices	CLO4



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M.Sc. (Applied Chemistry) Semester-II

	fission and nuclear fusion. The separation of stable isotopes, the separation of unstable isotopes, Nuclear fuels and reactors, Bhabha's three-stage nuclear power programme, processing nuclear materials.		
IV	Symmetry and Group theory Concepts of molecular symmetry: symmetry elements, 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), Molecular point groups: Identification and classification, notation of points groups, Applications of point group	Classroom Lecture, Seminars, Problem-Based Learning, Reflective Practices, Self-Directed Learning	CLO5

- **(*) 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**

- (E) 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 test



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M.Sc. (Applied Chemistry) Semester-II

(F) Weightage of Learning Efforts for External Assessment

• 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	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	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%

• CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO 1	3	2	3	3	2	1	–	1	–	1	1	–
CLO 2	3	2	3	3	2	1	–	1	–	1	1	–
CLO 3	3	1	2	2	1	–	–	1	–	1	1	–
CLO 4	3	1	2	2	1	–	–	1	1	2	1	–
CLO 5	3	1	2	3	2	–	–	1	–	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	-



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M.Sc. (Applied Chemistry) Semester-II

• 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, 2008	Tata McGraw Hill
3	Chemical Kinetics	K. J. Laidler	3 rd edition, 1987	McGraw Hill
4	Solid State Chemistry and Its Applications	Anthony R. West	2 nd edition, 2022	John Wiley & Sons
5	Essentials of Nuclear Chemistry	H. J. Arnikaar	1982	Wiley Eastern

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL Courses: Chemical Kinetics	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA==
2	SWAYAM: Chemical Kinetics	http://ndl.iitkgp.ac.in/he_document/swayam_ugc_moocs/swayam_ugc_moocs/IN_SUM_1UC_17CCSOM_CK_1978_CK4_tsk_20937_20938?e=4 chemical%20kinetics
3	e-PG Pathshala (INFLIBNET): Solid State	http://ndl.iitkgp.ac.in/he_document/openstax_cnx/openstax/93_chemistry_atoms_first_pages_10_5_the_solid_state_of_matter?e=2 solid%20state
4	National Digital Library (IIT Kharagpur): Nuclear Chemistry	http://ndl.iitkgp.ac.in/he_document/openstax_cnx/openstax/IN_O_1CAF_3C_20NC_3247_3479?e=2 nuclear%20chemistry



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M.Sc. (Applied Chemistry) Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCACH04	Ore-Alloy Analysis and Organic Synthesis Practical	0-8-0	120	04

• Course Learning Outcomes (CLOs)

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

Course Learning Outcomes (CLOs)

CLO1: Perform quantitative analysis of ores such as hematite, calcite, pyrolusite, and bauxite using gravimetric and volumetric methods.

CLO2: Apply analytical techniques to determine metal ions (Fe, Al, Mn, Ca, Mg) and components like carbonate and acid-insoluble residues in inorganic samples.

CLO3: Analyze industrial materials and cement samples for composition, including oxides such as SiO₂, Fe₂O₃, Al₂O₃, CaO, and MgO.

CLO4: Carry out alloy analysis (German silver, brass, bronze, steel) and interpret their chemical composition using standard laboratory procedures.

CLO5: Synthesize organic compounds through single-step reactions such as Perkin reaction, coumarin, chalcone, phenyl salicylate, and fluorescein preparation.

CLO6: Design and execute multi-step organic synthesis, including flavone, sulpha drugs, and dyes, while understanding reaction mechanisms and purification techniques.

Unit	Course Content	Learning Pedagogies*	CO(s)
	Ore-Alloy Analysis 1. Analysis of Hematite 1) Acid insoluble residue 2) Iron as Fe ₂ O ₃ 3) Iron by redox method (volumetrically) 2. To analyze the given sample of Pyrolusite 1) Acid insoluble residue 2) Iron as Iron oxide 3) Mn by using EDTA 4) MnO ₂ oxalic acid method/Iodometric method 3. To determine the amount of Al and Fe in the given sample of Bauxite ore 1) Al as Al ₂ O ₃ 2) Fe as Fe ₂ O ₃ Alloys analysis 1. Analysis of German silver 2. Analysis of Bronze 3. Analysis of Brass 4. Analysis of Steel 5. Miscellaneous	Problem-Based Learning, Research-Oriented Learning, Experiential Learning, Reflective Practices	CLO1 to CLO6



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M.Sc. (Applied Chemistry) Semester-II

Organic Chemistry			
Single-step preparations			
1. Synthesis of 7-hydroxy 4-methyl coumarin			
2. Synthesis of chalcone			
3. Synthesis of phenyl salicylate			
4. Synthesis of fluorescein from the reaction of resorcinol and phthalic anhydride			
5. Preparation of various dyes			
6. Preparation of <i>m</i> -Nitrophenol from <i>m</i> -Nitroaniline			
7. Preparation of <i>p</i> -Iodonitrobenzene from <i>p</i> -Nitroaniline			
8. Preparation of Ethyl-6-methyl-2-oxo-4-phenyl-1,2,3,4-tetrahydro-5-pyrimidine-carboxylate.			
9. Preparation of 2,3-Diphenylquinoxaline			
10. Preparation of Benzimidazole.			

- **(*) 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/Tools**

- (G)Formative assessment (Assessment for Learning)**

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

- (p) Journal Evaluation
- (q) Method of working
- (r) Attendance

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

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



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(B) Weightage of Learning Efforts for External 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 Evaluation, Method of workings, Attendance, Mid-Term Examination, Viva-voce	50%
2	End-Semester Examination	Practical Exam	50%

• CLOs – PLOs Matrix

CLO	PLO											
	PL O1	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	2	-	-	-	-	1	-	-
CLO2	2	3	3	2	3	1	-	-	-	1	-	-
CLO3	2	3	2	3	3	1	-	-	-	2	-	-
CLO4	2	3	3	3	2	1	-	-	-	1	-	-
CLO5	1	2	3	2	2	2	-	-	-	-	-	-
CLO6	1	3	3	3	3	3	1	1	-	1	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	Physical Methods in Inorganic Chemistry	R. S. Drago	1 st Edition, 1965	John-Wiley Publication
2	Vogel's Qualitative Inorganic Analysis	G. Svehla	7 th Edition, 1996	Orent Longman



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3	Vogel's Textbook of Quantitative Chemical Analysis	G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney	5 th Edition, 1989	ELBS Publication
4	A Textbook of Practical Organic Chemistry	A. I. Vogel	5 th Edition, 1989	Pearson edu
5	Modern Analytical Chemistry	D. Harvey	1 st Edition, 2000	The McGraw-Hill Publication

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL: Application of Spectroscopic Methods in Molecular Structure Determination	http://www.digimat.in/nptel/courses/video/104106075/L25.html
2	SWAYAM: Quantitative Methods in Chemistry	https://onlinecourses.nptel.ac.in/noc20_cy02/preview
3	NPTEL: Quantitative Methods in Chemistry, IISER Bhopal	https://nptel.ac.in/courses/104106121
4	LibreTexts Chemistry: Practical Organic Chemistry Techniques	https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Organic_Chemistry_Lab_Techniques_(Nichols)



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCACH05	Industrial Product Characterization Practical	0-8-0	120	04

• Course Learning Outcomes (CLOs)

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

Course Learning Outcomes (CLOs)

- CLO 1: Apply spectrophotometric and colorimetric techniques (e.g., Beer–Lambert law, pKa determination, glucose estimation) to quantify chemical species and evaluate molar absorptivity.
- CLO 2: Perform quantitative analysis of pharmaceutical and environmental samples (e.g., tablets, COD, caffeine extraction) using titrimetric, iodimetric, and instrumental methods with accuracy and precision.
- CLO 3: Analyze physicochemical properties of solutions such as solubility, ionic strength effects, critical micelle concentration (CMC), and acid value using appropriate experimental techniques.
- CLO 4: Interpret reaction kinetics and thermodynamic parameters (e.g., hydrolysis reactions, polymer decomposition via TGA, viscosity behavior) using experimental data and relevant models.
- CLO 5: Utilize electrochemical and pH-metric methods to study acid–base equilibria, including determination of dissociation constants and neutralization behavior of polybasic acids.
- CLO 6: Develop laboratory proficiency in sample preparation, data acquisition, and error analysis while adhering to safety protocols and good laboratory practices in chemical experimentation.

Course Content	Learning Pedagogies*	CO(s)
- To verify Beer-Lambert's law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of the given sample spectrophotometrically. - To determine the solubility of calcium oxalate in the presence of KCl (Ionic strength effect). - Analysis of Pharmaceutical tablets (paracetamol, aspirin, iron, calcium, zinc). - To estimate the amount of D-glucose in a given solution colourimetrically. - To determine the acid value of the given oil. - To determine the zero-shear viscosity of a polymer solution at different temperatures. - To titrate pH metrically a dibasic acid solution against alkali	Mini Research Tasks, Problem-Based Learning, Research-Oriented Learning, Experiential Learning, Reflective Practices	CLO1 to CLO6



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and calculate the first and second neutralisation of the acid - To determine the decomposition kinetics of a polymer by TGA using the iso-conversional method. - To determine the relative strength of HCl and H₂SO₄ by studying the hydrolysis of methyl acetate. - Determination of CMC of given surfactant by drop weight methods. - To determine the percentage purity of glucose by iodimetry. - Determination of the acid value of polyester resin. - To determine the epoxy equivalent weight of the given epoxy resin. - To determine chemical oxygen demand (COD) in a given water sample. - Extraction of caffeine from dry tea leaves and its quantitative determination. - To determine the pKa Value of an indicator by the spectrophotometric method.			
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• (*) 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
- (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) Inquiry-Based Learning
- (ccc) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies

(H) Internal Assessment

a. Internal Formative Assessment (30 Marks)

- (a) Journal Evaluation
- (b) Method of Working
- (c) Attendance

b. Internal Summative Assessment (20 marks)

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



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• Weightage of Learning Efforts for External 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

• CLOs – PLOs Matrix

CLO	PLO											
	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	3	3	3	2	2	1	–	1	–	1	1	–
CLO2	3	3	3	2	2	1	–	1	1	2	1	–
CLO3	3	3	2	2	2	1	–	1	–	1	1	–
CLO4	3	2	3	3	2	1	–	1	–	1	1	–
CLO5	3	3	2	2	2	1	–	1	–	1	1	–
CLO6	3	3	2	2	2	3	1	1	3	2	1	–

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

• Assessment and Evaluation:

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

• 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	2 nd edition, 1968	Elsevier
2	A Laboratory Manual of Experiments in Physical Chemistry	D. Brennan, C. F. H. Tipper	1975	McGraw-Hill
3	Experimental Physical Chemistry	R. C. Das, B. Behera	1983	McGraw-Hill



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4	Advanced Physico-Chemical Experiments	J. Rose	1964	London: Pitman
5	Vogel's Textbook of Quantitative Chemical Analysis	G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney	5 th edition, 1989	ELBS Publication

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	3D Chemistry Models	https://www.labster.com/3d
2	Virtual Chemistry	https://virtualchemlabs.com/
3	Amrita Vishwa Vidyapeetham	https://vlab.amrita.edu/?sub=2
4	Virtual Lab an Initiative of Ministry of Education	https://ea-dei.vlabs.ac.in/



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M.Sc. (Applied Chemistry) Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2T02NCACH06	Instrumental Methods of Analysis	2-0-1	60	02

• Course Learning Outcomes (CLOs)

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

- CLO1: Critically analyze the principles and classifications of chromatographic techniques, including adsorption and partition chromatography, and evaluate the chromatographic behavior of solutes with respect to partition forces, column efficiency, and resolution.
- CLO2: Formulate and optimize experimental strategies for various chromatographic methods such as Gas Chromatography (GC), High-Performance Liquid Chromatography (HPLC), Ion Exchange Chromatography, and Thin Layer Chromatography (TLC), including selection of column preparation, solvent systems, and detection methods.
- CLO3: Evaluate thermogravimetric analysis (TGA) techniques by analyzing instrumentation, TGA curves, and factors affecting them, and formulate methods to determine composition and percentage decomposition of compounds.
- CLO4: Analyze and interpret thermal analysis techniques such as Derivative Thermogravimetry (DTG), Differential Thermal Analysis (DTA), and Differential Scanning Calorimetry (DSC), including their theoretical basis, instrumentation, applications, and limitations.
- CLO5: Critically analyze the physico-chemical properties of nanomaterials by evaluating size-dependent characteristics and formulating distinctions between molecules, nanoparticles, and bulk materials in the context of thermal analysis.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Separation Methods Principle, classifications of chromatographic methods, adsorption and partition chromatography, nature of partition forces, chromatographic behaviour of solutes, Column efficiency and resolution, Gas chromatography: detector, optimization of experimental conditions. Ion exchange chromatography, thin layer chromatography (TLC), gas chromatography (GC), high-performance Liquid chromatography (HPLC). Preparation of column, solvent systems and detection methods.	Classroom Lecture, Seminars, Problem-Based Learning, Collaborative Learning, Self-Directed Learning	CLO1, CLO2
II	Thermal Methods of Analysis Thermogravimetry (TGA): Definition, types of TGA, instrumentation, information from TGA curve, factor affecting TGA curves (instrumental as well as characteristics of sample factors);	Classroom Lecture, Seminars, Problem-Based Learning, Research-Oriented Learning,	CLO3, CLO4, CLO5



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Application of thermogravimetry, Calculation of percent decomposition and composition of compounds, limitation and advantages of TGA. Derivative thermogravimetry (DTG) and its advantages. Differential Thermal Analysis (DTA): Definition, Theoretical basis of DTA, Instrumentation for DTA apparatus, Factors affecting the DTA curve, Application of DTA, Advantages and disadvantages of DTA. Differential Scanning Calorimetry (DSC): General definition, Nano chemistry basics, distinction between molecules, nanoparticles and bulk materials. Physico-chemical considerations of nanomaterials, Size dependent properties.	Collaborative Learning, Self-Directed Learning	
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• (*) Learning Pedagogies/Methods

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

• Assessment Methodologies

(I) Internal Assessment

a. Internal Formative assessment (30 Marks)

- (s) Quiz
- (t) Seminar
- (u) Assignment
- (v) Group Task
- (w) Attendance

b. Internal Summative Assessment (20 Marks)

Mid-term test



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(J) 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	30	1	3	8	12
II	CLO3, CLO4, CLO5	30	1	4	8	13
		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%

(K) 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	2	3	1	-	-	-	-	1	1	-
CLO2	2	3	3	2	2	2	-	1	-	-	2	1
CLO3	2	3	2	3	2	2	1	1	-	1	2	-
CLO4	3	2	2	3	2	1	-	1	1	1	2	-
CLO5	3	1	2	3	2	-	-	-	-	2	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
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1	Instrumental Methods of Analysis	Willard, Merrit, Dean and Settle	7 th edition 2004	CBS Publishers & Distributors
2	Fundamentals of Analytical Chemistry	D. A. Skoog, D. M. West	6 th edition 1992	Saunders College Publishing
3	Physical Chemistry	Ira N. Levine	4 th edition 2011	McGraw-Hill Education
4	Instrumental Methods of Chemical Analysis	V. K. Ahluwalia	1 st edition 2023	Springer
5	Instrumental method of Chemical Analysis	B. K. Sharma	33 rd edition 2023	Krishna Prakashan Media Pvt. Ltd.

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Libre Texts – Analytical Chemistry	https://chem.libretexts.org/Bookshelves/Analytical_Chemistry
2	e-PG Pathshala – Analytical Chemistry	https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=CHEMISTRY
3	Shimadzu- Excellence in science	https://www.shimadzu.com/an/service-support/technical-support/thermal/overview/whatis_thermal.html
4	Rigaku: Thermal Analysis	https://rigaku.com/resources/techniques/thermal-analysis