Curriculum and Credit Framework
As per NEP 2020

For

Post Graduate Programme
(M.Sc.) in Chemistry

(To be effective from the Academic Session 2026-27)

Department of Chemistry

Gurugram University, Gurugram

(A State Govt. University Established Under Haryana Act 17 Of 2017)

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Background

- The Chemistry Department of Gurugram University, Gurugram, Haryana - India was established in 2020.
- Department has started a postgraduation programme M.Sc.-Chemistry w.e.f. 2020-2021.
- The vision of the Department of Chemistry is to promote excellence and innovation in teaching and research and to create an academically stimulating atmosphere for students.
- The Mission of the Department of Chemistry is to educate and train students to achieve excellence in science *via* chemistry, which will empower them to contribute to the development of the nation.
- The department aims to encourage critical thinking and develop research skill.
- Specialization in Organic chemistry, Inorganic Chemistry and Physical Chemistry is being provided to students.
- Intake in first session 2021-22 was 20 students.
- In session 2024-25 intake increased up-to 30 students.

Vision and Mission

Vision

1. To impart knowledge and skills in the area of chemistry, to promote excellence and innovation, instil curiosity and ignite interest in relevant areas to inspire young minds to make significant contributions for the betterment of humankind.
2. To develop a department that can effectively harness its strength to create an academically inspiring atmosphere by inculcating students with cultural and ethical values.

Mission

1. To promote, inspire and nurture the fundamentals of chemistry through courses offered to the students.
2. To provide high quality and innovative education with emphasis on both theory and practical training for transformation of young budding chemists into productive scientists, excellent teachers, entrepreneurs and creative independent researchers.
3. To support inter disciplinary research with focus on solving problems of global significance by working jointly with other universities and research Institutes.

Programme Outcomes

On completing M.Sc. (Chemistry) Programme, the students shall be able to realize following programme outcomes:

S. No.	Component	Description
PO-1	Basic Knowledge	Equipped to convey fundamental disciplinary knowledge acquired during the programme.
PO-2	In-depth Knowledge	Proficient in explaining advanced concepts and insights gained throughout the programme.
PO-3	Critical Thinking and Problem-Solving Abilities	Skilled in critically evaluating results and applying acquired knowledge to address and solve problems.
PO-4	Creativity and Innovation	Competent in identifying, formulating, investigating, and analysing scientific problems, and creatively designing and developing practical solutions.
PO-5	Research Aptitude and Global Competency	Capable of developing a strong research aptitude and applying knowledge to solve significant research challenges on a global scale.
PO-6	Holistic and Multidisciplinary Education	Able to acquire knowledge through a holistic and multidisciplinary approach across diverse fields.
PO-7	Skills Enhancement	Proficient in learning specific disciplinary or multidisciplinary skills and advanced techniques, and applying them for the benefit of society.
PO-8	Leadership and Teamwork Abilities	Effective in working within a team and demonstrating leadership abilities.
PO-9	Environmental and Human Health Awareness	Knowledgeable about key issues related to environmental and human health, and capable of developing eco-friendly technologies.
PO-10	Ethical Thinking and Social Awareness	Instilled with a professional and ethical mindset, with the ability to engage with and address social issues.

Programme Specific Outcomes

On completing M.Sc. Chemistry programme, the students shall be able to realize following outcomes:

S. No.	Description
PSO-1	To demonstrate in-depth knowledge and understanding of key concepts in organic, inorganic, physical, and analytical chemistry, enabling them to solve complex chemical problems and conduct innovative research.
PSO-2	To acquire advanced laboratory techniques and skills, including the ability to design, conduct, and analyze experiments using modern instrumentation and methodologies in chemistry.
PSO-3	To independently design and execute original research projects, critically analyze data, and effectively communicate their findings through scientific publications and presentations.
PSO-4	To develop strong problem-solving and critical-thinking abilities, allowing them to apply chemical principles to real-world issues, including those related to industry, healthcare, and environmental sustainability.
PSO-5	To integrate knowledge from various sub-disciplines of chemistry and related fields such as biology, physics, and materials science, fostering interdisciplinary collaboration and innovation.
PSO-6	To understand and adhere to professional and ethical standards in chemistry, demonstrating a commitment to lifelong learning, responsible conduct of research, and the societal impact of their work.

Postgraduate Attributes

A postgraduate MSC student from Department of Chemistry is envisaged to have the following attributes:

- Disciplinary Knowledge
- Creative and Critical Thinking
- Reflective Thinking
- Problem Solving
- Communication Skills
- Research Skills
- Life Skills
- Multidisciplinary Competence
- Moral and Ethical Values
- Inculcate the importance of Life-long Learning
- Global Competence

Qualification Descriptors

To be eligible for admission in M.Sc. Chemistry programme the candidates should have minimum 50% marks in their Bachelor degree from a recognized university like B.Sc. (Hons.) in Chemistry/B.Sc.(Pass)/B.Sc. (Life Sciences) with Chemistry as the main subject.

Updated Scheme

(Scheme PG A2: Postgraduate Programmes (Course work + Research)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A01	Inorganic Chemistry - I	241/CHE/CC /101	3			3			3	25	50	_	_	75
					2			1	1			5	20	25
CC-A02	Physical Chemistry - I	241/CHE/CC /102	3			3			3	25	50	_	_	75
					2			1	1			5	20	25
CC-A03	Organic Chemistry - I	241/CHE/CC /103	3			3			3	25	50	_	_	75
					2			1	1			5	20	25
Discipline Specific Elective Courses														
DSE-01	Chemistry of Life Sciences	241/CHE/DS/ 101	3			3			3	25	50			75
	Mathematics for Chemist	241/CHE/DS/ 102												
	Applied Mathematics for Chemists	**241/CHE/DS /103**												
Multidisciplinary Course(s)														
MDC-01	From The Pool **Chemistry of Materials**	241/CHE/M D/101	3			3			3	25	50			75
Ability Enhancement Course(s)														
AEC-01	Environmental Chemistry – I	241/CHE/AE /101	2			2			2	15	35			50
Value-added Course(s)														
VAC-01	**Green Chemistry**	241/CHE/VA /101	2						2	15	35			50
Total Credits									**22**					

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A04	Inorganic Chemistry - II	241/CHE/CC /201	3			3			3	25	50		-	75
					2			1	1			5	20	25
CC-A05	Physical Chemistry - II	241/CHE/CC /202	3			3			3	25	50			75
					2			1	1			5	20	25
CC-A06	Organic Chemistry - II	241/CHE/CC /203	3			3			3	25	50	-	-	75
					2			1	1			5	20	25
Discipline Specific Elective Courses														
DSE-02	From the Pool **Spectroscopic methods in Chemistry - I**	241/CHE/DS/ 201	3			3			3	25	50			75
Multidisciplinary Course(s)														
MDC-02	From The Pool **Drug Design and Discovery**	241/CHE/M D/201	3			3			3	25	50			75
Ability Enhancement Course(s)														
AEC-02	Computer for chemists	241/CHE/AE /201	2			2			2	15	35			50
Skill Enhancement Course(s)														
SEC-01	Analytical Chemistry	241/CHE/SE/ 201	2						2	15	35			50
Total Credits									22					

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A07	Inorganic Chemistry Special - I	241/CHE/ CC/301	**3**		**2**	**3**		**1**	**4**	**25**	**50**	**5**	**20**	**100**
	Physical Chemistry Special - I	261/CHE/ CC/311												
	Organic Chemistry Special - I	241/CHE/ CC/321												
CC-A08	Inorganic Chemistry Special - II	241/CHE/ CC/302	**3**		**2**	**3**		**1**	**4**	**25**	**50**	**5**	**20**	**100**
	Physical Chemistry Special - II	261/CHE/ CC/312												
	Organic Chemistry Special - II	241/CHE/ CC/322												
CC-A09	Inorganic Chemistry Special - III	241/CHE/ CC/303	**3**		**2**	**3**		**1**	**4**	**25**	**50**	**5**	**20**	**100**
	Physical Chemistry Special - III	261/CHE/ CC/313												
	Organic Chemistry Special - III	241/CHE/ CC/323												
Discipline Specific Elective Courses														
DSE-03	From the Pool **Spectroscopic methods in Chemistry - II**	241/CHE/ DS/301	**3**			**3**			**3**	**25**	**50**			**75**
Multidisciplinary Course(s)														
MDC-03	From The Pool **Instrumental methods of Analysis**	241/CHE/ MD/301	**3**			**3**			**3**	**25**	**50**			**75**
Skill Enhancement Course(s)														

SEC-02	Medicinal chemistry	241/CHE/SE/301	2			2			2	15	35			50
Value-added Course(s)															
VAC-02	Interdisciplinary Chemistry	241/CHE/VA/301	2			2			2	15	35			50
Seminar															
Seminar									2					50
Internship/Field Activity#															
									4						
Total Credits									28						

#Four credits of internship earned by a student during summer internship after 2nd semester will be counted in 3rd semester of a student who pursue 2 year PG Programme without taking exit option.

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Ability Enhancement Course(s)														
AEC-03	Advanced Inorganic Chemistry	241/CHE/AE/401	2			2			2	15	35			50
	Advanced Physical Chemistry	241/CHE/AE/411												
	Advanced Organic Chemistry	241/CHE/AE/421												
Dissertation/Project Work														
Dissertation									20					
Total Credits									22					

CORE COURSES (CC)

Course Code CC-A01			Course Title Inorganic Chemistry-I								Course ID 241/CHE/CC/101
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	5	20	25
Examination Duration:			Theory: 3 Hrs				Practical: 4 Hrs (Two sessions)				

Course Objectives	1. Define and use group theory concepts, symmetry elements, and point groups to analyse molecular symmetry. 2. Examine formation constants, stability factors, and the chelate effect in metal-ligand complexes. 3. Study substitution reactions in octahedral complexes and theories of the trans effect. 4. Apply VSEPR theory, Walsh diagrams, and bonding rules to predict molecular shapes and bonding. 5. Understand crystal field theory, its limitations, and molecular orbital theory for various metal-ligand complexes. 6. Conduct qualitative analysis and prepare inorganic compounds for spectroscopic studies.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Use group theory and character tables to describe molecular symmetry and predict optical activity. 2. Calculate and interpret metal-ligand formation constants and the chelate effect. 3. Describe and predict mechanisms of substitution reactions and the trans effect in metal complexes. 4. Predict molecular shapes and bonding using VSEPR theory and Walsh diagrams. 5. Explain bonding in metal-ligand complexes using crystal field and molecular orbital theories. 6. Perform qualitative analysis and synthesize inorganic compounds for spectroscopic analysis.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Symmetry and Group Theory in Chemistry** Definitions of group, subgroup, relation between orders of finite groups and its subgroups. Conjugacy relation and classes.	12

	Symmetry elements and symmetry operations, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly). Character of a representation, reducible and irreducible representations. The great orthogonality theorem (without proof) and its importance, Derivation of character tables of C_{2v}, C_{3v} and D_{2h} Character tables and their use. Molecular asymmetry, dissymmetry, and optical activity.	
II	**Metal-Ligand Equilibria in Solution-I** Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.	**11**
III	**Metal-Ligand Equilibria in Solution-II** Substitution reactions in octahedral complexes-acid hydrolysis, Base hydrolysis, racemization of tris chelate complexes, theories of trans effect with respect to Pt(II) complexes. Brief account of electron transfer reactions, inert and labile complexes.	**11**
IV	**Stereochemistry and Bonding in Main Group Compounds** VSEPR Theory, Walsh diagrams (tri-atomic molecules), d_π-p_π bonds, Bent rule and energetics of hybridization **Metal-Ligand Bonding** Crystal field theory and its limitation, Crystal field effects, Jahn Teller distortion, nephelauxetic series, spin-orbital coupling, molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without π-bonding).	**11**
Practical Syllabus		**4**

Qualitative Analysis

Separation of the metal ions and determination of any one of them using volumetric/gravimetric methods.

Cu-Ni, Cu-Zn, Cu-Al, Ca-Ba, Fe-Mg, Fe-Ni etc.

1. Preparations:

Preparation of the following inorganic compounds and their spectroscopic studies.

I. $Hg[Co(SCN)_4]$
II. $[Cu(NH_3)_4]SO_4.H_2O$
III. Prussian Blue and Turnbull`s Blue
IV. $Na[Cr(NH_3)_2(SCN)_4]$
V. $Mn(acac)_3$
VI. $[Ni(NH_3)_6]Cl_2$
VII. $VO(acac)_2$

All the students must submit the recrystallized product along with m.p. for all the stages of preparation.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory:	1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley. 2. Inorganic Chemistry, J.E. Huheey, Harper & Row. 3. Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.

	4. Inorganic Chemistry: Principles of Structure and Reactivity; J.E. Huheey, E.A. Keiter, and R.L. Keiter (Indian Edition) 5. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe. 6. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons. 7. Inorganic Chemistry, A Modern Introduction; T. Moeller, John Wiley and Sons.	
Practical	1. A Text Book of Macro and Semi-micro quantitative Analysis, A. I. Vogel, Orient Longman. 2. A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (03 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 5 Marks	• Class Participation/ Seminar/Lab record: 5 Marks
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 5 Marks

Course Code CC-A02			Course Title Physical Chemistry-I				Course ID 241/CHE/CC/102				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	5	20	25
Examination Duration:			**Theory**: 3 Hrs				**Practical**: 4 Hrs (Two sessions)				

Course Objectives	1. Understand the foundational principles of quantum mechanics. 2. Explore the historical development and key experiments of quantum mechanics. 3. Solve the Schrödinger equation for various simple systems. 4. Apply quantum mechanical principles to the hydrogen atom and atomic orbitals. 5. Utilize perturbation theory for analyzing quantum systems. 6. Implement approximate methods in solving quantum mechanical problems. 7. Conduct practical experiments to reinforce theoretical concepts in Physical Chemistry.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Explain the historical experiments that led to the development of quantum mechanics. 2. Solve the Schrödinger equation for particles in one-dimensional and three-dimensional boxes. 3. Analyze the quantum mechanical behavior of the harmonic oscillator and rigid rotor. 4. Apply perturbation theory to solve problems involving simple quantum systems. 5. Utilize the variational principle to approximate solutions for complex systems. 6. Perform practical experiments on viscosity, conductometry, chemical kinetics, and adsorption. 7. Interpret experimental data and verify theoretical predictions in quantum mechanics.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs

I	**Basic Principles of Quantum Mechanics** Introduction to Quantum Mechanics, Historical background of quantum mechanics, Blackbody radiation and Planck's hypothesis, Photoelectric effect and Einstein's explanation, Compton effect, De Broglie hypothesis and matter waves, Heisenberg uncertainty principle, Wave-particle duality, Introduction to wave functions, Schrödinger equation: Time-dependent and time-independent forms, Interpretation of wave functions: Probability density and normalization	11
II	**Quantum Mechanics of Simple Systems** Particle in a one-dimensional box: Derivation and interpretation, Particle in a three-dimensional box, Harmonic oscillator: Schrödinger equation and solutions, Quantum mechanical treatment of the rigid rotor,	12
III	**Applications of Quantum Mechanics** Hydrogen atom: Schrödinger equation and solutions, Quantum numbers and their significance, Shapes of atomic orbitals, Spin angular momentum, Quantum mechanical tunnelling. Quantum Mechanics of Atoms: Application to multi-electron atoms, Introduction to the Pauli exclusion principle, Electronic configuration of atoms.	
IV	**Approximate Methods in Quantum Mechanics** Perturbation theory: Time-independent perturbation theory (first and second order), Applications of perturbation theory to simple systems, Quantum mechanical treatment of the helium atom, Time-dependent perturbation theory, Stark effect, Zeeman effect, Advanced perturbation techniques, Applications in molecular systems. Variational principle: Concept and applications,	11
Practical Syllabus		**4**

Viscosity

[1] Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol.

[2] Determination of molar mass of a polymer.

Conductometry

[3] Determine the strength of strong acid by conductometric titration with strong base.

[4] Determine the strength of weak acid by conductometric titration with strong base.

[5] Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base.

[6] Study precipitation titration between KCl and AgNO3conductometrically. Determine the strength of given solution of AgNO3.

[7] Determine solubility and solubility product of sparingly soluble salts like $PbSO_4$, $BaSO_4$.

[8] Determine the relative strength of chloroacetic acid and acetic acid by conductivity measurements.

Chemical Kinetics

[9] Study the hydrolysis of methyl acetate in presence of hydrochloric acid.

[10] Study saponification of ethyl acetate by sodium hydroxide solution using same initial concentration of both the reactants.

Adsorption and others

[11] Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid/oxalic acid on activated charcoal.

[12] Determination of critical solution temperature of phenol-water system.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books	
Theory	1. Introduction to Quantum Mechanics by David J. Griffiths, 2nd Edition, Pearson 2. Principles of Quantum Mechanics by R. Shankar, 2nd Edition, Springer 3. Quantum Chemistry by Ira N. Levine, 7th Edition, Pearson 4. Molecular Quantum Mechanics by P.W. Atkins and R.S. Friedman, 5th Edition, Oxford University Press 5. Quantum Chemistry by Donald A. McQuarrie, 1st Edition, University Science Books 6. Quantum Chemistry by R.K. Prasad, 4th Edition, New Age International Publishers
Practical	1. Advanced Practical Physical Chemistry by J.B. Yadav, 20th Edition, Goel Publishing House 2. Experiments in Physical Chemistry by Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, 8th Edition, McGraw-Hill Education 3. Experimental Physical Chemistry by Farrington Daniels and J.H. Mathews, 7th Edition, McGraw-Hill Education 4. Practical Physical Chemistry by Alexander Findlay, 9th Edition, Longmans, Green and Co. 5. Vogel's Textbook of Quantitative Chemical Analysis by G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, 6th Edition, Pearson 6. Experimental Physical Chemistry by Arthur M. Halpern and George C. McBane, 3rd Edition, W.H. Freeman and Company

	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks	• End Term Exam: 50 Marks

	(03 Hours)	s
Practical	Internal Assessment: 5 Marks	s Class Participation/Seminar/Lab record: 10 Marks
	External Assessment: 20 Marks	s End Term Practical Exam: 10 Marks s Lab record: 05 Marks s Viva Voce: 5 Marks

Course Code CC-A03			Course Title Organic Chemistry-I				Course ID 241/CHE/CC/103				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	5	20	25
Examination Duration:			**Theory**: 3 Hrs				**Practical**: 4 Hrs (Two sessions)				

Course Objectives	1. To understand the principles of reaction mechanisms in organic chemistry, focusing on the influence of structure, thermodynamic and kinetic requirements, and the behaviour of intermediates. 2. To provide a comprehensive understanding of the mechanisms, stereochemistry, and factors influencing nucleophilic aliphatic substitution and elimination reactions. 3. To provide a foundational understanding of stereochemistry, focusing on nomenclature, conformational analysis, and chirality in various organic systems. 4. To provide an advanced understanding of stereochemistry concepts, including topicity, stereospecific and stereoselective reactions, and the stereochemistry of sugars and decalins. 5. To equip students with hands-on experience in essential laboratory techniques, including crystallization, distillation, solvent extraction, and chromatography. 6. To provide practical exposure to key organic synthesis reactions, enabling students to prepare, purify, and characterize important organic compounds.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Analyse and predict reaction mechanisms using theoretical concepts; determine the stability and reactivity of intermediates. 2. Able to analyse and explain the detailed mechanisms of SN^1, SN^2, E1, and E2 reactions, including the effects of nucleophiles, solvents, and substituents on reactivity and stereochemistry. 3. Able to analyse and interpret the stereochemical properties and configurations of organic molecules, including simple, cyclic, and acyclic systems. 4. Accurately analyse and determine the stereochemistry of complex molecules, including sugars and decalins, using concepts like chirogenicity and pseudoasymmetry. 5. Proficiently perform crystallization, distillation, solvent extraction, and chromatography, demonstrating accurate execution and understanding. 6. Successfully synthesize, purify, and characterize organic compounds, submitting recrystallized products along with their melting points for all stages of preparation.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All

questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Reaction Mechanism: Structure and Reactivity** Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment-The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation. Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining reaction mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.	11
II	**Mechanism of Nucleophilic Aliphatic Substitution** The limiting cases SN^1 and SN^2, detailed mechanistic description and borderline mechanisms, nucleophilicity and solvent effects, competition between nucleophilicity and basicity, ambident nucleophiles, hard and soft nucleophiles and electrophiles, leaving group effects, steric and other substituent effects on substitution and ionization rates, stereochemistry of nucleophilic substitution. SN^i, $SN^{i'}$, $SN^{2'}$ and $SN^{i'}$ mechanisms. **Mechanism of Elimination Reactions** The El, ElcB and E2 mechanisms, Orientation Effects in Elimination Reactions, Saytzeff and Hoffman rules, Stereochemistry of E2 Elimination Reaction and Eclipsing Effects in E2 Eliminations. Dehydration of Alcohols, Elimination not involving C-H Bonds, Pyrolytic eliminations.	12
III	**Stereochemistry-I** Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat configuration) and acyclic systems. Axial and planer chirality, optical isomerism in allenes, biphenyls (atropoisomerism), spiranes, hemispiranes.	11
IV	**Stereochemistry-II** Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. stereospecific and stereoselective reaction.Elementary idea of principle categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule and horeaus rule. Stereochemistry of sugars-C1 and 1C conformations of hexoses, c_2'-endo and c_3'-endo conformation of pentoses. homomorphous sugars, abnormal mutarotation and Δ-2 instability factor. Stereochemistry of decalins,	11
Practical Syllabus		4
ISOLATION AND PURIFICATION TECHNIQUES Laboratory Safety		

Crystallization, recrystallization and sublimation
Distillation: Simple, Steam and Vacuum
Solvent Extraction
Drying of ethanol/ acetone/ diethylether/THF
Paper Chromatography
Thin Layer Chromatography

Two-step Preparation of some important organic compounds involving the reactions out of the followings representative reactions)

1. Acetylation (Synthesis of Aspirin, Paracetamol)
2. Esterification and saponification
3. Oxidation
4. Reduction or Hydrogenation
5. Partial Reduction
6. Nucleophilic substitution
7. Aromatic electrophilic substitution reaction
8. Condensation reactions
9. Hoffman's Bromamide reaction
10. Heterocyclic synthesis
11. Any other reaction as per requirement

All the students must submit the recrystallized product along with m.p. for all the stages of preparation.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory:	1. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley. 2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum. 3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman. 4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.. 5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall. 6. Modern Organic Reactions, H. O. House, Benjamin. 7. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional. 8. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan. 9. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International. 10. Stereochemistry of Organic Compounds, P.S, Kalsi, New Age International. 11. Stereochemistry of Organic compounds, E.L. Eliel, Mc Graw Hills, 1962.
Practical	1. A Hand book of Organic Analysis-Qualitative and Quantitative by H.T. Clarke, and revised by B.Haynee, Edward Arnold, London 1975. 2. Vogel's Text Book of Practical Organic Chemistry by B.S. Furhenet. al., Longman-Group Ltd. 3. Systematic Qualitative Organic Analysis by H. Middleton, Edward Arnold (Publishers) Limited, London 1959. 4. Elementary Practical Organic Chemistry by Arthur I. Vogel, EX CBS Publishers and Distributors.

	5. Experiments in Organic Chemistry by Louis, F.Fieser, D.C. Heath and Company Boston, 1955. 6. College Practical Chemistry by V. K. Ahluwalia, S. Dhingra and A. Gulati.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (03 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 5 Marks	• Class Participation/ Seminar/Lab record: 5 Marks
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)

Course Code DSE-01			Course Title Chemistry of Life Sciences				Course ID 241/CHE/DS/101		
L	T	P	L	T	P	Total Credits	MARKS		
(Hrs)			Credits				TI	TE	Total
3	-	-	3	-	-	3	25	50	75

Examination Duration:	3 Hrs
Course Objectives	1. To provide a comprehensive understanding of the structure and biological functions of carbohydrates, emphasizing their roles in biological recognition and physiological processes. 2. To equip the students with complete understanding of cell structure, and lipid biochemistry, focusing on the functions of intracellular organelles and key metabolic pathways. 3. To understand the structure, hydrolysis, sequencing, and secondary structure of amino acids, peptides, and proteins, along with the principles of protein denaturation. 4. To understand the structure, hydrolysis, sequencing, and secondary structure of amino acids, peptides, and proteins, along with the principles of protein denaturation.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Describe the structures and functions of important carbohydrates and glycoconjugates and explain their significance in biological systems and cellular recognition. 2. Demonstrate knowledge of cell structures and their functions, as well as an understanding of metabolic pathways and lipid biochemistry, including carbohydrate metabolism and lipid aggregates. 3. Able to analyse protein structure and sequence using methods like Sanger and Edman degradation and explain protein denaturation. 4. Demonstrate the ability to analyse protein structure and sequence using methods like Sanger and Edman degradation and explain protein denaturation.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Carbohydrates** Structure and biological functions of important monosachharides (excluding detailed conformational analysis) and derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars-*N*-acetylmuramic acid and sialic acid. Disaccharides-sucrose, lactose and maltose. Structure and biological functions of Structural polysaccharides (cellulose and chitin) and Storage polysaccharides (starch and glycogen).	12

	Heteropolysaccharides-glucosaminoglycans/mucopolysaccharides. Glycoconjugates-glyco proteins and glycolipids. Role of sugars in biological recognition. Blood group substances.	
II	**Cell Structure and Metabolism** Structure of prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview of metabolic processes-catabolism and anabolism. ATP - the biological energy currency. Carbohydrate metabolism: glycolysis and Kreb's cycle. **Lipids** Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids. Lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure. Lipid metabolism-β-oxidation of fatty acids.	**11**
III	**Amino-acids, Peptides and Protein** Peptide bond, Chemical and enzymatic hydrolysis of proteins to peptides, Sanger method and Edman degradation method for amino acid sequencing. Secondary structure of proteins-α-helix, β-sheet, forces responsible for holding the secondary structures of proteins. Denaturation of Proteins.	**11**
IV	**Nucleic Acids and Genetic Code** Structure and functions of nucleotides, nucleosides, DNA (Watson-Crick model, Chargaff's rules) and RNA (m RNA, r-RNA and t-RNA). Genetic code and its characteristics, codon-anticodon pairing (Wobble hypothesis). **Replication, Transcription and Translation (Prokaryotes only)** Replication of DNA: Maselson-Stahl experiment, mechanism of replication (Initiation, Elongation and Termination). Transcription: Promoters site, Initiation, Elongation, Termination. Translation: Activation of amino acids, Initiation, Elongation, Termination.	**11**
Suggested Books	1. Principles of Biochemistry, A. L. Lehninger, Worth Publishers. 2. Biochemistry, L.Stryer, W.H.Freeman. 3. Biochemistry, J. David Rawn, Neil Patterson. 4. Biochemistry, Voet and Voet, John Wiley. 5. Outlines of Biochemistry, E. E.Conn and P. K. Stumpf, John Wiley.	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (03 Hours)	• End Term Exam: 50 Marks

Course Code DSE-01			Course Title Mathematics for Chemists				Course ID 241/CHE/DS/101		
L	T	P	L	T	P	Total Credits	MARKS		
(Hrs)			Credits				TI	TE	Total
3	-	-	3	-	-	3	25	50	75
Examination Duration:							3 Hrs		

Course Objectives	1. To provide students with a fundamental understanding of vector mathematics and its applications in spectroscopy and quantum chemistry. 2. To provide a fundamental understanding of matrices and determinants, and their application in solving linear equations and problems in chemistry. 3. To understand and apply logarithms and graphical methods for solving chemical problems and analysing data with precision. 4. To provide students with a comprehensive understanding of algebraic, trigonometric, differential, and integral calculus concepts and their applications in solving chemical problems.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Demonstrate proficiency in performing vector operations, including addition, subtraction, multiplication, and differentiation, and apply these concepts to problems in spectroscopy and quantum chemistry. 2. Able to perform matrix operations and use determinants to solve linear equations, applying these concepts to relevant chemical problems. 3. Proficiently use logarithms and graphical techniques to solve chemical problems and analyse experimental data. 4. Able to apply calculus techniques to analyse and solve mathematical problems in chemistry, demonstrating proficiency in differentiation, integration, and differential equations.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Vectors** Examples of scalar and vectors, definitions of vectors in two, three spaces, representation and simple properties of vectors, addition and subtraction of vectors, vector addition by the method of triangles, resolution of vectors into rectangular components, addition of vectors by components, multiplication and differentiation of vectors. Scalar product of vectors, vector product, concept of normalization, orthogonality and complete set of unit vectors. Illustration of applications to spectroscopy and quantum chemistry.	11
II	**Matrices and Determinants**	11

	Definition of matrix, types of matrices, viz. row matrix, column matrix, null matrix, square matrix, diagonal matrix, addition, subtraction and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix, elementary transformation, representation and applications (without development of theory) to solution of linear equations. Definition of determinant, properties of determinants, evaluation of determinants. Illustration or applications to group theory, problems in chemistry.	
III	**Logarithm** Need for logarithm in chemistry. Theory and application of logarithms for solving general and chemical problems. **Graphical Representation of Equations** Rectangular coordinates, straight lines, slope and intercept of the equation, slope and point equation, two point equation, parallel lines, points of intersection, distance between two points, change of origin. Examples from problems in chemistry, curve fitting for least squares method. Data analysis, mean and standard deviation, Absolute and Relative errors	**11**
IV	**Elements of Algebraic and Trigonometric Functions** The binomial expansion, some example from chemistry, sines, cosines and tangents, trigonometric identities, polar coordinates in trigonometric functions. **Differential Calculus** Theory, graphical significance of differentiation, rules of differentiation, Algebraic simplification, Partial differentiation, Exact and inexact differential with their application to thermodynamic principles. **Integral Calculus** Integral theory, methods of integration, viz. algebraic simplifications, substitution, integration by parts, integration by partial fractions, integration between limits, curve sketching, integral as area, , Illustration of application in chemistry. **Differential Equation** Simple differential equations, separable variables, homogeneous equations, exact differential equations, linear differential equations, partial differential equations, application to physico-chemical problems.	**12**
Suggested Books	1. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill. 2. Mathematical Preparation for General Physics, J.B. Marian, R.C. Davidson Saunder Company. 3. Mathematical Methods for Science Students, G. Stephemen, ELBS. 4. Chemical Thermodynamics, R.C. Reid.	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (03 Hours)	• End Term Exam: 50 Marks

Semester-1

Discipline Specific Elective (DSE) (to be effective from the session 2026-27)

Course Code DSE-01			Course Title Applied Mathematics for Chemists				Course ID 241/CHE/DS/103		
L	T	P	L	T	P	Total Credits	MARKS		
(Hrs)			Credits				TI	TE	Total
3	-	-	3	-	-	3	25	50	75
Examination Duration:							3 Hrs		

Course Objectives	• Develop mathematical skills required for understanding and solving chemical problems involving algebraic, graphical, statistical, and calculus-based methods. • Introduce vector and matrix algebra and their applications in molecular symmetry, quantum chemistry, and molecular orbital theory. • Familiarize students with statistical methods for the analysis, interpretation, and validation of experimental chemical data. • Provide knowledge of differential and integral calculus and differential equations for modelling chemical kinetics, thermodynamics, and transport phenomena. • Enable students to apply mathematical techniques to interpret experimental observations and solve quantitative problems encountered in chemistry.
Course Outcomes:	• Apply algebraic, logarithmic, and exponential functions to solve problems related to chemical equilibrium, reaction kinetics, pH calculations, and graphical interpretation of chemical data. • Utilize vector algebra, matrices, determinants, eigenvalues, and eigenvectors to analyze molecular structures, symmetry operations, and molecular orbital representations. • Perform statistical analysis of experimental data using measures of central tendency, dispersion, regression, correlation, least-squares fitting, and error analysis to evaluate the reliability of chemical measurements. • Apply differential and integral calculus, including partial differentiation, multiple integrals, Jacobians, and differential equations, to model and solve problems in chemical kinetics, thermodynamics, and transport processes. • Integrate mathematical and statistical tools to formulate, analyze, and interpret quantitative chemical problems encountered in advanced studies and research.

COURSE SYLLABUS

Note:

1. Question No. 1 is compulsory and shall contain short answer type questions covering the entire syllabus.
2. Eight questions will be set, two from each of the Units I, II, III and IV. Candidates are required to attempt four questions in all, selecting at least one question from each unit.
3. The question paper must be set in consonance with the course outcomes.

Unit No.	Contents	Contact Hrs
I	**Algebra, Logarithms and Graphical Methods**	11

	Algebraic expressions and identities, linear and quadratic equations, binomial expansion, logarithmic and exponential functions, laws of logarithms, relationship between logarithmic and exponential functions, applications in chemical equilibrium, kinetics and pH calculations. Cartesian coordinates, plotting of straight-line, parabolic, hyperbolic, logarithmic and exponential functions, straight-line equation, slope and intercept, graphical representation of experimental data.	
II	**Vectors and Matrices** Scalars and vectors, vector algebra, scalar and vector products, vector spaces, orthogonality and normalization. Matrices and determinants, matrix operations, inverse and transpose of matrices, eigenvalues and eigenvectors. Applications in molecular symmetry and molecular orbital theory.	**11**
III	**Data Analysis and Statistics** Mean, median, mode, variance, standard deviation, absolute and relative errors, significant figures, least-squares fitting, correlation and regression analysis, propagation of errors and uncertainty analysis. Applications in experimental data analysis and analytical chemistry.	**11**
IV	**Differential and Integral Calculus** Limits and continuity, differentiation of algebraic, logarithmic and exponential functions, partial differentiation, maxima and minima, exact and inexact differentials, indefinite and definite integration, multiple integrals, Jacobians, first- and second-order differential equations, applications to chemical kinetics, thermodynamics and transport phenomena.	**12**
Suggested Books	1. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill. 2. Mathematical Preparation for General Physics, J.B. Marian, R.C. Davidson Saunder Company. 3. Mathematics for Chemists – R. Gopalan. 4. Mathematical Preparation for Physical Chemistry – F. Daniels. 5. Mathematics for Physical Chemistry – Robert G. Mortimer. 6. Mathematical Methods for Science Students – G. Stephenson. 7. Fundamentals of Mathematical Statistics – S.C. Gupta and V.K. Kapoor. 8. Physical Chemistry – P.W. Atkins and Julio de Paula. 9. Advanced Engineering Mathematics-Erwin Kreyszig	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 10 Marks • Mid Term Exam: 10 Marks
	External Assessment: 50 Marks (03 Hours)	• End Term Exam: 50 Marks

241/CHE/CC201

CC-A04: Inorganic Chemistry-II

Course Code CC-A04			Course Title Inorganic Chemistry-II				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	05	20	25
Examination Duration:			**Theory**: 2 Hrs				**Practical**: 4 Hrs (Two sessions)				

Course Objectives	1. Learn to interpret electronic spectra and magnetic properties of metal complexes. 2. Analyze organometallics and structures of boranes, carboranes, and metal clusters. 3. Basic knowledge of several chromatographic techniques. 4. Understand the role of metals in medicine and the O_2 transport system. 5. Investigate the chemistry of inorganic air pollutants and methods for removal of dissolved inorganics. 6. To impart knowledge of qualitative analysis of a given mixture.
Course Outcomes:	After completing this course, students will be able to: 1. Forecast the electronic and magnetic properties of coordination compounds. 2. Evaluate the structures of boranes, carboranes, and metal cluster compounds. 3. Analyze chromatographic separation techniques 4. Acquire knowledge about the role of inorganic metals in biological systems. 5. Understand the chemistry and hazards of inorganic air pollutants and a few techniques for waste-water treatment. 6. Examine the given mixture qualitatively.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Further, eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Electronic Spectra and Magnetic Properties of Transition Metal Complexes** Electronic arrangements of microstates, calculation of the number of microstates in various electronic arrangements, spectroscopic term	11

	symbols and splitting of terms in free atoms, determining the ground state terms, correlation and spin-orbit coupling in free ions for Ist series of transition metals. Interpretation of electronic spectra; Orgel ($d^1 - d^9$ states) and Tanabe-Sugano diagrams (d^2 and d^3 octahedral) for transition metal complexes, Spectrochemical and nephelauxetic series, calculation of Dq, B, β parameters, charge transfer spectra, magnetic properties; anomalous magnetic moments, magnetic exchange coupling and spin crossover.	
II	**Organometallic compounds** Valence electron count (16/18 electron rules), Total electron count (TEC), Compliance and violation of the 18-electron rule, Introduction and Classification of organometallic compounds by bond types viz. covalent, ionic, electron-deficient and cluster compounds. **Metal Clusters** **Higher boranes, structure types, nido, arachano, closo etc. structure prediction of boranes using Styx formulae, Wades rule, Wades Mingo rules, Isolobal analogy, carboranes, metalloboranes and metallocarboranes, Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.**	**12**
III	**Metals in Medicine** Essential and trace elements, Metal deficiency, diseases and their treatment (Fe, Cu, Zn), Toxic effects of heavy metals (Hg, Cr, Cd, Pd, As), chelating agents used in therapy, anticancer drugs with particular reference to cis-platin. **Calcium in Biology** Calcium in living cells, transport and regulation, Ca-pump, Ca in muscle contraction and blood clotting. **Transport and Storage of Dioxygen** Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanin and hemerythrin.	**11**
IV	**Chromatography** Theory of Chromatography, classification of chromatography, stationary phase and mobile phase, retardation factor, retention volume, principle and application of paper and thin layer chromatography, column chromatography, gel permeation chromatography, High-performance liquid chromatography and ion exchange chromatography. **Environmental Chemistry** Chemistry of ozone layer depletion, Gaseous inorganic air pollutants: CO, SO_2, NO_x (production and control); Waste water treatment: primary, secondary, and tertiary, Removal of dissolved inorganics: ion exchange, electrodialysis, reverse osmosis, phosphorus removal, nitrogen removal.	**11**
Practical Syllabus		**30**
1. Qualitative analysis:		

Total five radicals to be given containing two less common metal ions, one insoluble and two acid radicals: $CH_3COO^-, BO_3^{3-}, PO_4^{3-}, CO_3^{2-}, HCO_3^-, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, S^{2-}, SO_3^{2-}, SO_4^{2-}, S_2O_3^{2-}, F^-, C_2O_4^{2-}$.

Less common metal ions – W, Tl, Mo, Se, Ti, Zr, Th, V, U, Ce, Be (two metal ions in cationic and anionic forms)

Insoluble: Halides (AgCl, AgBr, AgI); Sulphates ($PbSO_4$, $BaSO_4$) and Oxides (Al_2O_3, Cr_2O_3, SnO_2, TiO_2, SiO_2)

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals

Suggested Books

Theory:	**Books Suggested:** 1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley. 2. Inorganic Chemistry, J.E. Huheey, Harper & Row. 3. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe. 4. Organometallic Chemistry; R.C. Mehrotra and A. Singh, New Age International. 5. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley. 6. Bioinorganic Chemistry by A.K. Das 7. Metal-Based Drugs: Molecular Design and Mechanism of Action, by James C. Dabrowiak 8. Principles of Bioinorganic Chemistry: S. J. Lippard and J. M. Berg, University Science Books. 9. The Inorganic Chemistry of Biological Process; M. N. Huges; John Wiley & Sons. 10. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley. 11. Basic Concepts of Analytical Chemistry by S. M. Khopkar. 12. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch 13. Environmental Chemistry by Stanley E. Manahan. 14. Environmental Chemistry: A Global Perspective by Gary W. vanLoon and Stephen J. Duffy **SUGGESTED WEB SOURCES:** 1. https://nptel.ac.in/course.html 2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 3. https://swayam.gov.in/explorer?category=Chemistry
Practical	1. Qualitative Inorganic Analysis by Arthur I. Vogel and F.G. Svehla 2. Practical Inorganic Chemistry by O.P. Pandey, D.N. Bajpai, S. Giri 3. Advanced Practical Inorganic Chemistry by Gurdeep Raj 4. Qualitative Chemical Analysis and Instrumental Methods by G. Chatwal and S. Anand 5. Comprehensive Practical Chemistry by N.K. Verma, S.K. Khanna, and B. Kapila

	6. https://nptel.ac.in/course.html	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05 Marks
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

241/CHE/CC202

CC-A05: Physical Chemistry-II

Course Code CC-A05			Course Title Physical Chemistry-II								Course ID
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	05	20	25
Examination Duration:			**Theory**: 2 Hrs					**Practical**: 4 Hrs (Two sessions)			

Course Objectives	The course aims to provide a comprehensive understanding of advanced concepts in physical chemistry and their practical applications. 1. To understand the principles of molecular orbital and valence bond theories in diatomic molecules. 2. To explore Huckel theory and its applications to conjugated π-electron systems. 3. To delve into the Third Law of Thermodynamics and its practical applications. 4. To study the concepts of activity, fugacity, and their relevance to chemical equilibria. 5. To analyze phase diagrams and phase rules for one- and two-component systems. 6. To gain insights into the kinetics of chemical reactions and polymerization mechanisms. 7. To familiarize with experimental techniques for determining physical and thermodynamic properties of systems.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Demonstrate understanding of chemical bonding through MO and VB theories. 2. Apply Huckel theory to predict properties of conjugated systems. 3. Utilize thermodynamic laws to determine entropy and other state functions. 4. Analyze the behavior of solutions using activity, fugacity, and phase rule concepts. 5. Interpret phase diagrams and predict system behavior in various compositions. 6. Evaluate chemical reaction mechanisms and rates using advanced theories. 7. Perform and interpret experiments involving calorimetry, phase behavior, and thermodynamic measurements.
COURSE SYLLABUS	
Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.	

2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Chemical bonding in diatomics** Elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems. **Advanced Thermodynamics-I** Statements of the Third Law of Thermodynamics, Nernst Heat Theorem and its application to noncondensed systems, Determination of entropy from the Third Law using the correction due to gas imperfections. Calorimetric entropy, Spectroscopic entropy, Comparison of calorimetric and Spectroscopic entropies, Raoult's laws, Henry's law, solubility behaviour of ideal solutions.	11
II	**ACTIVITY, FUGACITY, PHASE RULE** Concepts of fugacity, fugacity of gases and its determination. Activity and activity coefficient, choice of standard states, determination of activity coefficient for solute and solvent. ***Phase Rule:*** **Phase Rule and its determination, application, Phase diagram for one component system, for two completely miscible components systems like Pb-Ag system, KI+ H_2O system, Bi-Cd system, Ferric chloride + water system, Sodium chloride + water system, Na_2SO_4-H_2O system.**	12
III	**Chemical Kinetics-I** Empirical rate laws and temperature dependence; kinetics of complex reactions; equilibrium state and steady state approximation; determination of reaction mechanisms; theories of chemical reaction rates: collision theory, transition state theory, comparison of collision and absolute reaction rate theory, transition state theory in solution.	11
IV	**Macromolecules** **Basics of Polymers and Polymerization, Kinetics of Polymerization: Mechanism and Kinetics of chain-growth polymerization: free-radical, cationic, anionic, and coordination polymerization. Mechanism and Kinetics of step-growth polymerization. Comparison between step-growth and chain polymerization.** **Molecular mass of Polymers: Concept of number average and mass average molecular weights, Methods of determination of molecular weights (1) viscometry (2) osmometry (3) sedimentation (4) Light Scattering methods (5) GPC method.**	11
Practical Syllabus		**30**

1. To draw the mutual solubility curve of two immiscible liquids and find out the critical solution temperature of phenol-water system.
2. To obtain the phase diagram of water–ethanol-benzene system at room temperature.
3. To verify the Debye-Huckel-Onsager law for strong electrolytes using conductometer.
4. To determine the partial molar volume of urea and ethanol in aqueous solution from density measurements.
5. To determine the heat of neutralization of sulphuric acid using calorimeter.
6. To determine the heat of ionization of a weak base i.e. NH_4OH using calorimeter.
7. To find surface tension/interfacial tension between two immiscible liquids.
8. To determine the percentage composition of a given mixture of two liquids say CCl_4 and Toluene by surface tension method.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

	Suggested Books	
Theory	1. **Chemical Bonding and Molecular Structure by M. L. McKee (Wiley, 2020).** 2. **Modern Thermodynamics: From Heat Engines to Dissipative Structures by Dilip Kondepudi and Ilya Prigogine (Wiley, 2014).** 3. **Introduction to Chemical Engineering Thermodynamics by J. M. Smith, Hendrick Van Ness, and Michael Abbott (McGraw-Hill, 2005).** 4. **Physical Chemistry: A Molecular Approach by Donald A. McQuarrie and John D. Simon (University Science Books, 1997).** 5. **Physical Chemistry by Peter Atkins and Julio de Paula (Oxford University Press, 2014).** 6. **Principles of Physical Chemistry by Puri, Sharma and Pathania** (Vishal Publishing Co.). 7. A Textbook of Physical Chemistry by K. L. Kapoor (McGraw Hill Education).	
Practical	1. Advanced Practical Physical Chemistry by J.B. Yadav, 20th Edition, Goel Publishing House. 2. Experiments in Physical Chemistry by Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, 8th Edition, McGraw-Hill Education. 3. Experimental Physical Chemistry by Farrington Daniels and J.H. Mathews, 7th Edition, McGraw-Hill Education. 4. Practical Physical Chemistry by Alexander Findlay, 9th Edition, Longmans, Green and Co. 5. Vogel's Textbook of Quantitative Chemical Analysis by G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, 6th Edition, Pearson. 6. Experimental Physical Chemistry by Arthur M. Halpern and George C. McBane, 3rd Edition, W.H. Freeman and Company.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks

	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05 Marks
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

241/CHE/CC203

CC-A06: Organic Chemistry-II

Course Code CC-A06			Course Title Organic Chemistry-II								
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	05	20	25
Examination Duration:			**Theory**: 2 Hrs				**Practical**: 4 Hrs (Two sessions)				
Course Objectives			1. To develop a theoretical understanding of aromatic electrophilic and nucleophilic substitution mechanisms, including orientation effects and energy profile analysis. 2. To explore specialized substitution reactions such as Vilsmeier-Haack, Reimer-Tiemann, Fries rearrangement, and von-Richter rearrangement to understand their synthetic utility. 3. To understand the generation, stability, and reactivity of reactive intermediates such as arynes, free radicals, and carbocations, and their role in rearrangement and substitution reactions. 4. To analyze the mechanisms of aliphatic electrophilic substitution, including factors affecting reactivity and the role of neighboring group participation in anchimeric assistance and carbocation rearrangements. 5. To study the mechanisms of addition reactions to C-C multiple bonds, focusing on nucleophilic, electrophilic, and radical pathways, including hydroboration and organoborane chemistry. 6. To explore addition reactions to carbon-heteroatom multiple bonds, with emphasis on nucleophilic addition, reductions, and key condensation reactions such as Aldol, Perkin, and Claisen for carbon-carbon bond formation.								
Course Outcomes:			After the completion of this course, the students will be able to: **1.** Demonstrate a comprehensive understanding of aromatic electrophilic and nucleophilic substitution mechanisms and predict regioselectivity in various aromatic systems. **2.** Apply knowledge of specialized reactions like Vilsmeier-Haack, Fries rearrangement, and von-Richter rearrangement in designing synthetic pathways. **3.** Evaluate the structure, stability, and reactivity of intermediates like arynes, free radicals, and carbocations to rationalize reaction outcomes. **4.** Analyze the factors influencing aliphatic electrophilic substitutions and interpret the role of neighbouring group participation in rearrangement reactions. **5.** Solve mechanistic problems involving addition to C-C multiple bonds and apply these reactions in the synthesis of complex organic molecules.								

	6. Utilize addition reactions to carbon-heteroatom multiple bonds and key condensation reactions to synthesize and modify functionalized organic compounds.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Aromatic Electrophilic Substitution** Basic concept of aromaticity, Theoretical treatment of aromatic substitution reactions, structure-reactivity relationship in mono substituted benzene ring, orientation in other ring system, energy profile diagram, Vilsmeier-Haack reaction, Reimer-Tiemann reaction, Bischler-Napieralski reaction, Pechmann reaction, Houben-Hoesch reaction, Fries rearrangement **Aromatic Nucleophilic Substitution** Mechanism of Nucleophilic substitution in aromatic systems *via* diazonium ions, by addition-elimination and elimination-addition mechanism (involving arynes); von-Richter rearrangement, Sommelet-Hauser and Stevens rearrangements.	11
II	**Neighbouring Group Participation and Carbocation Rearrangements** Anchimeric assistance, neighbouring group participation by non-bonding electrons, sigma and π-bonds, classical and non-classical carbocations. Carbocations rearrangements: migratory aptitudes, Wagner Meerwein rearrangement, pincol pinacolone rearrangement, Demjanove rearrangement, Tiffeneau-Demjanov ring expansion, aldehyde-ketone rearrangement, dienone-phenol rearrangement and trans-annular rearrangements.	11
III	**Free Radicals** General aspects of generation, structure, stability and reactivity of free radicals, types of free radical reactions, halogenation including allylic halogenation (NBS), auto-oxidation, decomposition of azo compounds and peroxides, coupling of alkynes, homolytic aromatic substitution, Sandmeyer reaction and Hunsdiecker reaction. **Addition to C-C Multiple Bond** General mechanistic considerations, Mechanism of addition of hydrogen halide, H_2O, halogens, HOX and mercuric salt to alkenes and alkynes. Hydroboration, formation of C-C bonds *via* organoboranes, hydroboration of acetylenes, nucleophilic addition to alkenes.	11
IV	**Addition to Carbon-Hetero Atoms Multiple Bonds**	12

	General mechanistic considerations and reactivity, Hydration and Addition of Alcohols to Aldehydes, Ketones and Acids. Addition - Elimination Reactions of Ketones and Aldehydes, Reactivity of carbonyl compounds towards Addition. Lithium aluminium hydride reduction- carbonyl compounds, acids, esters, nitriles. Additions of Grignard reagents. Reformatsky reaction, Wittig reaction, Claisen condensation, Dieckman reaction, Aldol condensation, Knoevenagal condensation, Perkin reaction, Cannizzaro reaction, Benzoin condensation, Mannich Reaction, Robinson-Mannich reaction, Ester hydrolysis, aminolysis of esters, amide hydrolysis.	
Practical Syllabus		**30**

Organic Mixture Analysis

1. **Qualitative Analysis:** Demonstrations of separation of binary mixtures **(Solid-Solid)**: using H_2O, HCl, NaOH, $NaHCO_3$, Ether or other reagent as may be necessary along with required conditions for their use.

Systematic identification of organic mixtures: separation and identification of binary mixtures including derivatives, in the formation of individual components.

2. Spectroscopic confirmation of the binary mixtures using IR and NMR (IR & NMR spectra will be provided).

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory	**1**. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley. **2**. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum. **3**. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman. **4**. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press. **5**. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall. **6**. Modern Organic Reactions, H. O. House, Benjamin. **7**. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional. **8**. Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
Practical	**1**. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975). **2**. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959. **3**. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966. **4**. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors. **5**. "A Guide to spectroscopy in Organic Chemistry' by PAVY

	6. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons. **7.** "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming. **8.** Vogel's Text Book of Practical Organic Chemistry by B.S. Furnerset. al., Longman Group Ltd.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05 Marks
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

PG - DSE

241/CHE/DS201 Semester 2

DSE-02: Spectroscopic Methods in Chemistry-I

Course Code DSE-02			Course Title Spectroscopic Methods in Chemistry-I				Course ID		
L	T	P	L	T	P	Total Credits	MARKS		
(Hrs)			Credits				TI	TE	Total
3	-	-	3	-	-	3	25	50	75

Examination Duration:	2 Hrs

Course Objectives	1. Develop a comprehensive understanding of Spectroscopic principles and theories underlying UV-Visible, Infrared (IR), and Nuclear Magnetic Resonance (NMR) spectroscopy, including the interactions of electromagnetic radiation with matter. 2. Learn to interpret UV-Vis, IR, and NMR spectra for determining structural, electronic, and bonding characteristics of compounds. 3. To understand the relationship between molecular structure, solvent effects, and spectroscopic properties, including electronic transitions, vibrational frequencies, chemical shifts, and coupling constants. 4. Apply Spectroscopic Rules and Techniques to Problem-Solving.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Interpret UV-Vis, IR, and NMR spectra to deduce molecular structures and functional groups. 2. Apply Fieser-Woodward rules and Karplus correlations for predicting spectroscopic properties. 3. Assess the impact of hydrogen bonding, solvent effects, and electronic transitions on spectral data. 4. Solve complex structural and stereochemical problems using integrated spectroscopic techniques.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Ultraviolet and Visible Spectroscopy** Introduction and understanding of UV phenomenon, Various electronic transitions (185-800 nm), Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds. **Infrared Spectroscopy** Principle and Theory, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers,	12

	phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding on vibrational frequencies, overtones, combination bands and Fermi resonance. FT-IR.	
II	**Nuclear Magnetic Resonance Spectroscopy** **^{1}H-NMR** Basic principles of NMR, theory of nuclear magnetic resonance, spin lattice relaxation, spin-spin relaxation, experimental techniques chemical shift, the δ-scale of chemical shift, the origin of shielding constant, pattern of coupling, origin of spin-spin coupling, Chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic). Chemical shift values and correlation for protons bonded to other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto). Complex spin-spin interaction between two, three, four and five nuclei (first order spectra), spin system-Pople notation, Karplus curve - variation of coupling constant with dihedral angle. Fourier transform technique. **Carbon-13 NMR Spectroscopy** General considerations, Comparison of ^{1}H-NMR and ^{13}C-NMR, Proton coupled and proton decoupled ^{13}C-NMR, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants.	**12**
III	**Mass Spectrometry-I** Introduction, ion production - EI, CI, FD and FAB, Unsaturation index, Rule of thirteen, Nitrogen rule, Stevenson rule, molecular ion peak, metastable peak, Isotope profile of halogen compounds, Some common fragmentation pattern-simple cleavage, retro-Diels Alder, Hydrogen transfer like ortho effect, McLafferty rearrangement.	**10**
IV	**Mass Spectrometry-II** Mass-spectral fragmentation patterns of organic compounds: hydrocarbons, alcohols, phenols, ethers, aldehydes, ketones, esters, carboxylic acids, amines, nitro, amides, nitriles. **Composite Problems** Problems involving the application of various spectroscopic techniques (UV/Visible, IR, NMR and Mass) for structural elucidation of organic molecules.	**11**
Suggested Books	1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2nd Edn. By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York. 2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley. 3. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall. 4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill. 5. Spectroscopy of Organic Compounds by P.S. Kalsi, Wiley Estern, New Delhi. 6. Organic Spectroscopy by William Kemp, John Wiley. 7. Organic Spectroscopy (Principles & Applications) by Jagmohan.	

Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Course Code CC-A07			Course Title Inorganic Chemistry Special-I				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	5	20	25
Examination Duration:			Theory: 2 Hrs				Practical: 6 Hrs (Two sessions)				

Course Objectives	1. Understand the mechanisms of transition metal complex reactions. 2. Study the structure, bonding, and spectra of metal π-complexes. 3. Learn substitution and electron transfer mechanisms in metal complexes. 4. Explore the properties and applications of inorganic polymers. 5. Understand the behavior of non-aqueous solvents in chemical systems. 6. Synthesize inorganic compounds and examine them spectroscopically.
Course Outcomes:	After completing this course, students will be able to: 1. Analyze the reactivity and kinetics of metal complexes. 2. Understand various reaction mechanisms in metal complexes. 3. Interpret vibrational spectra for structural insights of metal π-complexes. 4. Compare inorganic and organic polymers in terms of structure and properties. 5. Explain the properties and applications of various non-aqueous solvents. 6. Synthesize metal complexes and characterize them.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Further, eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Reaction Mechanism of Transition Metal Complexes-I** Energy profile of a reaction, reactivity of metal complexes, kinetic application of valence bond and crystal field theories in determining inertness and lability of complexes, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidence in favour of conjugate mechanism, anation reactions, reactions without metal-ligand bond cleavage.	11
II	**Reaction Mechanism of Transition Metal Complexes-II** Substitution reactions in square planar complexes, Trans effect and its application, electron transfer reactions, mechanism of one	12

	electron transfer reactions, outer-sphere type reactions, cross-reactions and Marcus-Hush theory, inner sphere type reactions, two-electron transfer reactions, complementary and non-complementary reaction, mixed valence complexes and their electron transfer.	
III	**Metal π-Complexes** Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structure elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.	11
IV	**Inorganic polymers** Comparison of inorganic polymers with organic polymers, Boron-nitrogen polymers, silicones and silicates, Phosphorus-nitrogen compounds. **Non-aqueous Solvents** General properties of non-aqueous solvents, Physical and chemical properties of BrF_3, N_2O_4 and $POCl_3$	11
Practical Syllabus		4

A. Preparation of selected Inorganic Compounds and their Characterization by elemental analysis and spectroscopic methods (IR, NMR, EPR, Magnetic moment etc.).

I Choloropentaamminecobalt (III) Chloride
II Nitro/Nitritopentaamminecobalt (III) Chloride
III Potassium trioxalatoferrate (III)
IV Chromous acetate
V Cis and trans $[Co(en)_2Cl_2]$

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals

Suggested Books

Theory:	**Books Suggested:** 1. Mechanism of Inorganic Reactions; F. Basolo and R.G. Pearson, John Wiley and Sons, New York. 2. Advanced Inorganic Chemistry by F.A. Cotton, G. Wilkinson, C.A. Murillo, and M. Bochmann 3. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley. 4. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International 5. Introduction to Inorganic Chemistry by Douglas A. Skoog and Donald M. West 6. Inorganic Polymers by Harry R. Allcock, Frederick W. Lampe, and James E. Mark 7. Chemistry of Non-aqueous Solvents by J.J. Lagowski 8. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley and Sons Inc. 9. Non-aqueous Solvents in Chemistry by A.K. Holliday and A.G. Massey **SUGGESTED WEB SOURCES:** 1. https://nptel.ac.in/course.html 2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 3. https://swayam.gov.in/explorer?category=Chemistry
Practical	1. Experimental Inorganic Chemistry - W.G. Palmer

	2. Practical Inorganic Chemistry - G. Pass and H. Suteliffe 3. Synthesis and Technique in Inorganic Chemistry - Gregory S. Girolami, Thomas B. Rauchfuss, Robert J. Angelici 4. Spectroscopic Methods in Inorganic Chemistry - William W. Porterfield 5. Vogel's Textbook of Quantitative Chemical Analysis - G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney 6. Instrumental Methods of Analysis - Gurdeep R. Chatwal, Sham K. Anand 7. Practical Volumetric Analysis - Peter McPherson 8. Advanced Practical Chemistry - O.P. Agarwal	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Course Code CC-A08			Course Title Inorganic Chemistry Special-II				Course ID				
L	T	P	L	T	P	Total	MARKS				
(Hrs)			Credits			Credits	TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	05	20	25
Examination Duration:			Theory: 2 Hrs				Practical: 6 Hrs (Two sessions)				

Course Objectives	1. Understand synthesis and stability of alkyl and aryl metal complexes and organocopper complexes. 2. Study bonding and reactivity of π-complexes and metal-carbon multiple bonds. 3. Learn fluxional behavior in organometallic compounds. 4. Explore key reactions in homogeneous catalysis. 5. Analyze industrial cross-coupling reactions and catalytic cycles. 6. To know various types of titrations including complexometry/cerimetric/iodometric/oxidimetric titrations.
Course Outcomes:	After completing this course, students will be able to: 1. Understand alkyl, aryl, and organocopper complexes in synthesis. 2. Apply knowledge of π-complexes and metal-carbon multiple bonds in reactions. 3. Explain fluxionality and its impact on organometallic compounds. 4. Apply homogeneous catalysis principles to industrial processes. 5. Analyze industrially significant cross-coupling reactions and their catalytic mechanisms. 6. Perform complexometric/cerimetric/iodometric/oxidimetric titration.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Further, eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Alkyls and Aryls of Transition Metals** Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis **Transition Metal π–Complexes**: Transition metal π complexes with unsaturated molecules: alkenes, alkynes, allyl, & dienyl(metallocene) complexes, preparation, properties and nature of bonding and structural features, important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis.	11
II	**Compounds of Transition Metal-Carbon Multiple Bonds** Alkylidenes, alkylidynes. Transition metal-carbene complexes: Fischer type and Schrock type carbene complexes, their synthesis,	12

	reactions and structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features. **Fluxional Organometallic compounds** Fluxionality and dynamic equilibria in compounds such as η^2-olefin, η^3-allyl and dienyl complexes, Carbonyl scrambling	
III	**Homogeneous Catalysis** Stoichiometric reactions for catalysis: Characteristic reactions of organometallic complexes: oxidative addition, reductive elimination, Migratory insertion, activation of C-H bond, Catalytic Hydrogenation of alkenes, Hydrocyanation, Hydrosilylation, Hydroformylation, Methanol Carbonylation and Olefin Oxidation-Monsanto process, Cativa and Wacker process.	11
IV	**Cross-coupling reactions** Industrial application of cross-coupling reaction, Pd and Ni as coupling catalyst, Catalytic cycle of Heck reaction, Suzuki-Miyaura coupling, Sonogashira coupling, Stille coupling, Kumada coupling, Negishi coupling, Hiyama coupling; Buchwald-Hartwig C-N cross-coupling.	11
Practical Syllabus		4

1. Cerimetric/Iodometric/Oxidimetry titrations
2. Complexometric titration–using EDTA and Sequestering agent. Masking and demasking agents.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory:	**Books Suggested:** 1. Mechanism of Inorganic Reactions; F. Basolo and R.G. Pearson, John Wiley and Sons, New York. 2. Inorganic Chemistry; K.F. Purcell, J.C. Kotz; Holt-Sanders International Editions; Philadelphia. 3. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books. 4. Organometallic Chemistry by R.C. Mehrotra and A. Singh 5. Advanced Inorganic Chemistry by F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Murillo, and Manfred Bochmann 6. Organometallic Chemistry: A Unified Approach by Ajai Kumar 7. Principles and Applications of Organotransition Metal Chemistry by James P. Collman, Louis S. Hegedus, J. R. Norton, and Richard G. Finke 8. The Organometallic Chemistry of the Transition Metals by R. H. Crabtree **SUGGESTED WEB SOURCES:** 1. https://nptel.ac.in/course.html 2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 3. https://swayam.gov.in/explorer?category=Chemistry
Practical	1. Principles of Instrumental Analysis – Douglas A. Skoog, F. James Holler, Stanley R. Crouch 2. Analytical Chemistry – Gary D. Christian 3. Instrumental Methods of Analysis – Gurdeep R. Chatwal, Sham K. Anand

	4. A Textbook of Quantitative Inorganic Analysis – A.I. Vogel	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Course Code CC-A09			Course Title Inorganic Chemistry Special-III				Course ID				
L	T	P	L	T	P	Total	MARKS				
(Hrs)			Credits			Credits	TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	05	20	25
Examination Duration:			Theory: 2 Hrs				Practical: 6 Hrs (Two sessions)				

Course Objectives	1. Understand the roles of metalleproteins and metalloenzymes in biological systems. 2. Explore supramolecular chemistry and host-guest interactions. 3. To study inner transition elements' properties, applications, and separations (lanthanoids and actinoids). 4. To know the basic concept of nuclear chemistry, detectors used and analysis techniques. 5. Preparation and spectral analysis of inorganic complexes. 6. Understand column chromatographic analysis.
Course Outcomes:	After completing this course, students will be able to: 1. Gain knowledge of key metalloproteins, enzymes, and their functions. 2. Apply supramolecular chemistry principles in material science. 3. Understand the basic concept of f-block elements and explore its utility. 4. Explain nuclear and radiochemistry terms, detectors used and analysis techniques. 5. Preparation and spectral analysis of inorganic complexes. 6. Perform column chromatography.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Further, eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Advanced bioinorganic Chemistry** Structure and function of metalloproteins in electron transport processes-blue copper proteins (Cu) - iron-sulfur proteins (Fe)-cytrochromes; Carbon monoxide poisoning and its treatment; Metal storage protein: Ferritin, transferrin, and siderophores; Iron metalloenzymes - peroxidase, catalase and cytochrome P-450, copper enzymes - superoxide dismutase, Zinc enzymes – carboxypeptidase and carbonic anhydrase, alkaline phosphatase and alcohol dehydrogenase, Molybdenum oxatransferase enzymes – xanthine oxidase, Photosynthesis and nitrogen fixation.	11
II	**Supramolecular Chemistry**	11

	Terminology and definitions in supramolecular chemistry. Intermolecular forces: ion-ion, ion-dipole and dipole-dipole interactions; dipole induced dipole, hydrogen bonding; cation-pi, anion-pi, pi-pi interactions and Van der Waal forces. Structure of crown ethers, podands, cryptands, spherands, calixarenes, cyclodextrins, cyclophanes, cryptophanes, carcerands and hemicarcerands, Host-Guest interactions, pre-organization and complementarity, lock and key analogy. Binding of cationic, anionic, ion pair and neutral guest molecules. Co-receptor molecules and multiple recognition. Self-assembly and application of supramolecular materials.	
III	**Inner transition elements** Lanthanoids: electronic configuration, oxidation state, occurrence, lanthanoid contraction, general properties, complex formation, application. Actinoids: electronic configuration, oxidation state, occurrence, actinoid contraction, general properties, complex formation tendency, application. Separation, Similarity and dissimilarities in Ln and Ac. Analytical application.	11
IV	**Nuclear Chemistry** Nuclear stability, magic numbers, Mass and binding energy, nuclear fission and nuclear fusion, radioactivity, general characteristics of radioactive decay particles, Bethe's notation, types of nuclear reaction, nuclear cross section, compound nuclear theory, nuclear fission and nuclear fusion, Detectors (Proportional, Geiger-Muller and Scintillation counters) and their principles. Radiochemical techniques: Neutron activation analysis, isotopic dilution analysis, radiometric titrations.	11
	Practical Syllabus	4

1. Preparation of some inorganic compounds and their spectral studies.
Tris(acetyl-acetonato) manganese (III)
Tris(acetyl-acetonato) cobaltate (III)
Preparation of ferrocene
Tristhioureacopper (I) sulfate
Tris(acetylacetonato) chromium (III)
2. Column Chromatography
Note: Any experiment can be introduced/deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory:

1. Principles of Bioinorganic Chemistry by Stephen J. Lippard and Jeremy M. Berg
2. Inorganic Biochemistry by K.H. Reddy.
3. Bioinorganic chemistry by A.K. Das.
4. A Textbook of Supramolecular Chemistry by V. Ramamurthy and T. Sivakumar
5. Supramolecular Chemistry by Jonathan W. Steed and Jerry L. Atwood
6. Supramolecular Chemistry by Jean-Mary Lehn.
7. Lanthanides and Actinides: Chemistry and Applications by B.S. Ahn

	8. Essentials of Nuclear Chemistry by H. J. Arnikar. 9. Radio Chemistry & Nuclear Chemistry by G. Choppin, J.O. Liljenzin & J. Rydberg. 10. Flow through nuclear chemistry by R.K Malik, Neelam kumari, P.S. Sabharwal. **SUGGESTED WEB SOURCES:** 1. https://nptel.ac.in/course.html 2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 3. https://swayam.gov.in/explorer?category=Chemistry	
Practical	**Books Suggested:** 1. Synthesis and Characterization of Inorganic compounds. W. L. Jolly, Prentice Hall, Englowood. 2. A Text Book of Quantitative Analysis: A. I. Vogel, ELBS, London. 3. Inorganic Preparations: W. G. Palmer. 4. Principles and Practice of Chromatography – R.P.W. Scott 5. Advanced Practical Organic Chemistry – N.K. Vishnoi	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Core Course (To be applicable from the session 2026-27)

Course Code CC-A07			Course Title Physical Chemistry Special-I				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	5	20	25
Examination Duration:			**Theory**: 2 Hrs				**Practical**: 6 Hrs (Two sessions)				

Course Objectives	The objectives of this course are to enable students: 1. To understand advanced theoretical models like absolute rate theory and unimolecular reaction kinetics. 2. To explore the role of ionic strength, dielectric constant, and salt effects in reaction mechanisms. 3. To analyze chain reactions, including photochemical and polymerization processes. 4. To study adsorption phenomena and surface chemistry through theoretical and experimental approaches. 5. To understand the thermodynamics and kinetics of micellization and surface-active agents. 6. To develop hands-on skills in electrochemical and potentiometric titrations for chemical analysis. 7. To correlate experimental observations with theoretical principles in kinetics and surface chemistry.
Course Outcomes:	Upon completion of this course, students will be able to: 1. Apply partition function-based rate theories to chemical reactions. 2. Analyze and predict the behavior of chain and photochemical reactions. 3. Interpret adsorption data using models like Freundlich, Langmuir, and BET. 4. Evaluate surface phenomena and understand micelle formation mechanisms. 5. Perform and interpret results from pH-metric and potentiometric titrations. 6. Determine key thermodynamic and electrochemical parameters of chemical systems. 7. Connect theoretical kinetic models with real-world experimental practices.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Advanced Chemical Kinetics -I**	11

Chairperson
Department of Chemistry
Gurugram University
Gurugram

	Enzyme kinetics, partition function, Salt effects: primary and secondary salt effects in the light of mechanistic tests; Influence of ionic strength and dielectric constant. Unimolecular reactions: treatment of Lindemann, Hinshelwood, Rice-Ramsperger-Kassel (RRK), and Rice-Ramsperger-Kassel-Marcus (RRKM) theories; thermodynamic formulation of rate constant; transmission co-efficient.	
II	**Chain Reactions and photochemistry** Chain reactions (types, kinetics, mechanisms, applications) polymerization reaction kinetics, nuclear fission as a chain reaction or explosive reactions. Rice-Herzfeld mechanisms. Photochemical chain reactions (hydrogen and chlorine, hydrogen and bromine). Non-chain photochemical reactions (formation of phosgene, decomposition of H_2O_2 in presence of CO); Photolysis and radiolysis, Photochemical life processes: photosynthesis and vision.	12
III	**Adsorption** Introduction, Physical adsorption & Chemisorption, Freundlich adsorption isotherm, Langmuir theory of adsorption, BET theory of multilayer adsorption, BET equation, determination of surface area of the adsorbent, Gibb's adsorption equation.	11
IV	**Surface Chemistry and Colloidal systems** Surface phenomenon (surface tension, Laplace and kelvin equations), capillary action, surface films on liquids (electro kinetic phenomenon), zeta potential Surface active agents: structure & classification, properties, micellization (CMC and factor affecting CMC), mass action and phase separation model, hydrophobic interactions and counter ion binding, reverse micelles, detergents and emulsion, catalysis.	11
	Practical Syllabus	**4**

1 To determine the strength of strong acid versus strong base, weak acid versus strong base, mixture of strong and weak acids versus strong base, weak acid versus weak base, strong acid versus weak base using a pH meter.

2 To determine the concentration of a reductant or an oxidant i.e. Ferrous ammonium sulphate, $K_2Cr_2O_7$ and $KMnO_4$ by a pH metric titration method.

3 To determine the strength of strong acid versus strong base, weak acid versus strong base, mixture of strong and weak acids versus strong base, weak acid versus weak base, strong acid versus weak base using a potentiometer.

4 To prepare and test the standard reference electrode i.e., calomel electrode or silver-silver chloride electrode.

5 Titrate Mohr's salt against $KMnO_4$ potentiometrically and carry out the titration in reverse order.

6 To determine the thermodynamic parameters for a reaction from EMF measurement.

7 To determine the pH of a series of buffer solutions by potentiometric method.

8 To determine the solubility product of AgCl and to determine instability constant of

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$Ag(NH_3)^{2+}$ complex.

9 To determine the activity of hydrogen ion in acid medium using hydrogen electrode, hence to determine the ionic product of water and hydrolysis constant of sodium acetate.

10 To determine the degree of hydrolysis and hydrolysis constant of weak acid by Potentiometry.

11. To determine the concentration of a reductant or an oxidant i.e. Ferrous ammonium sulphate and Ceric sulphate by a potentiometric redox titration.

12. To determine the amount of KI and KCl present in a mixture by potentiometric titration

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books	
Theory	1. Physical Chemistry: Principles and Applications in Biological Sciences by Ignacio Tinoco, Kenneth Sauer, and James C. Wang (Prentice Hall, 2002). 2. Chemical Kinetics and Reaction Dynamics by Paul L. Houston (Dover Publications, 2007). 3. Surface Chemistry of Froth Flotation by S. K. Kawatra (Springer, 2015). 4. Physical Chemistry of Surfaces by Arthur W. Adamson and Alice P. Gast (Wiley-Interscience, 1997). 5. Chemistry of the Elements by J. Derek Woollins (Elsevier, 2019). 6. Physical Chemistry by Peter Atkins and Julio de Paula (Oxford University Press, 2014). 7. Principles of Physical Chemistry by Puri, Sharma and Pathania (Vishal Publishing Co.). 8. A Textbook of Physical Chemistry by K. L. Kapoor (McGraw Hill Education).
Practical	1. Advanced Practical Physical Chemistry by J.B. Yadav, 20th Edition, Goel Publishing House. 2. Experiments in Physical Chemistry by Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, 8th Edition, McGraw-Hill Education. 3. Experimental Physical Chemistry by Farrington Daniels and J.H. Mathews, 7th Edition, McGraw-Hill Education. 4. Practical Physical Chemistry by Alexander Findlay, 9th Edition, Longmans, Green and Co. 5. Vogel's Textbook of Quantitative Chemical Analysis by G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, 6th Edition, Pearson. 6. Experimental Physical Chemistry by Arthur M. Halpern and George C. McBane, 3rd Edition, W.H. Freeman and Company.

	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

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Course Code CC-A08			Course Title Physical Chemistry Special-II				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	5	20	25
Examination Duration:			Theory: 2 Hrs				Practical: 6 Hrs (Two sessions)				

Course Objectives	The primary objectives of this course are: 1. To understand various forms and mechanisms of corrosion and their industrial implications. 2. To study Debye-Hückel theory for dilute and concentrated ionic solutions and its application to electrochemistry. 3. To explore the thermodynamic behavior of ideal and non-ideal solutions and related functions. 4. To analyze thermodynamic functions in non-equilibrium systems and entropy production. 5. To develop competency in spectrophotometric and pH-metric analysis techniques. 6. To investigate the micellization process and the factors affecting critical micelle concentration. 7. To integrate theoretical , knowledge with experimental observations for chemical systems under equilibrium and non-equilibrium conditions.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Identify and differentiate types of corrosion and assess preventive strategies. 2. Apply Debye-Hückel theory to calculate activity coefficients and ionic potentials. 3. Evaluate excess thermodynamic properties of non-ideal solutions using theoretical models. 4. Interpret thermodynamic criteria for non-equilibrium states and entropy production in various systems. 5. Accurately determine acid strengths, dissociation constants, and perform spectrophotometric analyses. 6. Determine and interpret CMC values of surfactants and examine structure-property relationships. 7. Correlate experimental data with thermodynamic and electrochemical theories for real-world applications.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs

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I	**Corrosion** Forms and mechanism of material degradation; uniform, galvanic, localized (pitting, crevice), intergranular, stress-assisted (stress corrosion cracking, corrosion fatigue), fretting, dealloying, hydrogen embrittlement, erosion-corrosion, microbial induced, filiform and exfoliation. Prevention methods, polarization and tafel plots, Pourbaix diagram	11
II	**Electrochemistry** Debye-huckel theory (including limiting law, extended forms, and applications to activity coefficient), ionic strength, mean ionic activity, Nernst equation, emf of cell, conductance (Kohlrausch law), transport number, ionic mobility, conductometric and potentiometric titrations.	12
III	**Advanced Thermodynamics-III** Ideal and non-ideal solutions (Raoult's law, henry law, azeotropes) Thermodynamic functions of mixing of non-ideal solutions, Gibbs-Duhem-Margules equation and its applications, Excess thermodynamic function and determination of excess function, fugacity, phase equilibria and phase rule, le chatelier principle, Laws, state and path functions and their applications	11
IV	**Advanced Thermodynamics-IV** Thermodynamic functions for non-equilibrium states, Postulates and methodology, Linear laws, Gibbs equation, Thermodynamic criteria for non-equilibrium states, entropy production, entropy production in heat flow and matter flow, entropy production in chemical reaction. Entropy production in open system. Entropy production due to flow of current in electrical conductor, The phenomenological law, onsager reciprocal relations	11
	Practical Syllabus	4

1. Determine the strength of strong acid by pH-metric titration with strong base.
2. Determine the strength of weak acid by pH-metric titration with strong base.
3. Determine the dissociation constant of acetic acid using pH-meter.
4. Verification of the Lambert-Beer's law using solutions such as $K_2Cr_2O_7$, $CuSO_4$, $KMnO_4$ in water and I_2 in CCl_4.
5. Study of iron-tiron and iron-salicylic acid complexes.
6. Determination of the composition of various mixtures spectrophotometrically: (i) Potassium dichromate and potassium permanganate (ii) Crystal violet and aurine.
7. Determine the dissociation constant of phenolphthalein spectrophotometrically.
8. To determine the critical micelle concentration (CMC) of surfactants using surface tension measurements and analyze its dependence on temperature.
9. To study the effect of electrolytes on the critical micelle concentration of ionic surfactants in aqueous solutions.
10. To investigate the relationship between surfactant structure (e.g., chain length, head group) and its critical micelle concentration.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

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Theory	1. Introduction to Modern Electrochemistry by J. O'M. Bockris and A. K. N. Reddy (Wiley, 2000). 2. Introduction to Statistical Mechanics by Roger Bowley and Mariana Sánchez (Oxford University Press, 2002). 3. Physical Chemistry by Peter Atkins and Julio de Paula (Oxford University Press, 2014). 4. Principles of Physical Chemistry by Puri, Sharma and Pathania (Vishal Publishing Co.). 5. A Textbook of Physical Chemistry by K. L. Kapoor (McGraw Hill Education).	
Practical	1. Advanced Practical Physical Chemistry by J.B. Yadav, 20th Edition, Goel Publishing House. 2. Experiments in Physical Chemistry by Carl W. Garland, Joseph W. Nibler, and David P. Shoemaker, 8th Edition, McGraw-Hill Education. 3. Experimental Physical Chemistry by Farrington Daniels and J.H. Mathews, 7th Edition, McGraw-Hill Education. 4. Practical Physical Chemistry by Alexander Findlay, 9th Edition, Longmans, Green and Co. 5. Vogel's Textbook of Quantitative Chemical Analysis by G.H. Jeffery, J. Bassett, J. Mendham, and R.C. Denney, 6th Edition, Pearson. 6. Experimental Physical Chemistry by Arthur M. Halpern and George C. McBane, 3rd Edition, W.H. Freeman and Company.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

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Course Code CC-A09			Course Title Physical Chemistry Special-III				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	5	20	25
Examination Duration:			**Theory**: 2 Hrs				**Practical**: 6 Hrs (Two sessions)				

Course Objectives	The primary objectives of this course are to: 1. Introduce fundamental laws of photochemistry, photophysical processes, and their kinetics. 2. Provide a detailed understanding of the gaseous state, including velocity distributions, molecular collisions, and transport properties. 3. Explore advanced chemical kinetics concepts, including equilibrium constants, steady-state treatment, and reaction rate influences. 4. Study the principles of X-ray diffraction techniques and their application in structural analysis of crystals. 5. Familiarize students with the use of JCPDS card files for correlating crystal structures. . 6. Develop practical skills in synthesizing advanced materials such as reduced graphene oxide, carbon quantum dots, and conducting polymers. 7. Apply theoretical and experimental knowledge to design and fabricate basic energy storage devices.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Apply photochemical laws to analyze processes involving fluorescence, phosphorescence, and chemiluminescence. 2. Use kinetic theory to compute molecular velocities, collision frequencies, and transport properties of gases. 3. Analyze the influence of substituents on reaction rates and interpret linear free energy relationships. 4. Employ X-ray diffraction methods like Bragg's law, Laue method, and Debye-Scherrer technique for crystal structure determination. 5. Correlate experimental diffraction data with structures using JCPDS card files. 6. Synthesize and characterize advanced materials, including graphene derivatives and polymers, using practical techniques. 7. Design and fabricate basic batteries while understanding the underlying chemistry of energy storage.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

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3. The question paper must be set in consonance with course outcomes.		
Unit No.	**Contents**	**Contact Hrs**
I	**Photochemistry** Laws (Grott Huss-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law), quantum yield, quantum efficiency, singlet and triplet state, Jablonski diagram, photophysical processes: (radiative and non-radiative) fluorescence, phosphorescence and chemiluminescence, Kinetics of photophysical processes, relaxation time, Quenching mechanism (dynamic and static, Stern Volmer equation)	11
II	**Gaseous State** Distribution law (Barometric formula), Maxwell-Boltzmann distribution of velocity and energy, Gaussian density function, velocities (average, most probable and root mean square), Collision theory (mean free path, collision frequency). Properties of gases (viscosity, thermal conductivity and diffusion), Kinetic theory, variation of viscosity with temperature and pressure. Law of equipartition of energy.	12
III	**Polymer chemistry-II** Glass transition temperature (Tg), factors effecting Tg (molecular weight, chain flexibility, intermolecular forces). Polymer chain dimensions (end-to-end distance, radius of gyration, freely jointed chain model, influence of bond angle restrictions). Entropy and enthalpy of mixing by lattice model, Flory Huggins lattice theory and limitations, entropy of mixing by free volume theory, heat and free energy of mixing, partial molar quantities (chemical potential, heat of dilution, partial molar entropy), excluded volume, thermodynamic relations for dilute polymer solutions, molecular weight determination (Mark-Hou wink equation)	**11**
IV	**Solid State** Crystal packing (SC, BCC, FCC, HCP), packing efficiency and co-ordination number, density of unit cell, radius ratio, band theory, magnetic properties (dia, para and ferromagnetism). Bragg's law and its application, Miller indices, diffraction method (Laue, Debye Scherrer), index reflections, structure of simple lattices and X-ray intensities. JCPDS card file for corelating structure.	11
Practical Syllabus		**4**
Advanced synthesis 1. Synthesis of reduced graphene oxide via modified/improved hummers method. 2. Synthesis of carbon quantum dots. 3. Synthesis of any one conducting polymer depending on available precursors.		

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4. Fabricating a basic battery using precursors available in lab.
5. Synthesize nanoparticles by sol-gel method.
6. Synthesize nanoparticles by co-precipitation method.
7. Synthesize nanoparticles by reverse micelle technique.
8. Synthesize nanoparticles by Hydrothermal/Solvothermal technique.
9. Extract metal nanoparticles from plants and their products like Mg from chlorophyll.
10. Estimate direct and indirect optical energy band gap of metal nanoparticles by UV visible spectroscopy technique.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books	
Theory	1. Photochemistry by Nicholas J. Turro (Prentice Hall, 1991) 2. Physical Chemistry by Peter Atkins and Julio de Paula (Oxford University Press, 2014) 3. Advanced Physical Chemistry by James R. Partington (Longmans, 1957). 4. Chemical Kinetics by Keith J. Laidler (Pearson, 1987) 5. X-ray Diffraction: A Practical Approach by C. Suryanarayana (Springer, 1999). 6. Principles of Physical Chemistry by Puri, Sharma and Pathania (Vishal Publishing Co.). 7. A Textbook of Physical Chemistry by K. L. Kapoor (McGraw Hill Education).
Practical	1. Graphene: Synthesis and Applications by Rahul R. Salunkhe, Yunsoo Choi, and Soo-Jin Park (Wiley, 2019). 2. Carbon Nanomaterials in Polymer Nanocomposites by Sanjay K. Sharma and Radha R. S. (Springer, 2019). 3. Conducting Polymers: A Comprehensive Review by Marjan Zeynizadeh (Springer, 2018). 4. Energy Storage Materials by Liang An, Zhaoyang Zhang, and Sheng Liu (Elsevier, 2020).

	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

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Course Code CC-A07			Course Title Organic Chemistry Special-I				Course ID 241/CHE/CC/301				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	5	20	25
Examination Duration:			**Theory**: 2 Hrs				**Practical**: 6 Hrs (Two sessions)				
Course Objectives			1. To understand the principles, preparation, properties, and applications of organometallic reagents involving metals such as Li, Mg, Zn, Cu, Pd, and others in organic synthesis. 2. To explore oxidative processes and mechanisms, including oxidation of aldehydes, ketones, amines, and other functional groups using various oxidizing agents. 3. To examine reductive processes for carbonyl compounds, nitro groups, and epoxides, and understand hydrogenolysis mechanisms and applications. 4. To analyze the mechanisms and synthetic applications of important name reactions. 5. To develop skills in multistep organic synthesis and apply software tools for structure drawing, IUPAC naming, and NMR prediction.								
Course Outcomes:			After the completion of this course, the students will be able to: **1.** Apply organometallic reagents effectively in organic synthesis, understanding their properties and reactivity patterns. 2. Analyze and predict outcomes of oxidative transformations of diverse functional groups using appropriate reagents. 3. Demonstrate proficiency in reductive processes for carbonyl compounds, nitro groups, and epoxides, and understand their synthetic implications. 4. Solve complex synthetic problems using named reactions and rationalize their mechanisms. 5. Acquire hands-on experience in multi-step organic synthesis and utilize software tools for structural analysis and spectral prediction.								

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Organometallic Reagents** Principle, preparations, properties and applications of the reagents of the following metals/non-metals in organic synthesis with mechanistic details Li, Mg, Cd, Zn, Cu, Ni, Fe, Co, Cr and Pd (Wacker process, Heck reaction, Stille coupling, Suzuki coupling, Negishi coupling, Sonagashira reaction).	12

II	**Oxidation** Introduction, Different oxidative processes, Aldehydes, ketones, ketals and carboxylic acids.Amines, hydrazines, and sulphides. Oxidations with ruthenium tetraoxide, and thallium (III) nitrate.	11
III	**Reduction** Introduction, Different reductive processes, Carbonyl compounds – aldehydes, ketones, acids and their derivatives, Epoxides, Nitro, Nitroso, Azo and Oxime groups, Hydrogenolysis.	11
IV	**Name Reactions** A detailed study including mechanism of Arndt-Eistert synthesis Beckmann, Hofmann, Curtius, Lossen, Schmidt, Favorskii, Neber, Fritsch-Butenberg-Wiechell, Baeyer-Villiger, Benzil-benzillic acid rearrangements, Darzens synthesis, stroke enamine synthesis, Shapiro reaction, Sharpless asymmetric epoxidation, Prevost and Woodward hydroxylation.	11
Practical Syllabus		2

Preparations of Organic compounds involving two and three stages:

1. Typical preparations from which the two and three stage preparations can be chosen are:

1. Benzene — Acetopheneone — Acetophenoneoxime — Acetanilide
2. Benzoin — Benzil — Benzillic acid
3. Nitrobenzene — m-dinitrobenzene — m-nitroaniline — m-nitrophenol
4. Phthalic acid — phthalic anhydride – phthalimide — Anthranilic acid
5. Phthalic anhydride—o-benzolylbenzoic acid—anthraquinone.
6. Cholrobenzene—2,4-dinitrochlorobenzene —2,4-dinitrophenol
7. Resorcinol—resacetophenone — 4-ethyl resorcinol
8. Resorcinol — 4-methyl-7-hydroxycoumarin—6 and 8- nitro-4-methyl-7-hydroxycoumarin
9. Phenol — salicylaldehyde —coumarin
10. Aniline — 2,4,6-tribromaniline — 1,3,5-tribromobenzene

2. Demonstration of use of Chemistry software for drawing the structures of Organic compounds:

Draw the Scheme used for a multi-step preparation (two or three) using any structural drawing tool & get the IUPAC name and predicted ^{1}H-NMR spectrum for each compound involved in multi-step preparation.

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory	1. Modern Synthetic Reactions, H.O. House, W.A. Benzamin. 2. Some Modern Method of Organic Synthesis, W. Carruther, Cambridge Univ. Press. 3. Advanced Organic Chemistry, Reactions Mechanism and Structure, J. March, John Wiley. 4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional 5. Modern Synthetic Reactions, H.O.House, W.A. Benzamin. 6. Advanced Organic Chemistry Reactions, Mechanisms a Structures, J. March, Wiley. 7. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum

	Press.	
Practical	1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975). 2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959. 3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966. 4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors. 5. 'A Guide to spectroscopy in Organic Chemistry' by PAVY 6. 'Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons. 7. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming. 8. Vogel's Text Book of Practical Organic Chemistry by B.S. Furnerset. al., Longman Group Ltd.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05 Marks
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Course Code CC-A08			Course Title Organic Chemistry Special-II				Course ID 241/CHE/CC/302				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	05	20	25
Examination Duration:			**Theory**: 2 Hrs				**Practical**: 6 Hrs (Two sessions)				
Course Objectives			1. To introduce the concepts of molecular orbital symmetry, classification of pericyclic reactions, and their analysis using FMO and PMO approaches. 2. To understand the mechanisms and stereochemical aspects of sigmatropic rearrangements and related pericyclic processes. 3. To study the behavior of molecules in excited states and explore photochemical reactions of carbonyl compounds and olefins. 4. To learn photochemical reactions of aromatic compounds and understand aromatic, antiaromatic, and homoaromatic systems using molecular orbital theory and NMR. 5. To develop skills in the separation, identification, and spectroscopic analysis of components in binary organic mixtures.								
Course Outcomes:			After the completion of this course, the students will be able to: **1.** Classify pericyclic reactions and predict their stereochemical outcomes using FMO and PMO methods. **2.** Explain the mechanisms and stereochemistry of sigmatropic rearrangements and solve related problems. **3.** Describe excited states and apply photochemical principles to reactions of carbonyl compounds and olefins. **4.** Interpret photochemical transformations of aromatic compounds and assess aromaticity using theoretical and spectroscopic tools. **5.** Students will be able to separate and identify binary organic mixtures and confirm components using IR and NMR spectral data.								

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Pericyclic Reactions -I** Molecular orbital symmetry, frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system classification of pericyclic reactions, Woodward - Hoffmann correlation diagram. FMO & PMO approach, Electrocylic reaction - conrotatory and disrotatory motions. 4n, 4n+2, allyl systems, Cycloadditions-antarafacial and suparafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloadditions and cheleotropic	11

	Reactions.	
II	**Pericyclic Reactions -II** Sigmatropic Rearrangements-suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, [3,3] and [5,5] sigmatropic rearrangements, detailed treatment of Sommelet-Hauser, Claisen and Cope rearrangements, introduction to ene reactions. Simple problems on Pericyclic reactions, Group transfers and eliminations.	11
III	**Photochemistry-I** Excitation and excited states, Franck-Condon Principle, Jablonski diagram, energy transfer photosensitization, quenching, quantum efficiency and quantum yield. Photochemistry of carbonyl compounds: Norrish type I and type II changes, photoreaction of cyclic ketones, Paterno-Buchi reaction and Photoreducation. Photochemistry of olefins and 1,3-Butadiene (cis-trans isomerisation, dimerisation and cycloadditions). Di-π-methane rearrangement, enone and dienone rearrangements.	11
IV	**Photochemistry-II** Photochemistry of aromatic compounds, Photo-Fries rearrangements of ethers & anilides, Barton reaction, Hoffman-Lcefller-Freytag reaction. **Aromaticity** Concept of aromaticity, non-aromaticity, antiaromaticity, and homoaromaticity, Aromaticity in charged rings, HMO and PMO for determining aromatic, non-aromatic and anti-aromatic character of annulenes having various π-electron systems, application of ^{1}H-NMR in determining aromatic character of annulenes.	12
Practical Syllabus		2
Organic Mixture Analysis 1. **Qualitative Analysis:** Demonstrations of separation of binary mixtures (**Solid-Liquid & Liquid-Liquid**): using H_2O, HCl, NaOH, $NaHCO_3$, Ether or other reagent as may be necessary along with required conditions for their use. Systematic identification of organic mixtures: separation and identification of binary mixtures including derivatives, in the formation of individual components. 2. Spectroscopic confirmation of the binary mixtures using IR and NMR (IR & NMR spectra will be provided). *Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.*		
Suggested Books		
Theory	1. Pericyclic Reactions, S.M. Mukherji Macmilan India. 2. Organic Photochemistry, J Coxan& B. Halton, Cambridge University Press. 3. Introductory Photochemistry,.A. Cox and T. Camp McGraw Hill. 4. The Conservation of Orbital Symmetry, R.B. Woodward and R. Hoffmann" VerlagChemie Academic Press. 5. Problem Solving approach to Orbital Symmetry, R.E. Lehr and A.P. Merchand 6. Organic Reactions and Orbital Symmetry, T.L. Gilchrist and R.C. Storr, Cambridge University Press, Cambridge, 2ndEdn. 1979.	

Practical	1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975). 2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959. 3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966. 4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors. 5. 'A Guide to spectroscopy in Organic Chemistry' by PAVY 6. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons. 7. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming. 8. Vogel's Text Book of Practical Organic Chemistry by B.S. Furnerset. al., Longman Group Ltd.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05 Marks
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Course Code CC-A09			Course Title Organic Chemistry Special-III				Course ID 241/CHE/CC/303				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	05	20	25

Examination Duration:	**Theory**: 2 Hrs	**Practical**: 6 Hrs (Two sessions)
Course Objectives	**1.** To understand the properties, classification, mechanisms, and kinetics of enzyme action including inhibition models. **2.** To explore the mechanisms of enzyme catalysis with examples and study the role and function of biologically important coenzymes. **3.** To learn the classification, isolation, and structure determination of terpenoids with emphasis on geraniol and α-pinene. **4.** To understand the structure elucidation and synthesis of flavonoids and steroidal transformations derived from cholesterol. **5.** To develop practical skills in colorimetric analysis and isolation of bioactive compounds from natural sources.	
Course Outcomes	After the completion of this course, the students will be able to: 1. Explain enzyme properties, kinetics, and inhibition using models like Michaelis-Menten and Lineweaver-Burk. 2. Able to describe the catalytic mechanisms of selected enzymes and the biochemical roles of key coenzymes. 3. Classify terpenoids and determine their structures through chemical and spectroscopic methods. 4. Elucidate the structures and syntheses of flavonoids and explain key steroid transformations from cholesterol. 5. Estimate biomolecules colorimetrically and isolate natural products from various biological sources.	

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Enzymes** Introduction, remarkable properties of enzymes like catalytic power, pH and heat sensitivity, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling. Enzyme kinetics: Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. **Mechanism of Enzyme Action** Acid-base catalysis, electrostatic and covalent catalysis	11
II	**Mechanism of action of** chymotrypsin, papain and	12

	carboxypeptidase A. **Co-Enzyme Chemistry** Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure, biological functions and mechanisms of reactions catalyzed by coenzyme A, thiamine pyrophosphate (TPP), pyridoxal phosphate (PLP), NAD^+, $NADP^+$, FMN, FAD.	
III	**Terpenoids** Definition, classification, occurrence, isolation from essential oil, General aspects of structure determination of terpenoids. Complete structure elucidation and synthesis of geraniol and α-pinene. **Flavonoids** Occurrence, nomenclature, general methods (chemical and spectroscopic) of structure determination of flavonoids. Isolation, structure elucidation and synthesis of Cyanin, Quercetin, Diadzein and Chrysin.	11
IV	**Steroids** Nomenclature of steroids, Structure elucidation of cholesterol. Methods for the following conversions. 1. Cholesterol → Testosterone 2. Cholesterol → Progesterone 3. Cholesterol → 5-α and 5-β cholanic acids.	11
Practical Syllabus		2

1. **Colorimetric determination of the followings:** Carbohydrates, amino acids, proteins, cholesterol, urea.
2. **Extraction of organic compound from natural products**: Any one of the followings:–
   Isolation of Caffeine from tea leaves
   Isolation of β-carotene from carrot
   Isolation of limonene from citrus rind
   Isolation of nicotine from tobacco
   Isolation of lactose from milk
   Isolation of Casein from milk

Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals.

Suggested Books

Theory	1. Pericyclic Reactions, S.M. Mukherji Macmilan India. 2. Organic Photochemistry, J Coxan& B. Halton, Cambridge University Press. 3. Introductory Photochemistry,.A. Cox and T. Camp McGraw Hill. 4. The Conservation of Orbital Symmetry, R.B. Woodward and R. Hoffmann" VerlagChemie Academic Press. 5. Problem Solving approach to Orbital Symmetry, R.E. Lehr and A.P. Merchand 6. Organic Reactions and Orbital Symmetry, T.L. Gilchrist and R.C. Storr, Cambridge University Press, Cambridge, 2nd Edn. 1979.
Practical	1. "A Handbook of Organic Analysis Qualitative and Quantitative" by H.T. Clarke and revised by B.Maynes, Edward Arnold (Pub.)., Ltd. London, 1975). 2. "Systematic Qualitative Organic Analysis" by H.Middleton, Edward Arnold (Publishers) Ltd., London 1959.

	3. "A Text Book of Practical Organic Chemistry including Qualitative Organic Analysis" by Arthur I. Vogel, Longmans Green and Co., Ltd., London 1966. 4. "Elementary Practical Organic Chemistry" by Arthur I. Vogel, CBS Publishers & Distributors. 5. "A Guide to spectroscopy in Organic Chemistry' by PAVY 6. "Organic Spectroscopy', 3rd Ed., by William Kamp. John Wiley & Sons. 7. "Spectroscopic" Methods in Organic Chemistry, D.H. William & Ian Fleming. 8. Vogel's Text Book of Practical Organic Chemistry by B.S. Furnerset. al., Longman Group Ltd.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks
Practical	Internal Assessment: 05 Marks	• Class Participation/Seminar/Lab record: 05 Marks
	External Assessment: 20 Marks	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Course Code DSE-03			Course Title Spectroscopic Methods in Chemistry-II				Course ID 241/CHE/DS/301		
L	T	P	L	T	P	Total Credits	MARKS		
(Hrs)			Credits				TI	TE	Total
3	-	-		-	-	3	25	50	75

Examination Duration:	2 Hrs

Course Objectives	1. To understand the principles of vibrational spectroscopy, including diatomic and polyatomic molecular vibrations, anharmonicity, and normal modes. 2. To explore symmetry-based approaches to IR modes and their applications in studying bonding in ligands, complexes, and metalloproteins using resonance Raman spectroscopy. 3. To learn the basics and applications of Mossbauer spectroscopy for analyzing bonding, spin states, and oxidation states in metal complexes. 4. To gain some basic knowledge of electron spin resonance spectroscopy and its application in inorganic complexes. 5. Understanding of various concepts of Inorganic vibrational spectroscopy 6. Knowledge of various important segments of Inorganic nuclear magnetic spectroscopy
Course Outcomes:	After the completion of this course, the students will be able to: 1. Explain molecular vibrations, anharmonicity, and normal modes, and apply these concepts to analyze vibrational spectra. 2. Utilize symmetry and group theory to predict IR modes and interpret bonding in ligands, complexes, and metalloproteins. 3. Apply Mossbauer spectroscopy to study bonding, spin states, and oxidation states in metal complexes. 4. Understand basic concept of electron spin resonance spectroscopy and its application in structure and bonding of some inorganic complexes. 5. Determine the vibration active modes of different molecules of various structural pattern 6. Utility of inorganic molecules in NMR spectroscopy 7. Knowledge of various NMR spectroscopies of spin active inorganic nuclei.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Rotational spectroscopy** Basics of Molecular Spectroscopy: Electromagnetic radiation and	11

	its region, representation of spectra, signal to noise ratio, resolving power, width and intensity of spectral lines. Rotational (Microwave) Spectroscopy: Rotational Spectroscopy-Rigid diatomic Rotator, Selection rule for rotational/microwave spectrum, determination of bond-length, intensity of spectral lines, effects of isotopes on rotational spectra, Nonrigid rotator, Stark effect, Rotational spectra of linear polyatomic molecules, Application of microwave spectroscopy.	
II	**Vibrational Spectroscopy** The vibrating diatomic molecule, force constant, zero-point energy, simple harmonic vibrator, anharmonicity, Morse potential, fundamental bands, overtones, hot bands, diatomic vibrating rotators, P, Q, R branches, vibration of polyatomic molecules, normal mode of vibrations. **Raman Spectroscopy:** Stokes and anti-Stokes lines. Polarizability ellipsoids. Pure Rotational Raman spectra, pure vibrational Raman spectra. Selection rules. Rule of Mutual Exclusion. Polarization of light. Raman Effect. Application of Raman and Infra-red spectroscopy in structure determination.	11
III	**Mossbauer spectroscopy** Mossbauer Spectroscopy: Basic Principles, Spectral display, Doppler shift and recoil energy, isomer shift and its interpretation, Application of the technique to the studies of bonding and structures of Fe and Sn compounds. **ESR Spectroscopy** Electronic paramagnetic resonance spectroscopy: Theory and Principle, Presentation of spectra, Hyperfine splitting, g value, anisotropy in g value, significance of g-factor, zero-field splitting, Kramer's degeneracy, application to transition metal complexes. Double resonance in EPR.	12
IV	**Inorganic vibrational Spectroscopy** Symmetry, shapes and number of IR modes AB_2, AB_3, AB_4, AB_5 and AB_6 (Group theoretical treatment) mode of bonding of ambidentate ligands (nitro-nitrito & thiocynato-isothiocyanato complexes) **Inorganic Nuclear magnetic Resonance** Basic Principle of NMR, Nuclear relaxation, Factors affecting nuclear relaxation, effect of chemical exchange on spectrum, Double resonance, Lanthanide shift reagents, an overview of NMR of other nuclides with emphasis on ^{31}P, ^{19}F, and ^{119}Sn NMR. Application in inorganic chemistry	11
Suggested Books	1. Introduction to Spectroscopy- A Guide for Students of Organic Chemistry, 2nd Edn. By Donald L. Pavia, Gary M. Lampman and George S. Kriz. Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York. 2. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley. 3. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.	

	4. Spectroscopic Methods in Organic Chemistry, D. H. Williams and I. Fleming, Tata McGraw-Hill. 5. Organic Spectroscopy by William Kemp, John Wiley. 6. Organic Mass Spectrometry by K.G. Das & E.P. James, Oxford & IBH Publishing Co. 7. Organic Spectroscopy (Principles & Applications) by Jagmohan.	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Course Code			Course Title				Course ID				
MDC-03			Instrumental Methods of Analysis				241/CHE/MD/301				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
Examination Duration:			Theory: 2 Hrs								
Course Objectives			1 Understand the fundamentals of qualitative and quantitative analysis, including sampling, data evaluation, and error management. 2 Develop a thorough understanding of statistical techniques for evaluating analytical data and expressing accuracy and precision. 3 Explore the principles of IR and UV-spectroscopy, including the interaction of radiation with matter and the application of Beer-Lambert's law. 4 Learn thermal methods of analysis, including thermogravimetry, differential thermal analysis, and their applications in quantitative estimation. 5 Understand principle and application of atomic absorption spectroscopy and flame photometry. 6 Study the principles and applications of electroanalytical techniques such as pH metric, potentiometric, conductometric titrations. 7 Acquire an understanding of polarography, including its principles, instrumentation, and applications.								
Course Outcomes:			After the completion of this course, student will be able to: 1 Apply the principles of qualitative and quantitative analysis to evaluate and interpret analytical data effectively. 2 Perform error analysis and statistical testing using F, Q, and t-tests and calculate confidence intervals. 3 Analyze spectral data using the principles of UV-Visible and infrared spectrometry and interpret structural information. 4 Demonstrate proficiency in using thermal analysis techniques (TGA, DTA, DSC) for quantitative estimation and material characterization. 5 Learn atomic absorption spectroscopy and flame photometry principles and uses. 6 Conduct pH metric, potentiometric, and conductometric titrations to determine equivalence points and pKa values. 7 Use polarography for the analysis of various samples and								

	understand its role in analytical chemistry.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**QUALITATIVE AND QUANTITATIVE ASPECTS OF ANALYSIS** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q, and t-test, rejection of data, and confidence intervals. Origin of spectra, the interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.	11
II	**OPTICAL METHODS OF ANALYSIS** UV-Visible spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument. Infrared spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instruments; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.	11
III	**THERMAL METHODS OF ANALYSIS** Thermogravimetric Analysis (TGA): Instrumentation, thermogram, factors affecting thermograms, application of thermogravimetry; Differential Thermal Analysis (DTA): Instrumentation, DTA curves, factors affecting DTA curves, applications of DTA. Differential Scanning Calorimetry (DSC): Introduction, Instrumentation, DSC curves, factors affecting DSC curves, applications. **ATOMIC ABSORPTION SPECTROSCOPY** Atomic Absorption Spectroscopy: Principle, instrumentation, Hollow cathode lamp, Application of atomic absorption spectroscopy, Advantages and Disadvantages of Atomic Absorption Spectroscopy. **FLAME PHOTOMETRY** Theory of flame photometry, Effect of Solvents in Flame photometry, Factors that influence the intensity of emitted Radiation in Flame photometry, limitations, application of flame photometry, Interferences in Flame photometry.	12
IV	**ELECTROANALYTICAL METHODS**	11

	Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values. Polarography: General principles, diffusion-controlled current, dropping mercury electrode, Ilkovic equation (without proof), Half-wave potentials, application of polarography, Amperometry: principle and application.	
Suggested Books	1. Mendham, J., A. I. Vogel's (2009) Quantitative Chemical Analysis 6th Ed., Pearson. 2. Willard, H.H. et al. (1988) Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company: Belmont, California, USA. 3. Christian, G.D. (2004) Analytical Chemistry, 6th Ed. John Wiley & Sons: New York. 4. Sesták J. Thermal Methods of Analysis: Principles, Applications and Problems 5. Chatwal G.R. and Anand. S.K. Instrumental Methods of Analysis 6. Skoog, D.A. Holler F.J., Crouch. S. R. Atomic Absorption Spectrometry 7. Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016. 8. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009. 9. Skoog, D.A. Holler F.J. & Nieman, T.A. (1979) Principles of Instrumental Analysis, Cengage Learning India 10. Mikes, O. (2008) Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons. 11. Ditts, R.V. (1974) Analytical Chemistry; Methods of separation, van Nostrand.	
	Assessment and Evaluation	
Theory	Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
	External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Course Code VAC-02			Course Title Interdisciplinary chemistry				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
2			2			2	15	35	-	-	50

Examination Duration:	Theory: 2 Hrs	Practical Nil

Course Objectives	• Understanding of various concepts Solid-state chemistry • Study of various ionic solid structures • Understanding of various concepts of X-ray crystallography • Knowledge of Electronic Structure of Solids • Understanding of Semiconductors, their types and properties • Study of Nomenclature of heterocyclic compounds • Synthetic methods and chemical properties of heterocyclic compounds of various ring sizes.
Course Outcomes:	Students will be able to learn about: • Concepts of Solid-state chemistry and the ionic structure of some important ionic structure • X-ray crystallography and important aspects • Electronic structure of Solids specially semiconductors and their properties. • Nomenclature, syntheses and chemical reactions of heterocyclic compounds of different ring sizes

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Further, eight questions will be set, two from each of the sections A, B, C & D. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Solid state-I** Solid-state Chemistry: Introduction: unit cell its classifications, lattice, lattice planes, Weiss indices, miller indices, d spacing formulae, interfacial angle, some ionic solid structures; rock salt, zinc blende or sphalerite, fluorite, antifluorite, rutile structure, anti-rutile, perovskite, cristobalite.	8
II	**Solid state-II** Miller indices for plane, Bragg method of X-ray structural analysis of crystals, electronic structure of solids- band theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, superconductors, Optical and Magnetic properties.	7
III	**Heterocyclic compounds-I** Systematic (Hantzsch-Widman) nomenclature for monocylic and fused ring systems, General synthesis and reactions (including	8

	mechanism) of the followings: Three-membered heterocycles: oxirane, azirane, oxazirane, diaziridines Four-memebered heterocycles: Oxetane and azetidine	
IV	**Heterocyclic compounds-II** General synthesis and reactions (including mechanism) of the followings: Five-membered heterocycles: pyrazole, imidazole, oxazole, isooxazole, thiazole, isothiazole: Comparison of their basic character.	7

Suggested Books

Theory:	SUGGESTED WEB SOURCES: • Solid state chemistry: An introduction by L. E. Smart, E. A. Moore. • Solid State Chemistry and its Applications by Anthony R. Wes. • Principles of the Solid State by H.V. Keer • Physical Chemistry by Peter Atkins and Julio de Paula (Oxford University Press, 2014). • Principles of Physical Chemistry by Puri, Sharma and Pathania (Vishal Publishing Co.). • A Textbook of Physical Chemistry by K. L. Kapoor (McGraw Hill Education) • Heterocylic Chemistry, T.L. Gilchrist, Longman Scientific Technical. • Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergaman Press. • Heterocyclic Chemistry, Vol-I & II, R. R. Gupta, M. Kumar, V. Gupta.

Assessment and Evaluation

Theory	Internal Assessment: 15 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 05 Marks
	External Assessment: 35 Marks (02 Hours)	• End Term Exam: 35 Marks

Course Code SEC-02			Course Title Medicinal Chemistry				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
2			2			2	15	35	-	-	50
Examination Duration:			Theory: 2 Hrs								
Course Objectives			• To understand drug discovery, SAR, lead optimization, and basic pharmacokinetic-pharmacodynamic principles. • To study the synthesis, action, and uses of antineoplastic and antimalarial drugs. • To learn the chemistry and therapeutic roles of analgesics, antipyretics, and anti-inflammatory agents. • 4. To explore the synthesis and medicinal use of cardiovascular and anti-HIV drugs.								
Course Outcomes:			After the completion of this course, student will be able to: • Explain the principles of drug design, SAR, and the role of lead compounds in drug development. • Describe the synthesis and mechanisms of action of selected antineoplastic and antimalarial drugs. • Analyze the structure, synthesis, and therapeutic applications of common analgesics and anti-inflammatory drugs. • Discuss the chemistry and mode of action of cardiovascular and anti-HIV agents.								

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Drug Design** Classification and discovery of new drugs, drug development: screening of natural products, isolation and purification, structure determination, structure-activity relationships (SAR), synthetic analogues, isosteres and bioisosteres, concept of lead compounds, therapeutic index, LD50 and ED50. Elementary idea about drug action: the receptor role, neurotransmitters and receptors, ion channels and their control.	8

Course Code AEC-03			Course Title Advanced Organic Chemistry				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
2			2			2	15	35	-	-	50
Examination Duration:			**Theory**: 2 Hrs								
Course Objectives			1. To introduce the concepts of synthons, synthetic equivalents, and functional group interconversions, emphasizing principles of the disconnection approach in organic synthesis. 2. To explain one- and two-group C-X and C-C disconnections, with a focus on chemoselectivity, regioselectivity, stereoselectivity, and stereospecificity in synthetic planning. 3. To explore advanced synthetic strategies, including polarity reversal, amine and alkene synthesis, ring construction, and the role of photochemistry and ketones in organic synthesis. 4. To provide insights into protection strategies for functional groups and their application in C-C disconnections involving Diels-Alder reactions, carbonyl condensations, and Michael additions.								
Course Outcomes:			After the completion of this course, student will be able to: 1. Demonstrate an understanding of synthons, synthetic equivalents, and the principles of the disconnection approach in designing organic syntheses. 2. Apply knowledge of C-X and C-C disconnections to solve problems involving chemoselectivity, regioselectivity, and stereoselectivity. 3. Analyze and design synthetic pathways using polarity reversal, photochemistry, and functional group transformations for complex molecule synthesis. 4. Implement protection strategies for functional groups in multistep organic syntheses, applying advanced disconnection techniques for carbon-carbon bond formation.								

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Disconnection Approach-I** An introduction of synthons and synthetic equivalents, general principles of the disconnection approach, functional group interconversions, the importance of order of events in organic synthesis, one group C-X and two group C-X disconnections.	8

II	**Disconnection Approach-II** One group C-C disconnection, chemoselectivity, regioselectivity, regiospecificity, stereoselectivity and stereospecificity. Reversal of polarity, amine synthesis, Synthesis of alkenes-use of wittig reagents, use of acetylene and aliphatic nitro compounds in organic synthesis, synthesis of three membered rings.	**8**
III	**Disconnection Approach-III** Photochemistry in organic synthesis: synthesis of four membered rings, uses of ketenes in organic synthesis, synthesis of five and six membered rings. Principle of protection of alcoholic, amino, carbonyl and carboxylic groups.	**7**
IV	**Disconnection Approach-IV** Two group C-C disconnection- Diels Alder reactions, 1,3-difunctionalized compounds and α,β-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalized compounds-Michael addition and Robinson Annulation.	**7**

Suggested Books	1. Designing Organic Synthesis, S.Warren, Wiley. 2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press. 3. Modern Synthetic Reactions, H. O. House, W.A. Benzamin.	
	Assessment and Evaluation	
Theory	Internal Assessment: 15 Marks	• Class Participation: 05 Marks • Seminar/Presentation/Assignment: 05 Marks • Mid Term Exam: 05 Marks
	External Assessment: 35 Marks (02 Hours)	• End Term Exam: 35 Marks

Course Code AEC-03			Course Title Physical Chemistry Special-IV				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			2			2	15	35	-	-	50
Examination Duration:			**Theory**: 2 Hrs								

Course Objectives	The primary objectives of this course are: 1. To introduce the fundamentals of quantum states, complexions, and probability distributions in statistical mechanics. 2. To develop a deep understanding of Maxwell-Boltzmann statistics and the role of partition functions in thermodynamics. 3. To analyze the statistical basis of heat capacities in gases and solids at various temperatures. 4. To study advanced quantum statistics including Bose-Einstein and Fermi-Dirac distributions. 5. To connect microscopic particle behavior with macroscopic thermodynamic properties. 6. To explore quantum effects in systems like electron gases, liquid helium, and ortho/para hydrogen. 7. To equip students with tools to apply statistical methods to real-world physical and chemical systems.
Course Outcomes:	After the completion of this course, the students will be able to: 1. Describe and calculate probabilities and distributions for quantum and classical systems. 2. Evaluate partition functions and relate them to thermodynamic quantities for molecular systems. 3. Analyze heat capacity behavior in solids using Einstein and Debye models. 4. Compare and apply Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics. 5. Explain quantum phenomena in low-temperature systems and condensed matter. 6. Calculate equilibrium constants using partition functions and interpret their physical significance. 7. Apply statistical mechanics to predict physical behavior of gases, solids, and quantum systems.

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.
2. Eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.
3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Statistical Mechanics-I** Quantum states and complexions, The combinatory rule, System with	8

	definite total energy, Degeneracy of energy levels, Probability and most probable distribution, Indistinguishability.	
II	**Statistical Mechanics-II** Maxwell-Boltzmann statistics, partition function, Translational, rotational, vibrational, nuclear and electronic partition functions, partition functions and their relation to thermodynamic quantities, Maxwell-Boltzmann law for gaseous system, Thermodynamic functions for gaseous systems	7
III	**Statistical Mechanics-III** Heat capacity of hydrogen at low temperatures, Heat capacities of monoatomic crystals, The Einstein model, Debye's theory of solid, Heat capacities of crystals at very low temperatures. Expression of equilibrium constant in terms of partition functions	7
IV	**Statistical Mechanics-IV** Bose-Einstein statistics, Fermi Dirac Statistics, Comparison of M-B, B-E and F-D statistics, Fermi-Dirac gas (Electron gas in metals)-Bose-Einstein gas (liquid Helium). Statistical thermodynamics of ortho and para hydrogen.	8

Suggested Books

Theory

1. Statistical Mechanics: Algorithms and Computations by Werner Krauth (Oxford University Press, 2006).
2. Introduction to Modern Statistical Mechanics by David Chandler (Oxford University Press, 1987).
3. Polymer Chemistry: An Introduction by Malcolm P. Stevens (Oxford University Press, 1999).
4. Principles of Polymer Chemistry by Paul J. Flory (Cornell University Press, 1953).
5. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles (McGraw-Hill, 2007).
6. Physical Chemistry by Peter Atkins and Julio de Paula (Oxford University Press, 2014).
7. Principles of Physical Chemistry by Puri, Sharma and Pathania (Vishal Publishing Co.).
8. A Textbook of Physical Chemistry by K. L. Kapoor (McGraw Hill Education).

Assessment and Evaluation

Theory	Internal Assessment: 15 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 5 Marks
	External Assessment: 35 Marks (02 Hours)	• End Term Exam: 35 Marks

Course Code AEC-03			Course Title Advanced Inorganic Chemistry				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
2			2			2	15	35	-	-	50
Examination Duration:			Theory: 2 Hrs				Practical: 6 Hrs (Two sessions)				
Course Objectives			1. Learn fundamental principles of photochemistry and analyze photochemical reactions using Jablonski diagrams and related processes. 2. Develop proficiency in light scattering techniques like nephelometry and turbidimetry, with an understanding of their applications. 3. Master polarographic analysis techniques, including wave evaluation and electrode behavior. 4. Gain practical knowledge in electrogravimetry, including electrolysis processes and deposition principles. 5. Explore advanced electrochemical methods such as coulometry, amperometry, and voltammetry for quantitative analysis.								
Course Outcomes:			After completing this course, students will be able to: 1. To have basic understanding of photochemistry, Jablonski diagram and Franck-Condon principle. 2. Differentiate between nephelometry and turbidimetry based on principles and applications. 3. Apply polarographic techniques, interpret polarographic waves, and understand electrochemical principles. 4. Perform electrogravimetry, coulometry, and amperometry for quantitative analysis. 5. Utilize voltametric techniques such as cyclic, anodic, and cathodic stripping voltammetry.								

COURSE SYLLABUS

Note: 1. Question no. 1 is compulsory, which contains short answer type questions and to be set from the entire syllabus.

2. Further, eight questions will be set, two from each of the units I, II, III & IV. The candidates are required to attempt four questions in all selecting at least one question from each section. All questions shall carry equal marks.

3. The question paper must be set in consonance with course outcomes.

Unit No.	Contents	Contact Hrs
I	**Photochemistry** Laws of photochemistry: (Grothus-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law), quantum yield, quantum efficiency, singlet and triplet state, Jablonski Diagrams: Vibrational Relaxation, Internal Conversion, Intersystem Crossing, Fluorescence, and Phosphorescence; Fluorescence Spectra, Franck-Condon principle, Radiative Lifetime.	7
II	**Nephelometry and Turbidimetry** Theory-light scattering, choice and comparison between nephelometry and turbidimetry, factors affecting measurement, instrumentation, applications.	8

	Polarography General principles, diffusion controlled current, dropping mercury electrode, IIkovic equation (without proof), Half-wave potentials, over potential, Evaluation of Polarographic waves, Conditions for performing Polarographic determinations and applications of Polarography	
III	**Electro analytical methods of Analysis** Electrogravimetry: Current-voltage relationship during an electrolysis, decomposition potential, constant current electrolysis, constant cathode potential electrolysis, apparatus, electrodes, mercury cathode, applications physical properties of electrolytic precipitates, chemical factors of importance in electrodeposition.	**8**
IV	**Coulometry and Amperometry** Coulometric analysis: Principle, Coulometric methods of constant electrode potential and coulometric titrations. Apparatus and applications. Amperometric titrations, cathodic stripping voltammetry, anodic stripping voltammetry, and cyclic voltammetry.	**7**

Suggested Books

1. Physical methods in Chemistry; R. S. Drago; Saunders, Philadelphia.
2. Fundamentals of Analytical Chemistry; D.A. Skoog, O.M. West and F.J. Holler; W.B. Saunders.
3. Instrumental methods of Analysis; L.L. Merits, R.H. Willard and J.A. Dean; Van Nostrand-Reinhold.
4. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal and Sham K. Anand
5. A Textbook of Quantitative Inorganic Analysis, A.I. Vogel; ELBS, London.
6. Electroanalytical Methods: Guide to Experiments and Applications by Fritz Scholz
7. Principles of physical chemistry by Puri Sharma Pathania

Theory:	**SUGGESTED WEB SOURCES:** 1. https://nptel.ac.in/course.html 2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 3. https://swayam.gov.in/explorer?category=Chemistry	
	Assessment and Evaluation	
Theory	Internal Assessment: 15 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 05 Marks
	External Assessment: 35 Marks (02 Hours)	• End Term Exam: 35 Marks