Department of Chemistry
Scheme: M.Sc Chemistry (02 Years)

(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/Mathematics for Chemist	241/CHE/DS/ 101	3			3			3	25	50			75
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**					

Department of Chemistry
Scheme: M.Sc Chemistry (02 Years)

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					

Department of Chemistry
Scheme: M.Sc Chemistry (02 Years)

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	241/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	241/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	241/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	241/CHE/ MD/301	3			3			3	25	50			75

Department of Chemistry
Scheme: M.Sc Chemistry (02 Years)

	Instrumental methods of Analysis													
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					

Course Code CC-A07	Course Title Inorganic Chemistry Special-I	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	-	-	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. Sutcliffe 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 metalloproteins 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

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

	Absolute rate theory in terms of 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** Chain reactions: types, examples and characteristics of chain reactions, kinetics of chain reactions, 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 reactions; 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** Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), surface films on liquids (electro kinetic phenomenon). Surface active agents: General features, structure & classification, micellization, mass action model and phase separation model, hydrophobic interactions, critical micelle concentration (CMC), factors affecting CMC of surfactants, thermodynamics of micelle formation, counter ion binding to micelles, reverse micelles.	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 $Ag(NH_3)^{2+}$ 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

<table>
<tr><td colspan="3">Course Code
CC-A08</td><td colspan="4">Course Title
Physical Chemistry Special-II</td><td colspan="5">Course ID</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total Credits</td><td colspan="5">MARKS</td></tr>
<tr><td colspan="3">(Hrs)</td><td colspan="3">Credits</td><td>TI</td><td>TE</td><td>PI</td><td>PE</td><td>Total</td></tr>
<tr><td>3</td><td></td><td></td><td>3</td><td></td><td></td><td>3</td><td>25</td><td>50</td><td>-</td><td>-</td><td>75</td></tr>
<tr><td></td><td></td><td>2</td><td></td><td></td><td>1</td><td>1</td><td>-</td><td>-</td><td>5</td><td>20</td><td>25</td></tr>
<tr><td colspan="3">Examination Duration:</td><td colspan="5">Theory: 2 Hrs</td><td colspan="4">Practical: 6 Hrs (Two sessions)</td></tr>
<tr><td colspan="3">Course Objectives</td><td colspan="9">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.</td></tr>
<tr><td colspan="3">Course Outcomes:</td><td colspan="9">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.</td></tr>
<tr><td colspan="12">COURSE SYLLABUS</td></tr>
<tr><td colspan="12">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.</td></tr>
</table>

Unit No.	Contents	Contact Hrs
I	**Corrosion** Forms of Corrosion, Uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, stress corrosion cracking, corrosion fatigue, fretting corrosion, dealloying, hydrogen embrittlement, erosion-corrosion, microbial induced corrosion, filiform corrosion, and exfoliation.	11
II	**Electrochemistry** Debye- Huckel Theory of the structure of dilute ionic solution, charge density and electrical potential, Properties of ionic cloud, activity coefficients from Debye-Huckel theory, Limiting law and its verification, Debye-Huckel Theory to more concentrated solutions, The triumph and limitations of Debye-Huckel theory of activity coefficients, electrical potential and mean activity coefficient in the case of ionic clouds with finite sized ions.	12
III	**Advanced Thermodynamics-III** Ideal and non-ideal solutions, Thermodynamic functions of mixing of non-ideal solutions, Gibbs-Duhem-Margules equation and its applications, Excess thermodynamic function and determination of excess function.	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.	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	
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

<table>
<tr><td colspan="3">Course Code
CC-A09</td><td colspan="4">Course Title
Physical Chemistry Special-III</td><td colspan="5">Course ID</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total Credits</td><td colspan="5">MARKS</td></tr>
<tr><td colspan="3">(Hrs)</td><td colspan="3">Credits</td><td>TI</td><td>TE</td><td>PI</td><td>PE</td><td>Total</td></tr>
<tr><td>3</td><td></td><td></td><td>3</td><td></td><td></td><td>3</td><td>25</td><td>50</td><td>-</td><td>-</td><td>75</td></tr>
<tr><td></td><td></td><td>2</td><td></td><td></td><td>1</td><td>1</td><td>-</td><td>-</td><td>5</td><td>20</td><td>25</td></tr>
<tr><td colspan="3">Examination Duration:</td><td colspan="5">Theory: 2 Hrs</td><td colspan="4">Practical: 6 Hrs (Two sessions)</td></tr>
<tr><td colspan="3">Course Objectives</td><td colspan="9">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.</td></tr>
<tr><td colspan="3">Course Outcomes:</td><td colspan="9">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.</td></tr>
<tr><td colspan="12">COURSE SYLLABUS</td></tr>
<tr><td colspan="12">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.</td></tr>
</table>

<table>
<tr><td colspan="3">3. The question paper must be set in consonance with course outcomes.</td></tr>
<tr><th>Unit No.</th><th>Contents</th><th>Contact Hrs</th></tr>
<tr><td>I</td><td>Photochemistry
Laws of photochemistry: (Grothus-Draper law, Stark-Einstein law of photochemical equivalence and Lambert-Beer's law), quantum yield, quantum efficiency, singlet and triplet state, Jablonski diagram, photophysical processes: (radiative and non-radiative) fluorescence, phosphorescence and chemiluminescence, Kinetics of photophysical processes, relaxation time, Kinetics of quenching: Stern Volmer equation.</td><td>11</td></tr>
<tr><td>II</td><td>Gaseous State
Distribution law (Barometric formula), Maxwell's law of distribution of velocity and energy, Maxwell's law and Gaussian density function, R, M, S, Mean and Most probable velocities, Collision frequency, Collision between like and unlike molecules.
Kinetic theory of thermal conductivity and diffusion coefficient of gases (quantitative treatment), viscosity of gases and its relation to mean free path, variation of viscosity with temperature and pressure. Law of equipartition of energy.</td><td>12</td></tr>
<tr><td>III</td><td>Polymer chemistry-II
Glass transition temperature (Tg), factors influencing the glass transition temperature, effect of molecular weight and melting point on glass transition temperature, importance of glass transition temperature.
Average end-to-end distance, average radius of gyration of polymer chains, statistical distribution of end-to-end dimensions, freely jointed chain in three dimensions, influence of bond angle restrictions. Entropy of mixing and enthalpy of mixing by lattice model, Flory Huggins lattice theory, limitations of lattice model, entropy of mixing by free volume theory, heat and free energy of mixing, partial molar quantities i.e., chemical potential, heat of dilution and partial molar entropy of mixing, excluded volume, thermodynamic relations for dilute polymer solutions.</td><td>11</td></tr>
<tr><td>IV</td><td>X-ray diffraction
Bragg condition, Miller indices, Laue method, Debye-Scherrer method of X-ray structural analysis of crystals, index reflections, structure of simple lattices and X-ray intensities.
JCPDS card file for corelating structure.</td><td>11</td></tr>
<tr><td colspan="2">Practical Syllabus</td><td>4</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

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

Course Code CC-A07			Course Title Organic Chemistry Special-I					Course ID 241/CHE/CC/301			
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	-	-	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

<table>
<tr><td></td><td colspan="2">Press.</td></tr>
<tr><td>Practical</td><td colspan="2">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.</td></tr>
<tr><td></td><td colspan="2">Assessment and Evaluation</td></tr>
<tr><td rowspan="2">Theory</td><td>Internal Assessment: 25 Marks</td><td>• Class Participation: 05 Marks
• Seminar/Presentation/ Assignment: 05 Marks
• Mid Term Exam: 15 Marks</td></tr>
<tr><td>External Assessment: 50 Marks (02 Hours)</td><td>• End Term Exam: 50 Marks</td></tr>
<tr><td rowspan="2">Practical</td><td>Internal Assessment: 05 Marks</td><td>• Class Participation/Seminar/Lab record: 05 Marks</td></tr>
<tr><td>External Assessment: 20 Marks</td><td>• End Term Practical Exam: 10 Marks
• Lab record: 05 Marks
• Viva Voce: 05 Marks</td></tr>
</table>

Course Code CC-A08			Course Title Organic Chemistry Special-II				Course ID 241/CHE/CC/302				
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. 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-Leefller-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. "Spectroscepic" 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	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.** 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

<table>
<tr><td colspan="3">Course Code
MDC-03</td><td colspan="4">Course Title
Instrumental Methods of Analysis</td><td colspan="5">Course ID
241/CHE/MD/301</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>L</td><td>T</td><td>P</td><td rowspan="2">Total Credits</td><td colspan="5">MARKS</td></tr>
<tr><td colspan="3">(Hrs)</td><td colspan="3">Credits</td><td>TI</td><td>TE</td><td>PI</td><td>PE</td><td>Total</td></tr>
<tr><td>3</td><td></td><td></td><td>3</td><td></td><td></td><td>3</td><td>25</td><td>50</td><td>-</td><td>-</td><td>75</td></tr>
<tr><td colspan="3">Examination Duration:</td><td colspan="9">Theory: 2 Hrs</td></tr>
<tr><td colspan="3">Course Objectives</td><td colspan="9">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.</td></tr>
<tr><td colspan="3">Course Outcomes:</td><td colspan="9">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</td></tr>
</table>

	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

<table>
<tr><td></td><td colspan="2">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.</td><td></td></tr>
<tr><td>Suggested Books</td><td colspan="3">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.</td></tr>
<tr><td></td><td colspan="3">Assessment and Evaluation</td></tr>
<tr><td rowspan="2">Theory</td><td>Internal Assessment: 25 Marks</td><td colspan="2">• Class Participation: 05 Marks
• Seminar/Presentation/ Assignment: 05 Marks
• Mid Term Exam: 15 Marks</td></tr>
<tr><td>External Assessment: 50 Marks (02 Hours)</td><td colspan="2">• End Term Exam: 50 Marks</td></tr>
</table>

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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

<table>
<tr><td></td><td colspan="2">mechanism) of the followings: Three-membered heterocycles: oxirane, azirane, oxazirane, diaziridines
Four-memebered heterocycles: Oxetane and azetidine</td><td></td></tr>
<tr><td>IV</td><td colspan="2">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.</td><td>7</td></tr>
<tr><td colspan="4">Suggested Books</td></tr>
<tr><td>Theory:</td><td colspan="3">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.</td></tr>
<tr><td colspan="4">Assessment and Evaluation</td></tr>
<tr><td rowspan="2">Theory</td><td>Internal Assessment: 15 Marks</td><td colspan="2">Class Participation: 05 Marks
Seminar/Presentation/ Assignment: 05 Marks
Mid Term Exam: 05 Marks</td></tr>
<tr><td>External Assessment: 35 Marks (02 Hours)</td><td colspan="2">End Term Exam: 35 Marks</td></tr>
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Course Code SEC-02			Course Title Medicinal Chemistry				Course ID				
L	T	P	L	T	P	Total	MARKS				
(Hrs)			Credits			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