Syllabus

2nd Semester

M.Sc. (Chemistry)

241/CHE/CC201

CC-A04: Inorganic Chemistry-II

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

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

COURSE SYLLABUS

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

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

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

<table>
<tr><td colspan="2">Total five radicals to be given containing two less common metal ions, one insoluble and two acid radicals: $CH_3COO^-, BO_3^{3-}, PO_4^{3-}, CO_3^{2-}, HCO_3^-, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, S^{2-}, SO_3^{2-}, SO_4^{2-}, S_2O_3^{2-}, F^-, C_2O_4^{2-}$.
Less common metal ions – W, Tl, Mo, Se, Ti, Zr, Th, V, U, Ce, Be (two metal ions in cationic and anionic forms)
Insoluble: Halides (AgCl, AgBr, AgI); Sulphates ($PbSO_4$, $BaSO_4$) and Oxides (Al_2O_3, Cr_2O_3, SnO_2, TiO_2, SiO_2)
Note: Any experiment can be introduced or deleted in the practical class on the basis of availability of instruments/chemicals</td></tr>
<tr><td colspan="2">Suggested Books</td></tr>
<tr><td>Theory:</td><td>Books Suggested:
1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huheey, Harper & Row.
3. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
4. Organometallic Chemistry; R.C. Mehrotra and A. Singh, New Age International.
5. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
6. Bioinorganic Chemistry by A.K. Das
7. Metal-Based Drugs: Molecular Design and Mechanism of Action, by James C. Dabrowiak
8. Principles of Bioinorganic Chemistry: S. J. Lippard and J. M. Berg, University Science Books.
9. The Inorganic Chemistry of Biological Process; M. N. Huges; John Wiley & Sons.
10. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J.J. Alexander; John Wiley.
11. Basic Concepts of Analytical Chemistry by S. M. Khopkar.
12. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch
13. Environmental Chemistry by Stanley E. Manahan.
14. Environmental Chemistry: A Global Perspective by Gary W. vanLoon and Stephen J. Duffy

SUGGESTED WEB SOURCES:
1. https://nptel.ac.in/course.html
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5
3. https://swayam.gov.in/explorer?category=Chemistry</td></tr>
<tr><td>Practical</td><td>1. Qualitative Inorganic Analysis by Arthur I. Vogel and F.G. Svehla
2. Practical Inorganic Chemistry by O.P. Pandey, D.N. Bajpai, S. Giri
3. Advanced Practical Inorganic Chemistry by Gurdeep Raj
4. Qualitative Chemical Analysis and Instrumental Methods by G. Chatwal and S. Anand
5. Comprehensive Practical Chemistry by N.K. Verma, S.K. Khanna, and B. Kapila</td></tr>
</table>

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

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241|CHE|CC202

CC-A05: Physical Chemistry-II

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

Course Objectives

The course aims to provide a comprehensive understanding of advanced concepts in physical chemistry and their practical applications.

1. To understand the principles of molecular orbital and valence bond theories in diatomic molecules.
2. To explore Huckel theory and its applications to conjugated π-electron systems.
3. To delve into the Third Law of Thermodynamics and its practical applications.
4. To study the concepts of activity, fugacity, and their relevance to chemical equilibria.
5. To analyze phase diagrams and phase rules for one- and two-component systems.
6. To gain insights into the kinetics of chemical reactions and polymerization mechanisms.
7. To familiarize with experimental techniques for determining physical and thermodynamic properties of systems.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Demonstrate understanding of chemical bonding through MO and VB theories.
2. Apply Huckel theory to predict properties of conjugated systems.
3. Utilize thermodynamic laws to determine entropy and other state functions.
4. Analyze the behavior of solutions using activity, fugacity, and phase rule concepts.
5. Interpret phase diagrams and predict system behavior in various compositions.
6. Evaluate chemical reaction mechanisms and rates using advanced theories.
7. Perform and interpret experiments involving calorimetry, phase behavior, and thermodynamic measurements.

COURSE SYLLABUS

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

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

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

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

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

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

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

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

241/CHE/CC203

CC-A06: Organic Chemistry-II

Course Code CC-A06			Course Title Organic Chemistry-II				Course ID				
L	T	P	L	T	P	Total Credits	MARKS				
(Hrs)			Credits				TI	TE	PI	PE	Total
3			3			3	25	50	-	-	75
		2			1	1	-	-	05	20	25

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

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

COURSE SYLLABUS

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

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

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

Organic Mixture Analysis

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

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

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

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

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

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

PG - DSE

241/CHE/DS201 Semester - 2

DSE-02: Spectroscopic Methods in Chemistry-I

Course Code DSE-02			Course Title Spectroscopic Methods in Chemistry-I				Course ID		
L	T	P	L	T	P	Total Credits	MARKS		
(Hrs)			Credits				TI	TE	Total
3	-	-	3	-	-	3	25	50	75
Examination Duration:							2 Hrs		

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

COURSE SYLLABUS

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

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

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

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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

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