Kurukshetra University, Kurukshetra

(Established by the State Legislature Act-XII of 1956)
("A++" Grade, NAAC Accredited)

Syllabus
for
Post Graduate Programme

M.Sc. Chemistry

as per NEP 2020
Curriculum and Credit Framework for Postgraduate Programme

With Multiple Entry-Exit, Internship and CBCS-LOCF
With effect from the session 2024-25 (in phased manner)

DEPARTMENT OF CHEMISTRY
FACULTY OF SCIENCES

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119
HARYANA, INDIA

CC-1

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Name of the Course	Inorganic Chemistry-I		
Course Code	M24-CHE-101		
Course Type	CC-1		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To know about the basic aspects of symmetry and group theory and also their applications CLO 2: To know about the concept of bonding using VSEPR theory and applications of Huckel theory to various molecules and also some substitution reactions of boron, silicon and Nitrogen. CLO 3: To know about the metal equilibria in solutions with reference to stability and factors affecting the stability of complexes. CLO 4: To know about the limitations of crystal field theory and its effects in coordination complexes and to apply the concept of molecular orbital theory to tetrahedral square planar and octahedral complexes.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper-Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Symmetry and Group Theory in Chemistry** Definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Symmetry elements and symmetry operation, Point symmetry group. Schönflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly). Character of a representation, reducible and irreducible representations, The great orthogonality theorem (without proof) and its importance, Derivation	15

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	of character tables of C_{2v}, C_{3v} and their use. Molecular asymmetry, dissymmetry and optical activity.	
II	**Stereochemistry and Bonding in Main Group Compounds** VSEPR Theory, Walsh diagrams (tri- atomic molecules), d-pπ bonds, Bent rule and energetics of hybridization, Huckel theory with reference to ethylene and butadiene, Some simple substitution reactions of covalently bonded molecules of boron, silicon and nitrogen.	15
III	**Metal-Ligand Equilibria in Solution** Stepwise and overall formation constants and their interaction, trends in stepwise constants, inert and labile complexes, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry. Substitution reactions in octahedral complexes, theories of trans effect with respect to Pt(II) complexes.	15
IV	**Metal-Ligand Bonding** Crystal field theory and its limitations of crystal field theory, Crystal field effects on ionic radii, Lattice energies, Heat of hydration & Geometry of coordination complexes, John-Teller distortion, Consequences of John-Teller distortion, Nephelauxetic effect and Nephelauxetic series, spin-orbital coupling, Molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without n-bonding).	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	30	➢ **Theory:**	70
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Chemical Applications of Group Theory; F.A. Cotton, Wiley, New York.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. The Chemical bond; J.N.Murrell, SFA Kettle and J.M. Tedder; Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H. J. Emeleus and Sharpe.
7. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H. McDaniel and J. J. Alexander; John Wiley and Sons.
8. Inorganic Chemistry, A Modern Introduction; T Moeller, John Wiley and Sons.

CC-2

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Name of the Course	Physical Chemistry-I		
Course Code	M24-CHE-102		
Course Type	CC-2		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understanding thermodynamics and partial molar properties. CLO 2: To demonstrate thermodynamic formulations of activated complex theory. CLO 3: To understand the electrochemistry of ion-ion interaction and concept of electrical double layer CLO 4: Understand different adsorption models and their application in heterogeneous catalysis.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Partial Molar Properties** Recapitulation of thermodynamic laws, Partial molar quantities, chemical potential and Gibbs-Duhem equation, variation of chemical potential with temperature and pressure, chemical potential for an ideal gas, chemical potential of ideal gas mixture(s), determination of partial molar volume, thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of fugacity and activity, dependence of activity on temperature and pressure, determination of activity by (i) measurement of vapour pressure and (ii) emf measurement.	15
II	**Chemical Kinetics** Collision theory of reaction rates, the steric requirement, Arrhenius equation and Conventional Transition State Theory (CTST), Equilibrium hypothesis, Statistical mechanics and Chemical Equilibrium, Comparison of Collision theory and CTST, Potential energy surfaces (Only basic Idea), Thermodynamic formulation of activated complex theory, Chain reactions (hydrogen-halogen reaction), Unimolecular reactions: Lindemann-Christiansen Hypothesis, Hinshelwood treatment.	15

III	**Electrochemistry** Debye-Hückel theory of ion-ion interaction and activity coefficient, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte. Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye-Falkenhagen effect, Wein effect. D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation. Metal/Electrolyte interface, Concept of electrical double layer and its structure: Helmholtz-Perrin, Gouy-Chapman, and Stern models, electrokinetic phenomena, determination of zeta potential.	15
IV	**Surface Chemistry and Catalysis** Langmuir adsorption isotherm (L.A.I.) and its derivation for non-dissociative and dissociative adsorption, BET adsorption isotherm, its derivation and applications, Surface Tension and Gibbs Adsorption Isotherm. Heterogeneous catalysis: Fundamentals and examples, Surface heterogeneity, Miller indices and Bravais-Miller indices of planes and directions in solids, Based on L.A.I. - rate calculation of surface catalyzed unimolecular and bimolecular reactions, Activation energy for surface reactions, Comparison of uncatalyzed and catalyzed reaction rates.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	70
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. An Introduction to Chemical Thermodynamics, R.P. Rastogi and R.R. Misra, Vikas Pub.
2. Physical Chemistry, P.W. Atkins, Oxford University Press.
3. Thermodynamics for Chemists, S. Glasstone, Affiliated East-West Press.
4. Thermodynamics, I.M. Klotz and R.M. Rosenbers, Benzamin.
5. Chemical Kinetics, K.J. Laidler, McGraw Hill.
6. Kinetics and Mechanism, A. A. Frost and R.G. Pearson, John Wiley and Sons.
7. Electrochemistry, S. Glasstone, Affiliated East-West Press.
8. Physical Chemistry, G.W. Castellan, Narosa.
9. Heterogeneous Catalysis: Fundamentals and Applications, Julian R.H. Ross, Wiley-VCH; 2nd, Revised and Enlarged Edition edition (October 1, 2007).
10. Concepts of Modern Catalysis and Kinetics, I. Chorkendorff and J. W. Niemantsverdriet.
11. Physical Chemistry, by Robert J. Silbey, Robert A. Alberty, Moungi G. Bawendi, Wiley India; Fourth edition (1 January 2015)

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CC-3

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	**I**		
Name of the Course	Organic Chemistry-I		
Course Code	**M24-CHE-103**		
Course Type	**CC-3**		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To understand the general aspects (theoretical and experimental) of organic reaction mechanism and reaction intermediates. CLO 2: To understand mechanistic details of aliphatic nucleophilic substitution reactions and elimination reactions. CLO 3: To understand the stereo-chemical terms and conformational aspects in cyclic and acyclic systems. CLO 4: To understand the important stereochemical terms and aspects related to asymmetric synthesis. Idea about conformations of sugars and decalines.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Reaction Mechanism: Structure and Reactivity** Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment -The Hammett equation and linear free energy relationship, substituent and reaction constants and Taft equation. Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining reaction mechanisms. Generation, structure, stability and reactivity of carbocations, carbanions, carbenes and nitrenes.	15
II	**Mechanism of Nucleophilic Aliphatic Substitution**	15

	The limiting cases SN^1 and SN^2, detailed mechanistic description and borderline mechanisms, nucleophilicity and solvent effects, ambident nucleophiles, hard and soft nucleophiles and electrophiles, leaving group effects, steric and other substituent effects on substitution and ionization rates, stereochemistry of nucleophilic substitution. SN^i, $SN^{1'}$, $SN^{2'}$ and $SN^{i'}$ mechanisms. **Mechanism of Elimination Reactions** The El, ElcB and E2 mechanisms, Orientation Effects in Elimination Reactions, Saytzeff and Hoffman rules, Stereochemistry of E2 Elimination Reaction and Eclipsing Effects in E2 Eliminations, Dehydration of Alcohols, Pyrolytic eliminations.	
III	**Stereochemistry-I** Symmetry elements, D-L, R-S, E-Z and threo-erythro nomenclature, interconversion of Fischer, Newman, Sawhorse and flying wedge formulae. Conformational analysis, enantiomerism and diastereomerism of simple, cyclic (chair and boat conformations) and acyclic systems. Axial and planar chirality, optical isomerism in allenes, biphenyls (atropisomerism), spiranes, hemi-spiranes. Elementary ideas about stereochemistry of tertiary amines, quaternary salts, sulphur and phosphorous compounds.	15
IV	**Stereochemistry –II** Topicity of ligands and faces, their nomenclature and prostereoisomerism, stereogenecity, chirogenicity, pseudoasymmetry and prochiral centre. Stereospecific and stereoselective reactions. Elementary idea of principal categories of asymmetric synthesis, Cram's rule and its modification, Prelog rule and horeaus rule. Stereochemistry of sugars- C1 and 1C conformations of hexoses, c_2'-endo and c3'-endo conformation of pentoses, homo-morphous sugars, abnormal mutarotation and Δ-2 instability factor. Stereochemistry of decalins, Chemical correlation of configuration-determination of relative configuration of 2-butanol, isoserine, alanine, malic acid, lactic acid and mandelic acid.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Reaction Mechanism in Organic Chemistry by Mukherji and Singh revised by S.P. Singh and Om Prakash published by Laxmi Publication, New Delhi.
2. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
3. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.

4. A Guide-Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
6. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
7. Modern Organic Reactions, H. O. House, Benjamin.
8. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic & Professional.
11. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
12. Stereochemistry of Organic Compounds, P.S, Kalsi, New Age International.
13. Stereochemistry of Organic compounds, E.L. Eliel, Mc Graw Hills, 1962.
14. Organic Chemistry, Volume 1 and 2, I.L. Finar, Pearson Publication

CC-4

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Name of the Course	Environmental and Bioinorganic Chemistry		
Course Code	M24-CHE 104		
Course Type	CC-4		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To know about the chemical aspects of hydrosphere and atmosphere CLO 2: To know about the concept and role of various dioxygen carriers with reference to hemoglobin, myoglobin, hemocyanin and also some model compounds as synthetic oxygen carriers. CLO 3: To discuss about the metal storage, their transportations in living organisms and biomineralization and also to learn about the role of vitamin B6 and vitamin B12 and calcium in living organisms.		
Credits	Theory	Tutorial	Total
	3	0	3
Teaching Hours per week	3	0	3
Internal Assessment Marks	25	0	25
End Term Exam Marks	50	0	50
Max. Marks	75	0	75
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 7 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 3 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting at least one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Hydrosphere** Hydrological cycle, water pollutants, eutrophication, trace elements in water, Chemical speciation (heavy metals like Pb, Hg and As). Water quality parameters and standards, monitoring techniques and methodology: effect of pH, Dissolved Oxygen, fluoride, ammonia, nitrate, nitrite, phosphate and sulfide, total hardness of water, chemical oxygen demand, metal and metalloids. **Atmosphere** Air pollutants and their types, air quality standards, analysis of CO, NOx, SOx, hydrocarbons, photochemical smog, acid rain, effect of atmospheric pollution, tropospheric chemistry.	15

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II	**Transport and Storage of Dioxygen** Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanin and hemerythrin, model synthetic complexes of iron and cobalt. **Electron Transfer in Biological Systems** Structure and function of metalloproteins in electron transport processes-cytochromes and iron-sulfur proteins, synthetic models.	15
III	**Biomineralization, Metal storage and its transportation** Na /K pump, Ferritin, transferrin, and siderophores **Calcium in Biology** Role of Calcium in living cells, its transport and regulation, calcium pump, role of calcium in muscle contraction	15
	Total Contact Hours	45

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**25**	➢ **Theory :**	**50**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Environmental Chemistry; A. K. De, Wiley Eastern.
2. Environmental Pollution Analysis; S. M. Khopkar, Wiley Eastern.
3. Environmental Chemistry; S. K. Banerji: Prentice– Hall.
4. Principles of Bioinorganic Chemistry: S. J. Lippard and J. M. Berg, University Science Books.
5. The Inorganic Chemistry of Biological Process; M. N. Huges; John Wiley & Sons.

PC-1

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Name of the Course	Inorganic Chemistry Practical-I		
Course Code	M24-CHE-105		
Course Type	PC-1		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Able to analyse the given mixture for the presence of two acidic radicals, insoluble salt. CLO 2: Able to detect the presence of two rare earth metal ions present in the given mixture. CLO 3: Able to perform the Cerimetric/Iodometric titrations to find out the strength of the given analyte.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	6 hours		

Part B- Contents of the Course

Unit	Topics	Contact Hours
I	**Qualitative analysis:** Total five radicals to be given containing two less common metal ions, one insoluble and two acid radicals: CH_3COO^-, BO_3^{3-}, PO_4^{3-}, CO_3^{2-}, HCO_3^-, NO_2^-, NO_3^-, Cl^-, B^{r-}, 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) Cerimetric / Iodometric/ Oxidimetry titrations.	30 6 Hours Per Week
II	Lab Record and Viva-Voce	15
	Total Contact Hours	45

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Suggested Evaluation Methods			
Internal Assessment: 25		**End Term Examination: 50**	
• **Practical**	**25**	• **Practical**	**50**
• Class Participation:	5	Practical Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A. I. Vogel, Orient Longman.
2. A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.

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PC-2

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Name of the Course	Physical Chemistry Practical-I		
Course Code	M24-CHE-106		
Course Type	PC-2		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To understand the concept of Surface Tension and pH metric titration to find out the strength of acids. CLO 2: To understand the fundamentals of potentiometric experiments and study of extent of adsorption with verification of Freundlich and Langmuir adsorption isotherm. CLO 3: To study and conduct experiments related to chemical kinetics for the determination of order and rate constant of the reaction and further learn about data handling/analysis.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	6 hours		

Part B- Contents of the Course

Instructions for Paper- Setter:

Unit	Topics	Contact Hours
	Surface Tension 1 Determine the surface tension of given organic solvents. 2 Study the effect of soap concentration on the lowering of surface tension of water. 3 Compare the cleansing powers of two cloth detergents provided to you. **pH-metry** 4 Determine the strength of strong acid by pH-metric titration with strong base. 5 Determine the strength of weak acid by pH-metric titration with strong base. 6 Determine the dissociation constant of acetic acid using pH-meter. **Potentiometry** 7 Determine the standard electrode potential of Cu and Zn. 8 Determine the strength of a given solution of ferrous ammonium sulphate by potentiometric titration with $K_2Cr_2O_7$ solution.	6 Hours per week

	9 Study the precipitation titration between KCl and $AgNO_3$ potentiometrically. 10 Determine the standard free energy change and equilibrium constant for the reaction $Cu + 2Ag^{+} \rightleftharpoons Cu^{2+} + 2Ag$ **Adsorption** 11 Verify the Freundlich and Langmuir adsorption isotherms for adsorption of acetic acid/oxalic acid on activated charcoal. **Chemical Kinetics** 12 Study the hydrolysis of methyl acetate in presence of hydrochloric acid. 13 Study saponification of ethyl acetate by sodium hydroxide solution using the same initial concentration of both the reactants. 14 Study saponification of ethyl acetate by sodium hydroxide solution taking the initial concentration of ester and base to be different. **Data Handling** 15 Wherever possible, error analysis in the experimental observations and results should be reported.	
	Total Contact Hours	90

Suggested Evaluation Methods

Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practical**	**25**	➢ **Practical**	**50**
• Class Participation:	5	Practical Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Practical Physical Chemistry, S.R. Palit and S.K. De, Science.
4. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
5. Advanced Practical Physical Chemistry, J. B. Yadav Krishna Prakashan
6. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj Anjali Publication.
7. A Comprehensive Guide to Physical Chemistry Experiments and Viva Questions, Neelam Seedher.

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	I		
Name of the Course	Organic Chemistry Practical-I		
Course Code	M24-CHE-107		
Course Type	PC-3		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To understand the basic laboratory and purification techniques in organic chemistry. CLO 2: To understand the concept of stepwise synthesis in synthesizing some important organic compounds. CLO 3: To understand the role of TLC in checking the purity of compounds. To study the IR & NMR spectra of the final products.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	6 hours		

Part B- Contents of the Course

Unit	Topics	Contact Hours
	Demonstrations of Laboratory & Purification techniques Refluxing, Solvent extraction, Purification of solvents and reagents using various techniques like crystallization, distillation, steam distillation, and vacuum distillation. Drying and storage of solvents, sublimation etc. **Two-step Preparation of some important organic compounds involving the reactions out of the following representative reactions)** 1. Esterification and saponification 2. Oxidation 3. Reduction or Hydrogenation 4. Partial Reduction 5. Nucleophilic substitution 6. Aromatic electrophilic substitution reaction 7. Condensation reactions 8. Hoffman's Bromamide reaction 9. Heterocyclic synthesis 10. Any other reaction as per requirement For example 1. Synthesis of m-nitroaniline from nitrobenzene. 2. Synthesis of aniline from benzoic acid.	6 Hours Per Week

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	3. Synthesis of m-nitrobenzoic acid from methylbenzoate. 4. Synthesis of anthranilic acid from pthalic anhydride. 5. Synthesis of p-bromoaniline from acetanilide. 6. Synthesis of p-nitroaniline from acetanilide. 7. Synthesis of phenytoin from Benzoin 8. Synthesis of 4-aminobenzoic acid from 4-nitrotoluene. 9. Synthesis of S-benzylisothiouronium salt of any acid **The purity of the above synthesized compounds should be checked with thin layer chromatography (TLC)** **Copies of IR & NMR of the above synthesized compounds should be provided for study** **All the students must submit the recrystallised product along with m.p. for all the stages of preparation.**	
	Total Contact Hours	90

Suggested Evaluation Methods

Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practical**	**25**	➢ **Practical**	**50**
• Class Participation:	5	Practical Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

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. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.

SEM

Session: 2024-25	
Name of the Programme	M.Sc. Chemistry
Semester	I
Name of the Course	Seminar
Course Code	M24-CHE-108
Course Type: (CC/DEC/PC/Seminar/CHM/OEC/EEC)	Seminar
Level of the course	400-499
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To understand the deep concept and get knowledge of topic in details. CLO 2: To understand the teaching methodology and expression of concepts in classroom.
Credits	Seminar 2
Teaching Hours per week	2
Max. Marks	50
Internal Assessment Marks	0
End Term Exam Marks	50
Examination Time	1 hour
Instructions for Examiner: Evaluation of the seminar will be done by the internal examiner(s) on the parameters as decided by staff council of the department. There will be no external examination/viva-voce examination.	

CC-5

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	**II**		
Name of the Course	Inorganic Chemistry-II		
Course Code	**M24-CHE-201**		
Course Type	**CC-5**		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 1**: To know about electronic transitions occurring in the metals and their complexes and also to apply the concept for assignment of absolute configuration in optically active metal chelates and their stereochemical information **CLO 2**: To explain the synthesis, structural characteristics, chemical properties and reactivity of metal-n complexes. **CLO 3**: To know the various classifications of metal cluster compounds and to categories the metal boranes carboranes, metallo-boranes and metallo-carboranes and their various aspects. **CLO 4:** To learn about basic concepts of photochemistry viz photochemical laws, quantum yield, electronically excited states and to learn about the Energy dissipation by radiative and non radiative processes along with Franck condon principle.		
Credits	Theory	Tutorial	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
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 symbols, vector diagrams to indicates coupling of orbital angular momenta in p^2, p^3, d^2 configurations and spin orbit coupling for p^2 arrangement, spectroscopic terms, spectral terms of d^2 to d^8 metal ions,	15

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	determining the ground state terms-Hund's rules, derivation of the term symbols for a closed subshell. Interpretation of electronic spectra, Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of Dq, B and b parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.	
II	**Metal л-Complexes** Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important chemical reactions of metal carbonyls, preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.	15
III	**Metal Clusters** Boranes: Introduction, Nomenclature, synthesis and properties of some important members (B_2H_6, B_4H_{10}, B_5H_9, B_5H_{11} and $B_{10}H_{14}$), bonding in Boranes, STYX code, Borane anions, Carboranes: Introduction, general methods of preparations and important properties, Polyhedral skeletal electron pair theory, Metalloboranes and metallocarboranes :Introduction, general methods of preparation and properties, Isolobal analogy, Metal carbonyl and halide clusters, introduction, Structure and bonding of compounds having M-M bonds, calculation of M-M bond.	15
IV	**Photochemistry** Absorption, absorption spectra, excitation, photochemical laws, quantum yield, electronically excited states- Jablonski Diagrams: Vibrational Relaxation, Internal Conversion, Intersystem Crossing, Fluorescence, and Phosphorescence; Fluorescence Spectra, Rules of fluorescence, Fluorescence Quantum Yield, Franck-Condon principle, Radiative Lifetime. Bimolecular quenching: Stern-Volmer relation, photochemical kinetics, photochemical stages-primary and secondary.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harper & Row.
3. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
4. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
5. Introduction to Ligand fields; B.N. Figgis, Wiley, New York.
6. Modern Aspects of Inorganic Chemistry; H.J. Emeleus and Sharpe.
7. Introduction to Ligand Field Theory; C.J.Ballahyen, McGraw Hill, New York.

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Organometallic Chemistry; R.C. Mehrotra and A.Singh, New Age International.
9. Concepts and Models of Inorganic Chemistry; B. Douglas, D.H.McDaniel and J.J. Alexander; John Wiley.
10. The Organometallic Chemistry of the Transition Metals; R.H. Crabtree, John Wiley.
11. Basic concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
12. Photochemistry of coordination compounds, K.Balzani and V.Carassti, Academic press.
13. Elements of Inorganic Photochemistry; G.J. Ferraudi, Wiley.

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	**II**		
Name of the Course	Physical Chemistry-II		
Course Code	**M24-CHE-202**		
Course Type	**CC-6**		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To learn to setup Schrödinger equation for simple systems and find their solutions CLO 2: To learn about the systems showing rotational motion and determine solutions of their Schrödinger equations besides knowing about angular momentum operators CLO 3: To understand the basic concepts of polymers ,polymerization and their molecular weights. CLO 4: To know the basic concepts of nuclear and radiochemistry.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Quantum Mechanics-I** The postulates of quantum mechanics, Linear and Hermitian opera Commutation of operators and Uncertainty Principle. Eigen functions Eigen values. Schrödinger equation, free particle, Schrödinger equation particle in a box, the degeneracy, particle in a box with a finite ba Tunneling Problem: Tunneling through a rectangular barrier Schrödi equation for linear harmonic oscillator and its solution, zero point energy	15
II	**Quantum Mechanics-II** Energy levels and wave-functions of Rigid rotator. Hydrogen atom: Complete solution (separation of variables in spherical polar coordinates and its solution). Radial distributions. Angular momentum and its directional quantization, Angular momentum operators, commutation relations, Ladder operators, shapes of atomic orbitals upto d-level and their discussion.	15
III	**Polymers**	15

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	Basic concepts, 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: Significance of average molecular mass. Poly-dispersity. Determination of molecular mass by viscosity method. Electrically conducting polymers, Flame retardant polymers, Liquid crystal polymers.	
IV	**Nuclear and Radiochemistry** Nuclear stability and binding energy. Mass and binding energy, Nuclear fission and nuclear fusion, fission cross section, chain fission, fission product and fission yield. Interaction of nuclear radiation with matter, Detectors (Proportional, Geiger-Muller and Scintillation counters) and their principles. Units for measuring radiation absorbed, radiation dosimetry.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	70
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
2. Quantum Chemistry, I.M. Levine, Prentice Hall.
3. Essentials of Nuclear Chemistry, 4th Edition (1995), H.J. Arnikar, Wiley Eastern, New Delhi.
4. Nuclear & Radiochemistry, 3rd Edition (1981), G. Fridlander, J.W. Kennedy, E. S. Macias, and J. M. Miller, John Wiley, New York.
5. Introduction to Nuclear Chemistry, B. C. Harvey Prentice-Hall (1969).
6. Polymer Chemistry, Billmayer.
7. Polymer Chemistry, Gowarikar.
8. Principles of Polymerization, Geroge Odian.
9. Quantum Chemistry, B. K. Sen, Kalyani Publishers.
10. Quantum Chemistry, R.K. Prasad, New Age International.

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	**II**		
Name of the Course	Organic Chemistry-II		
Course Code	**M24-CHE-203**		
Course Type	**CC-7**		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To know the concept of Aromatic substitution/displacement reactions. CLO 2: To understand the concept of neighbouring group participation and carbocation rearrangements. CLO 3: To describe the generation, structure, stability and reactivity of free radicals and to know the mechanisms of addition to alkenes and alkynes. CLO 4: To understand the concept of addition to carbon hetero atom multiple bonds with emphasis on >C=O group.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Aromatic Electrophilic Substitution** Theoretical treatment of aromatic substitution reactions, structure-reactivity relationship in mono substituted benzene ring, orientation in other ring systems, partial rate factor, energy profile diagram, Vilsmeir-Haak reaction, Reimer-Tiemann reaction, Bischler-Napieralski reaction, Pechmann reaction, Houben-Hoesch reaction, Fries rearrangement. **Nucleophilic Aromatic 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, Stevens and Smiles rearrangements. General aspects of generation, structure, stability and reactivity of arynes.	15

II	**Neighbouring Group Participation and Carbocation Rearrangements** Anchimeric assistance, neighbouring group participation by non-bonding electrons, sigma and -bonds, classical and non-classical carbocations. Carbocations rearrangements: migratory aptitudes, Wagner Meerwein rearrangement, pinacol pinacolone rearrangement, Demjanove rearrangement, Tiffeneau-Demjanov ring expansion, aldehyde-ketone rearrangement, dienone-phenol rearrangement and trans-annular rearrangements and the Stieglitz rearrangement.	15
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.	15
IV	**Addition to Carbon-Hetero Atoms Multiple Bonds** 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.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	05	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Reaction Mechanism in Organic Chemistry by Mukherji and Singh revised by S.P. Singh and Om Prakash published by Laxmi Publication, New Delhi.
2. Advanced Organic Chemistry Reactions, Mechanism and Structure, Jerry March, John Wiley.
3. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
6. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
7. Modern Organic Reactions, H. O. House, Benjamin.
8. Principles of Organic Synthesis, R. O. C. Norman and J. M. Coxon, Blackie Academic &

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Professional.
9. Advanced Organic Chemistry and Reaction Mechanisms, Reinhard Bruckner, Academic Press.
10. Organic Chemistry, Jonathan Clayden, Nick Greeves, and Stuart Warren, Oxford University Press.

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CC-8

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	**II**		
Name of the Course	Physical Spectroscopy		
Course Code	**M24-CHE-204**		
Course Type	**CC-8**		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: Understand rotational and vibrational spectroscopy and their applications in Chemistry. CLO 2: Understand basics and significance of NMR, NQR and ESR techniques in Chemistry. CLO 3: Understand basics of X-ray Crystallography and interpret powder XRD patterns of cubic crystals.		
Credits	Theory	Practical	Total
	3	0	3
Teaching Hours per week	3	0	3
Internal Assessment Marks	25	0	25
End Term Exam Marks	50	0	50
Max. Marks	75	0	75
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 7 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 3 parts covering the entire syllabus. The examinee will be required to attempt 5 questions, selecting at least one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Microwave Spectroscopy** Basics of spectroscopy. The rotation of molecules, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non-rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules. **Infrared Spectroscopy** The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, diatomic vibrating rotators, P,Q,R branches, vibration of polyatomic molecules, normal mode of vibrations. **Raman Spectroscopy** Classical and quantum theories, pure rotational Raman spectra of linear molecules, vibrational Raman spectra, mutual exclusion principle, polarization of the light and Raman effect, depolarization of Raman lines.	15

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II	**Nuclear Magnetic Resonance Spectroscopy** Basic principles of NMR, theory of nuclear magnetic resonance, spin lattice relaxation, spin-spin relaxation, experimental techniques, chemical shift, the origin of shielding constant, pattern of coupling, origin of spin-spin coupling. **Nuclear Quadrupole Resonance Spectroscopy** Introduction, energies of quadrupole transitions, relationship between electric field gradient and molecular structure, applications, interpretations of structural information from NQR spectra. **Electron Spin Resonance Spectroscopy** Basic principles of ESR, experimental technique, hyperfine splitting and hyperfine structure (Hydrogen, methyl radical etc.), Instrumentation of ESR and its applications to the study of free radicals and Mc-Connell relationship.	15
III	**X-ray Crystallography** Symmetry elements in crystals, stereographic projections, point groups (illustration of R, R-bar, Rm, R/m, (R-bar)m point groups only), criteria for determining unit cell of lattice, space lattices, space groups P1, Pbar1, P2, $P2_1$, Pm, Pc, C2, Cm, Cc. Bragg's Law, Reciprocal lattice concept and its importance, Definition of Reciprocal lattice vector (derivation excluded). Interplanar spacing using reciprocal lattice concept for cubic, tetragonal, orthorhombic and hexagonal crystal systems, Structure factor calculations for primitive, base-centered, body-centered and face centered unit cells. Relation of structure factor to electron density and intensities (derivation excluded), Interpretation of powder photographs for cubic crystals, Data reduction (Brief overview), Phase problem (definition only), Correctness of a structure (Discrepancy Index).	15
	Total Contact Hours	45

Suggested Evaluation Methods

Internal Assessment: 25		**End Term Examination: 50**	
➢ **Theory**	**25**	➢ **Theory:**	**50**
• Class Participation:	05	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.
6. Elementary Crystallography, L. Azaroff.
7. Structure Determination by X-ray Crystallography, M. Ladd and R. Palmer.
8. X-Ray Structure Determination: A Practical Guide, 2nd Edition by George H. Stout and Lyle H. Jensen.
9. X-Ray Diffraction: A Practical Approach by C. Suryanarayana and M. Grant Norton
10. An Introduction to Crystallography by F. C. Phillips

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Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	II		
Name of the Course	Inorganic Chemistry Practical-II		
Course Code	M24-CHE-205		
Course Type	PC-4		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To know the concept of quantitative analysis and its application. CLO 2: Able to separate and quantify the presence of two metal ions in a solution. CLO 3: Able to prepare various coordination complexes and their spectroscopic study.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	6 hours		

Part B- Contents of the Course

Unit	Topics	Contact Hours
I	**Quantitative analysis:** Separation of the metal ions and determination of any one of them using volumetric/gravimetric methods. Cu-Ni, Cu-Zn, Cu-Al, Ca-Ba, Fe-Mg, Fe-Ni etc. **Preparations:** Preparation of the following inorganic compounds and their spectroscopic studies. I. $Hg[Co(SCN)_4]$ II. $[Cu(NH_3)_4]SO_4.H_2O$ III. Prussian Blue IV. $Na[Cr(NH_3)_2(SCN)_4]$ V. $Mn(acac)_3$ VI. $[Ni(NH_3)_6]Cl_2$ VII. VO(acac)	30 6 Hours Per Week
II	Lab record and Viva-voce	15
	Total Contact Hours	45

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Suggested Evaluation Methods			
Internal Assessment: 25		**End Term Examination: 50**	
• **Practical**	**25**	• **Practical:**	**50**
• Class Participation:	5	Practical Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. A Text Book of Macro and Semi-micro Quantitative Analysis, A. I. Vogel, Orient Longman.
2. A Vogel's Text Book of Quantitative Inorganic Analysis, J. Bassett, R. C. Denney, G. B. Jaffery and J. Menaham, Longman, London.

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PC-5

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	II		
Name of the Course	Physical Chemistry Practical-II		
Course Code	M24-CHE-206		
Course Type	PC-5		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To know the concept of viscosity and solution chemistry of different mixtures. CLO 2: To understand and master the fundamentals of conductometric titrations in aqueous media. CLO 3: To study the specific/molar rotation of sugars and kinetics of inversions of sucrose by polarimetry.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	6 hours		

Part B- Contents of the Course

Unit	Topics	Contact Hours
	Viscosity 1 Determine the viscosity of given organic solvents. 2 Study the variation of viscosity with concentration for a glycerol solution using Ostwald viscometer and determine the unknown concentration of given solution of glycerol. 3 Determination of molar mass of a polymer using viscometric method **Conductometry** 4 Determine the strength of strong acid by conductometric titration with strong base. 5 Determine the strength of weak acid by conductometric titration with strong base. 6 Determine the strength of strong acid and weak acid in a mixture by conductometric titration with strong base. 7 Study precipitation titration between KCl and $AgNO_3$ conductometrically. Determine the strength of the given solution of $AgNO_3$. 8 Determine solubility and solubility product of sparingly soluble	6 Hours Per Week

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	salts like $CaSO_4$, $BaSO_4$. 9 Determine the relative strength of chloroacetic acid and acetic acid by conductivity measurements. **Polarimetry** 10 Study the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and determine the unknown concentration of the same substance in given solution. 11 Determine the specific and molecular rotation of sucrose or glucose at a number of concentrations. 12 Study the kinetics of inversion of cane-sugar (sucrose) in presence of an acid. 13 Distinguish between dextro/laevo rotatory substances using polarimeter and determine their specific rotation. **Solution Chemistry** 14 Determine the solubility product of calcium hydroxide by saturation titration method. 15 Determine the molal volume of ethanol and its partial molal volume in dilute aqueous solution. 16 Determine C.S.T. of phenol and water in presence of (a) 1% NaCl, (b) 0.5% napthalene and (c) 1% succinic acid. **Note: Any experiment can be introduced / omitted in the practical class on the basis of availability of instruments/chemicals.**	
	Total Contact Hours	90

Suggested Evaluation Methods

Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practical**	**25**	➢ **Practical :**	**50**
• Class Participation:	5	Practical Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman.
3. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg, Adarsh Gulati - Publisher: R Chand & Co.
4. Advanced Practical Physical Chemistry, J. B. Yadav Krishna Prakashan
5. Experimental Physical Chemistry, V .D. Athawale and P. Mathur - New Age International Publishers
6. Vogel's Textbook of Quantitative Chemical Analysis by Vogel, Bassett, Jeffrey, Mendam, Denney - Longman Higher Education; 5th edition
7. CRC Handbook of Laboratory Safety, 5th Edition by A. Keith Furr

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PC-6

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	II		
Name of the Course	Organic Chemistry Practical-II		
Course Code	M24-CHE-207		
Course Type	PC-6		
Level of the course	400-499		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: To understand the basic principle & techniques of separation of binary mixtures. CLO 2: To get expertise in identification of components of the given binary mixtures. CLO 3: To get expertise in preparing the derivatives of given organic compounds.		
Credits	Theory	Practical	Total
	0	3	3
Teaching Hours per week	0	6	6
Internal Assessment Marks	0	25	25
End Term Exam Marks	0	50	50
Max. Marks	0	75	75
Examination Time	6 hours		

Part B- Contents of the Course

Unit	Topics	Contact Hours
	Organic Mixture Analysis **Demonstrations of separation of binary mixtures:** 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 mixtures of pure organic compounds: separation and identification of simple binary mixtures having acidic, basic and neutral components. Preparation of their derivatives, determination of b.p./m.p. for components and their derivatives. **Any other experiment be added as per requirement**	6 Hrs Per Week
	Total Contact Hours	90

Suggested Evaluation Methods

Internal Assessment: 25		**End Term Examination: 50**	
➢ **Practical**	**25**	➢ **Practical:**	**50**
• Class Participation:	5	Practical Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	10		

Part C-Learning Resources
Recommended Books/e-resources/LMS: 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. Vogel's Text Book of Practical Organic Chemistry by B.S. Furners et. al., Longman Group Ltd.