1. Structure of the Programme:

Curriculum Framework
Syllabus – M.Sc. (Chemistry) 2022-23
L-8 (I & II Semester)

I-Semester

Level / Semester	Nature of Course	Courses Code	Course Title	MM	L	T	P	C
L-8 I Semester	Discipline Specific: Major	CHE-DSM-121	Inorganic Chemistry	100	4	0	0	4
	Discipline Specific: Major	CHE-DSM-122	Laboratory Course: Inorganic Chemistry	100	0	0	2	2
	Discipline Specific: Major	CHE-DSM-123	Organic Chemistry	100	4	0	0	4
	Discipline Specific: Major	CHE-DSM-124 CHE-DSM-124	Laboratory Course: Organic Chemistry	100	0	0	2	2
	Multi Discipline Major	CHE-MDM-121	Chemical Physics	100	4	0	0	4
	Multi Discipline Major	CHE-MDM-122	Laboratory Course: Chemical Physics	100	0	0	2	2
	Skill Enhancement Course	CHE-SEC-121	Spectroscopy	100	3	0	0	3
	Skill Enhancement Course	CHE-SEC-122	Laboratory Course: Spectroscopy	100	0	0	1	1
Total Credits								22

II-Semester

Level / Semester	Nature of Course	Courses Code	Course Title	MM	L	T	P	C
L-5 II Semester	Discipline Specific: Major	CHE-DSM-221	Inorganic Chemistry	100	4	0	0	4
	Discipline Specific: Major	CHE-DSM-222	Laboratory Course: Inorganic Chemistry	100	0	0	2	2
	Discipline Specific: Major	CHE-DSM-223	Organic Chemistry	100	4	0	0	4
	Discipline Specific: Major	CHE-DSM-224	Laboratory Course: Organic Chemistry	100	0	0	2	2
	Multi Discipline Major	CHE-MDM-221	Chemical Physics (Theory)	100	4	0	0	4
	Multi Discipline Major	CHE-MDM-222	Laboratory Course: Chemical Physics	100	0	0	2	2
	Skill Enhancement Course	CHE-SEC-221	Computer for Chemist	100	3	0	0	3
	Skill Enhancement Course	CHE-SEC-222 CHE-SEC-222	Computer for Chemist (Laboratory)	100	0	0	1	1
Total Credits								22
Exit with Post-Graduate Diploma								

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Department of Chemistry
Dr. HarisinghGourVishwavidyalaya, Sagar
Scheme of M.Sc. Program in Chemistry under CBCS system
Objectives and Learning Outcomes of M.Sc. Chemistry

Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	First	CHE-DSM-121	Inorganic Chemistry	100	04

Course Objectives: To equip the students with the knowledge of bonding and structures of Inorganic compounds and their chemical aspects

Course Learning Outcomes: Upon successful learning, students will be able to
Unit I: access structural knowledge of inorganic molecules and their applications
Unit II: understand metal- ligand interaction in solution phase and their applications
Unit III: apply crystal field theory and molecular orbital theory for metal-ligand bonding
Unit IV: evaluate acidic nature acids formed by oxides and hydroxides of metals
Unit V: understand preparation, properties and structural aspects of metal-ligand pi complex.

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M.Sc. Chemistry, Semester I
CHE-DSM-121: Inorganic Chemistry

Credits :4 60 Hrs

UNIT I	(a) Stereochemistry and Bonding in Main Group Compounds, VSEPR Theory, Walsh diagrams (tri- and Penta- atomic molecules), dpi-ppi bonds. Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules. (b) Advances in Chemistry of f-block elements.	12
Unit II	(a) Chemistry of chalcogens, Selected examples of single, double, and triple bonded Si compounds; Multiple bonding in heavier main-group elements:-structure and reactivity. (b) Metal-organic frameworks. Definition, nomenclature, and classification of metal-organic frameworks (MOFs). Synthesis, Physico-chemical properties, and catalytic applications.	12
UNIT III	Metal-Ligand Equilibria in Solution, Stepwise and overall formation constants and their interaction, 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.	12
UNIT IV	Metal - Ligand Bonding , Limitation of Crystal field theory, ACFT, Ligand Field Theory, Basic aspects of Angular Overlap model; Origin of MO's; molecular orbital theory, octahedral, tetrahedral and square planer complexes, σ and pi bonding and MOT. Jahn-Teller effect.	12
UNIT V	Metal -pi Complexes, Metal carbonyls, metal nitrosyls, structure and bonding, Vibrational spectra of metal carbonyls for bonding and structural elucidation & important reactions of metal carbonyls; bonding, structure and important reactions of transition metal nitrosyl; dinitrogen and dioxygen complexes; tertiary Phosphine as ligand, metal olefin complexes – structure and bonding (difference between M-sigma and M-pi bonding), Role of Transition metal compounds in Catalysis. Concept of isolobality and stereochemical nonrigidity.	12

References

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E.Huhey, Harpes & Row.
3. Chemistry of Elements, N.N. Greenwood and A Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier
5. Magnetochemistry, R.L.Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D.gillars and J.A.McCleverty, Pergamon.
7. Coordination Chemistry, D.Banerjee, TMH,N.Delhi,1995
8. Coordination Chemistry, M.Satake, Discovery Publication House N.Delhi.
9. Essential Trends in Inorganic Chemistry, D.M.P. Mingos, Oxford Univ. Press, N.Delhi 1995.
10. Structural Inorganic Chemistry, A.F.Wells, ELBS
11. Modern Aspects of Inorganic Chemistry, H.J.Emeleus, UBSID, New Delhi

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Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	First	CHE-DSM-122	Laboratory Course-Inorganic Chemistry	100	02

Course Objectives: To impart practical knowledge of qualitative and quantitative analysis of less common ion in metallic mixture, in alloys and in less soluble inorganic compounds

Course Learning Outcomes: Upon successful learning, students will be able to

- Identify the less common ions directly and in the mixture
- Analyze less soluble metal oxides
- Identify metals from the metallic alloys

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M.Sc. Chemistry, Semester – I
CHE-DSM-122
Laboratory Course - Inorganic Chemistry

Credits :2

Qualitative and Quantitative Analysis:

(a). Less Common metal ions – Tl, Mo, W, Ti, Zr, Th, U, (two metal ions in cationic / anionic forms)
(b). Insoluble – oxides, sulphates and halides
(c). Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe, Ag-Ni, Ag-Cu etc involving Volumetric and gravimetric methods.

References

1. Vogel's Textbook of quantitative Analysis, revised, J. Bassett R. C. Denney, G. H. Jeffery and J. Mendham, ELBS
2. Synthesis and Characterization of Inorganic compounds, W. L. Jolly, Prentice Hall

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Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	First	CHE-DSM-123	Organic Chemistry	100	04

Course Objectives: To impart advanced knowledge on nature of bonding in organic molecules, structure and reactivity, reaction mechanism, nucleophilic substitution, addition reactions to carbon-heteroatom multiple bonds and radical reactions.

Course Learning Outcomes: Upon successful completion of the course, students will be able to understand:

Unit I: The fundamental concept of delocalized chemical bonding, conjugation in organic molecules and role of electronic effects.

Unit II: Types of organic reactions and determining reaction mechanism, kinetics, energetics, structure, stabilities and reactivities of various reactive intermediates.

Unit III: The fundamental concepts of aliphatic nucleophilic substitution reactions, neighbouring group participations including their reaction mechanism and stereochemical outcomes of products.

Unit IV: The fundamental aspects of various addition reactions to carbon-heteroatom multiple bonds including their mechanistic aspects and applications in organic synthesis.

Unit V: The chemistry for the generation radicals, detection, radical geometry and stability, various types of free radical reactions, including radical substitution, rearrangement and oxidation reaction, mechanistic aspects of various free radical reactions.

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M.Sc. Chemistry Semester I
Discipline Specific: Major-2
CHE-DSM-123
Organic Chemistry

Credits:4 **60 Hrs.**

UNIT I **Nature of Bonding in Organic Molecules** 12

Delocalized chemical bonding, conjugation, resonance, hyper-conjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of π-molecular orbitals, annulenes, anti-aromaticity, □□-aromaticity, homo-aromaticity, PMO approach, Bonds weaker than covelent-addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins.

UNIT II **Reaction Mechanism; Structure and Reactivity:** 12

Types of mechanism, types of reactions. Thermodynamic and kinetic requirements, kinetic and thermodynamic control. Hammond's postulate. Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases.

Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.

Effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy

UNIT III **Aliphatic Nucleophilic Substitution:** 12

The S_N1, S_N2, mixed S_N1 and S_N2 and SET mechanisms.

The neighbouring group-mechanism: neighbouring group participations by πand □bonds, anchimeric assistance, Classical and nonclassicalcarbocations, norbornyl system, common carbocation rearrangements.

The $S_N1$mechanism:

Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity: The effects of substrate structure, Attacking nucleophile, Leaving group and Reaction medium; Phase transfer catalysis

UNIT IV **Addition to Carbon-Hetero Multiple Bonds** 12

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids esters and nitriles. Addition of Grignard reagents, organo-zinc and organo-lithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.

UNIT V **Free Radical Reactions**

Types of free radical reactions and their detection. Free radical substitution mechanism, mechanism at aromatic substrates. Reactivity in the attacking radicals. The effect of solvents on reactivity.

Allylic halogenations (NBS) oxidation of aldehydes to carboxylic acids, auto-oxidation, Radical coupling, arylation of aromatic compounds by diazonium salts. Sand Meyer reaction. Free radical rearrangement. Hunsdiecker reaction.

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References:

1. Advanced Organic Chemistry-Reactions. Jerry March, John Wile
2. Advanced Organic Chemistry, F.A. Carey and n 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.Byd. 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. Pericyclic Reactions, S.M.Mukherji, Macmillan, India.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P.Singh, Macmillan.
10. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International
11. Setereochemistry of Organic Compounds, P.S.Kalsi, New Age International
12. Basic Stereochemistry of Organic Molecules, S.Sengupta, Book, Syndicate Pvt.Ltd. Kolkata, 1987.
13. Organic Photochemistry and Pericyclic Reactions, M.G.Arora, Anmol Publications, N.Delhi, 1994.

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Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	First	CHE-DSM-124	Laboratory Course - Organic Chemistry	100	02

Course Objectives:

- To develop experimental skills of various qualitative analysis including separation and purification techniques, TLC and column chromatographic methods, functional group identification using IR spectra.
- To prepare various organic compounds, study of reaction mechanism involving different reactive intermediates, characterization of products by spectral techniques.
- To develop experimental skills for quantitative analysis.

Course Learning Outcomes:Upon successful learning, students will be able

- To acquire knowledge on the qualitative analysis of separation of binary mixture of organic compounds and purification techniques,
- To understand separation by TLC methods, separation and purification by column chromatographic methods,
- To develop knowledge on functional group identification using IR spectra.
- To prepare various organic compounds involving different reactive intermediates, study of reaction mechanism, characterization of products by various spectral techniques.
- To understand quantitative analysis and develop experimental skill to determine iodine and saponification values of an Oil sample and acquire knowledge on DO, COD, BOD of water sample.

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M.Sc. Chemistry Semester I
Discipline Specific: Major-2
CHE-DSM-124
Laboratory Course – Organic Chemistry

Credits: 2 **30 Hrs**

Qualitative Analysis:
Separation, purification and identification of compounds of Binary mixture preferably one liquid and one solid) using TLC and column chromatography, chemical tests, IR spectra to be used for functional group identification.
Organic Synthesis :
Acetylation of Cholesterol and separation of cholesterylacetate by column chromatography.
Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.
Grignard reaction: Synthesis of triphenylmethanol from benzoic acid.
Aldol Condensation: Dibenzal acetone from benzaldehyde.
Sandmeyer reaction, p-chloro toluene and para toluidine
The products be characterized by spectral techniques.
Quantitative Analysis:
Determination of iodine and saponification values of an Oil sample
Determination of DO, COD, BOD of water sample.

References:

1. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall
2. Macroscale and Microscale Organic Experiments, K. L. Williamson, D. C. Heath.
3. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
4. Handbook of Organic Analysis-Qualitative and quantitative, H. Clark, Adward Arnold.
5. Vogel's Textbook of Practical Organic Chemistry, A. R. Tatchell, John Wiley

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Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	I[st]Sem	CHE-MDM-121	Chemical Physics(Multi-Disciplinary: Major 3)	Mid Sem: 40 End Sem = 60	04

Course Objectives: To impart advanced knowledge on laws of quantum mechanics, classical thermodynamics. The use of group theory for the chemical applications, understanding of surface, electrochemistry and the macromolecules

Course Learning Outcomes: Upon successful completion of the course, students will be able to understand:
Unit I: Basic principles and laws of Quantum Chemistry
Unit II: Basic principle of symmetry and group theory and its chemical applications
Unit III: Understanding about classical thermodynamics including non ideal systems.
Unit IV: Surface phenomenon and chemistry of macromolecules.
Unit V: Different aspects of Electrochemistry

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M.Sc. Chemistry, Semester – I
Multi-Disciplinary: Major 3
Chemical Physics (CHE-MDM- 121)

Credits :4 60 Hrs

Unit I **Quantum Chemistry:** 12

A) Introduction to Exact Quantum Mechanical Results
The Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz., particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom.
B) Approximate Methods: The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Applications of these approximate methods to the Helium atom
C) Molecular Orbital Theory: Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc. Introduction to extended Huckel theory.

Unit II **Symmetry and Group Theory** 12

A) Symmetry elements and Symmetry operations, definitions of group, subgroups, relationship between orders of finite group and its subgroup.
B) Schonflies symbols, representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, etc groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance.
C) Character tables and their use in spectroscopy.

Unit III **Thermodynamics :** 12

A)Classical Thermodynamics: Brief resume of concepts of laws of thermodynamics,
B) Free energy, chemical potential and entropies. Partial molar properties; partial molar free energy, partial molar volume and partial molar heat content and their significance. Determination of these quantities. Concept of fugacity and determination of fugacity
C). Non-ideal systems: Excess functions for non ideal solutions. Activity and activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength

Unit IV **Surface Chemistry and Macromolecules:** 12

A) Adsorption : Surface tension, capillary action, pressure difference across curved surface (Laplace euqation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation) surface films on liquids (Electro-kinetic phenomenon), catalytic activity at surfaces.
B) Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of

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micellization-phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

C) Polymer-definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods) sedimentation, chain configuration macromolecules, calculation of average dimension of various chain structures.

Unit V **Electrochemistry:** 12

A) Electrochemistry of solution. Debye-Huckel. Onsagar treatment and its extension, ion solvent interactions. Dye-Huckel- Jerum mode. Thermodynamics of electrified interface equations. Derivation of electro-capillarity. Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces. Guoy-Chapman, Stern, Graham Devanathan- Mottwatts. Tobin, Bockris, Devanathanmodels.Over potentials, exchange current density, derivation of butler-Volmer equation, Tafel plot. Quantum aspects of charge transfer at electrodes-solution interfaces, quantization charge transfer, tunneling.

B) Fuel cell, type of fuel cell, oxide ion and proton conducting fuel cells. Superoxide ion conductor anditsapplictions. Electrocardiography. Solide State Batterries. Polarography theory, Ilkovic equation; half wave potential and its significance. Amperometric titrations.

C) Introduction to corrosion, homogenous theory, forms of corrosion, corrosion monitoring and prevention methods.

References:

1. Physical Chemistry; P.W. Alkins, ELBS
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill,1995
3. Quantum Chemistry, Ira N. Levine, Prentice Hall, 1975
4. Quantum Chemistry, R.K. Prasad, New Age Intl., New delhi.
5. Coulson's Valence, R.McWeeny, ELBS.
6. Chemical Kinetics, K.J.Laidler, McGraw Hill.
7. Kinetics Mechanism of Chemical Transformations, J.Rajaram and J. Kuriacose, McMillan.
8. Micelles, Theoretical and Applied Aspects. V.Moroi, Plenum.
9. Modern Electrochemistry Vol. 1 and II J.O.M. Bockris and A.K.N. Reddy, Plenum.
10. Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, wiley Eastern.
11. Electroanalyutical Chemistry, R.T. Sane, Quest Publications, Mumbai, 1999.
12. Introduction to Electrochemistry, S.Glasstone, Affiliated East West Press, New Delhi, 1995.
13. Chemical kinetics, G.L. Agrawal, TMH, New Delhi.
14. Physical Chemistry for Macromolecules, D.D. Deshpande, Vishal Publications.
15. Physical Chemistry for Macromolecules, D.D.Deshpande Vishal Publications.
16. Introductory Polymer Chemistry, G.S.Misra, New Age Intl., N.Delhi.
17. Introduction to Chemical Thermodynamics, R.P. Rastogi, Vikas, Pub. House, N.Delhi. 1997.
18. Statistical Thermodynamics, M.C.Gupta, New Age Intl., N.Delhi.
19. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Sears and Salinger. Narosa Publishing House, New Delhi.
20. Physical Chemistry, G.W.Narosa Publ.H., New Delhi, 1994.

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Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	First	CHE-MDM-122	Laboratory Course: Chemical Physics: (Multi-Disciplinary)	Mid Sem: 40 End Sem = 60	02

Course Objectives:

- To show the practical applications of basic principles of physical chemistry, like of surface chemistry, phase equilibrium, chemical kinetics, and electrochemistry

Course Learning Outcomes: Upon successful learning, students will be able to understand

- How to analyse errors and other statistical data
- To get hand on eexperience how to measure adsorption, determine congruent composition of binary mixture, glass transition temperatures, constructing phase diagram for 3 component system
- To calculate velocity constant of various rate equations including ester hydrolysis, iodine clock reaction and primary kinetic salt effect.
- To determine molecular weight, degree of dissociation of different electrolyte.
- To determine the rate constant for hydrolysis/ inversion of sugar using polarimeter

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M.Sc. Chemistry Semester – I **Laboratory Course (CHE-MDM-122)**		
Credits :2		30 Hrs
Unit I	**Errors And Analysis And Statistical Data Analysis :** Statistical treatment of errors analysis, student's 't' test , null hypothesis, rejection criterin , F & Q test; Linear regression analysis, curve fitting. Calibration of Volumetric Apparatus, burette, pipette and standard flasks. Note: Such exercise be incorporated as practice work while verifying the experimental data.	6
Unit II	**Adsorption** To Study surface tension – concentration relationship for solutions (Gibbs equation). **Phase Equibliria** Determination of congruent composition and temperature of a binary system (e.g. diphenylamine-benzophenone system) Determination of glass transition temperature of a given salt (e.g.$CaCl_2$) conduct metrically. To construct the phase diagram for three component system (e.g. chloroform – acetic acid – water).	6
Unit III	**Chemical Kinetics** Determination of the effect of (a) Change of temperature (b) Change of concentration of reactants and catalyst and (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester / ionic reactions. Determination of the velocity constants of hydrolysis of an ester / ionic reactions in micellar media. Determination of the rate constant for the oxidation of iodide ions by hydrogen peroxide studying the kinetics as an iodine clock reaction. Flowing clock reactions (Ref:: Experiments in Physical chemistry by Showmaker). Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidised by persulphate ion). Oscillatory reaction.	6
Unit IV	**Solutions** Determination of molecular weight of non-volatile and non-electrolyte /electrolyte by cryoscopy method and to determine the activity coeffieient of an electrolyte. Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occurs with a strong electrolyte.	6
Unit V	**Polarimetry** Determination of the rate constant for hydrolysis/ inversion of sugar using polarimeter. Enzyme kinetics – inversion of sucrose	6

References:

1. Practical Physical Chemistry, a. M. James and F. E. Prichard, Longman
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.

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Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	I	CHE-SEC-121	Spectroscopy (Skill Enhancement Course) Theory	Mid Sem: 40 End Sem = 60	03
Course Objectives: To make students aware with various aspects of spectroscopy and diffraction methods as well as to equip them to use this knowledge for practical purposes. **Course Learning Outcomes:** Upon successful learning, students will be able						
Unit I:	To understand various aspects of NulclearMagnetic Resonance Spectroscopy like NMR like shielding of magnetic nuclei; factors influencing chemical shift etc.					
Unit II:	To understand basic principles of Electron Spin Resonance Spectroscopy (ESR) and other important factors like factors affecting the 'g' value, Isotropic and anisotropic hyperfine constant etc.					
Unit III:	To understand basic principles of photoelectron spectroscopy.					
Unit IV:	To understand principles and different aspects ofX-ray diffraction, electron diffraction and Neutron diffractionDebye–Scherr method of X-ray structural analysis of crystals, Ramchandran diagrams etc.					
Unit V:	To understand rich heritage of Indian Science specially chemistry since ancient times and again resurrection of Indian Science from Renaissance Period					

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Skill Enhancement Courses:(Theory)

M.Sc. Chemistry, Semester - I

Spectroscopy: CHE-SEC-121

Credits :03 45Hrs

UNIT I **Magnetic Resonance Spectroscopy : Nuclear Magnetic Resonance Spectroscopy**
Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift, factors influencing chemical shift, deshielding, spin-spin interaction, factors influencing coupling constant 'J' , classification, (ABX, AMX, ABC, A_2B_2 etc.), spin decoupling, basic ideas about instrument, NMR studies of nuclei other than proton, ^{13}C, ^{19}F and ^{31}P. FT-NMR and its advantages, use of NMR in medical diagnostics.

UNIT II **Electron Spin Resonance Spectroscopy**
Basic principles, Zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine constant, spin Hamiltonian, spin densities and McConnell relationship, measurement techniques, applications. Hyperfine Coupling, spin polarization for atoms and transitional metal ions, spin orbit coupling and significance of g-tensors, application to transitional metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH_4, F_2^- and $[BH_3]^-$

UNIT III **Photo electron spectroscopy**
Basic principles, photo-electric effect, ionization process, Koopman's theorem, photo electron spectra of simple molecules, ESCA, chemical information from ESCA. Auger electron spectroscopy – basic idea.

UNIT IV **X-RAY Diffraction**
Braggs condition, Miller Indices, Laue method, Bragg method, Debye – Scherr method of X-ray structural analysis of crystals, index reflections, identification of unit cell from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem. Description of the procedure for an X-ray structure analysis, absolute configuration of a molecules, Ramchandran diagrams. **Electron Diffraction**: Scattering intensity vs scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules, low energy electron diffraction and structure of surfaces.

Neutron Diffraction: Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques, Elucidation of structure of magnetically ordered unit cell.

UNIT V A) **Frontiers of Indian RasayanShastra: History, Heroes and Heritage:** Advancement of Ayurveda, Metallurgy, Mathematics, astronomy etc. in the Indian subcontinent from ancient time.

B) **Resurrection of Indian Science Since Renaissance Period:** Influence of Acharya P. C. Ray, J. C. Bose, S. N. Bose, C. V. Raman, M. N. Saha and their discoveries like chemistry of mercury, microwave optics, Bose-Einstein Condensation theory, Raman Effect etc.

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References

1. C. N. Banwel, Fundamentals of Molecular Spectroscopy,
2. Modern spectroscopy, J. M. Hollas, John Eiley.
3. Applied Electron Spectroscopy for Chemical Analysis Ed. H.Windai and F.L. Ho Wiley Interscience.
4. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V.parish, Ellis Harwood.
5. Physical Methods in Chemistry, R.S.Drago, Saunders College,
6. Chemical Application of Group Theory, F.A.Cotton.
7. Introduction to Molecular Spectroscopy, G.M. Borrow, MsGraw Hill.
8. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
9. Theory and Applications of UV Spectroscopy, P.K.Gosh, John Wiley.
10. Introduction to Magnetic Resonance, A. Carrington and A.D.Maclachalan, Harper & Row.

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Objectives and Learning Outcomes of M.Sc. Chemistry

Department of Chemistry						
Class	**Subject**	**Semester**	**Course Code**	**Course Title**	**Marks**	**Credit**
M.Sc.	Chemistry	One	CHE-SEC-122	Laboratory Course: Spectroscopy (Skill Enhancement)	Mid Sem: 40 End Sem = 60	01

Course Objectives: To impart practical knowledge of spectral analysis of organic, Inorganic molecules, compounds and complexes

Course Learning Outcomes: Upon successful learning, students will be able to

- Understand spectral characteristics of the molecules
- Apply spectroscopic knowledge in molecular characterization
- To gain knowledge on characterization of organic compounds using physical methods and spectroscopic analysis of IR and NMR spectra

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School Board

M.Sc. Chemistry, Semester - I

CHE-SEC-122

Laboratory Course (Skill Enhancement)

Credits :01

- Measurement and interpretation of different spectra from UV-Vis, IR and NMR using organic, inorganic compounds and molecules.
- Analysis of diffraction pattern obtained from Powder X-ray diffractometeretc (calculation of crystallite size using Scherer equation etc.
- Thermogravimetric analysis of compound, molecules etc.
- Understanding electrochemical behaviour of molecules etc.

References

1. L. A. Morill, J. K. Kammeyer, Spectroscopy 101: A Practical Introduction to Spectroscopy and Analysis for Undergraduate Organic Chemistry Laboratories, Journal of Chemical Education, 94 (10), 2017. DOI: 10.1021/acs.jchemed.7b00263
2. R. M. Silverstein, F.A. Webster, Spectromeric Identification of Organic Compounds, 6th Ed., John Wiley and Sons, New York.
3. C. Suryanarayana and M.G. Norton, X-ray diffraction: A Practical approach, Springer.
4. P. Gabott, Principles and Applications of Thermal Analysis, John- Wiley Blackwell Publishing Ltd.
5. J. Wang, Analytical Electrochemistry, 3rd Edition, John- Wiley Blackwell Publishing Ltd.

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