Second Semester (CBCS)

Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)		Marks	
				L	T	P	Thy	P	SEE	IA
MSC 201	CCC	INORGANICCHEMISTRY-II	6	4	3	00	3	0	70	30
MSC 202	CCC	ORGANICCHEMISTRY-II	6	4	3	00	3	0	70	30
MSC 203	CCC	PHYSICAL CHEMISTRY-II	6	4	3	00	3	0	70	30
MSC 204	CCC	THEORY AND APPLICATION OF SPECTROSCOPY-II	6	4	3	00	3	0	70	30
MSC 205	CCC	LAB COURSE- 1	6	0	0	09	0		100	
MSC 206	CCC PRJ/SSC	SOCIAL OUT REACH & SKILL DEVELOPMENT FIELD WORK	6	0	0	09	0		100	
MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 36			Total Credit= 36							

M.Sc. CHEMISTRY SECOND SEMESTER			
COURSE CODE: MSC 201		**COURSE TYPE: CCC**	
COURSE TITLE: **INORGANIC CHEMISTRY-2**			
CREDIT: **THEORY: 6**	**PRACTICAL:0**	**HOURS:** **THEORY: 90**	**PRACTICAL: 00**
MARKS: **THEORY: 70+30**	**PRACTICAL:**	**MARKS** **THEORY:**	**PRACTICAL:**

OBJECTIVE:

To develop the understanding of basic concepts of mechanism involved in substitution and electron transfer reactions of transition metal complexes. Introduction of structural features of metal carbonyls, Inorganic rings, chains and clusters especially boranes and heteroboranes.

UNIT-1 24 Hours

KINETICS AND MECHANISM OF SUBSTITUTION REACTIONS:

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, anation reactions and reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect.

UNIT-215 Hours

ELECTRON TRANSFER REACTIONS:

Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.

UNIT-3 15 Hours

METAL CARBONYLS AND RELATED COMPOUNDS:

Preparation, structure, and properties: bonding in metal carbonyls, variants of CO bridging, vibrational spectra of metal carbonyls, principal reaction types of metal carbonyls.

UNIT-416 Hours

INORGANIC RINGS, CHAINS AND CLUSTERS:

Metal-metal bonds. Concept of quadrupolar bond and its comparison with a C-C bond; Types of metal clusters and multiplicity of M-M bonds. Simple and condensed metal carbonyl clusters. Applications of PSEPT and Wade's-Mingo's and Lauhr's rule over metal carbonyl clusters.

UNIT-5 20 Hours

CLUSTERS AND ELEMENT-ELEMENT BONDS:

Polyhedral boranes: Electron deficiency *vs*sufficiency. Types and IUPAC nomenclature. Wade's polyhedral skeleton electron pair theory (PSEPT). W. N. Lipscomb's styx rules and semi-topological structures of boranes. Equivalent and resonance structures. Types of heteroboranes with special reference to carboranes, structure, bonding and IUPAC nomenclature. Metallaboranes, Metallacarboranes, metal σ and π bonded borane/carborane clusters. Principle of Isolobility: Development and formulation of the concept of isolobility and its applications in the understanding of structure and bonding of heteroboranes.

RECOMENDE READINGS BOOKS

1. F. Basalo and R. G. Pearson, Mechanism of Inorganic Reactions, 2nd Edn (1967), Wiley Eastern Ltd., New Delhi.
2. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd Edn. (1999), ELBS, London.
3. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John Wiley & Sons, New York.
4. D.N. Sathyanarayana, Electronic Absorption Spectroscopy and Related Techniques, Universities Press (India) Ltd., Hyderabad (2001).
5. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, W. B. Sauders Com. (1987), Hong Kong.
6. Martin L. Tobe and John Burgess, Inorganic Reaction Mechanisms, Longmans IstEdn.

M.Sc. CHEMISTRY SECOND SEMESTER

COURSE CODE: MSC 202	**COURSE TYPE: CCC**
COURSE TITLE: **ORGANIC CHEMISTRY-II**	
CREDIT: **THEORY: 6** **PRACTICAL:0**	**HOURS:** **THEORY: 90** **PRACTICAL: 00**
MARKS: **THEORY: 70+30** **PRACTICAL:**	**MARKS** **THEORY:** **PRACTICAL:**

OBJECTIVE:

To understand various addition reaction to carbon-carbon double bonds, elimination reaction with mechanism and understanding of the theoretical basis for Pericyclic reactions and skills for the utilization of these reactions in the organic synthesis.To understand the basics of photochemistry- excitation of molecules by light, various photochemical reactions and the photochemistry of Alkenes and Carbonyl compounds.

UNIT-119 Hours

ADDITION TO CARBON - CARBON MULTIPLE BONDS:

Electrophilic, free-radical and nucleophilic addition: Mechanistic and Stereochemical aspects.

UNIT-2 19Hours

ELIMINATION REACTIONS:

The E1, E2 and E1cB mechanisms, Orientation of the double bond. Hofmann versus Saytzeff elimination, Pyrolyticsyn-elimination, Competition between substitution and elimination reactions.

UNIT-3 20Hours

PERICYCLIC REACTIONS:

Woodward-Hoffmann rules and molecular orbitals; Cycloaddition [2+2] and [4+2] and higher order reactions, 1,3-Dipolar cycloaddition and cheletropic reactions; Electrocylic reactions. Sigmatropic rearrangements; Group transfer reactions: Ene reactions.

UNIT-4 16 Hours

INTRODUCTION AND BASIC PRINCIPLES OF PHOTOCHEMISTRY:

Absorption of light by organic molecules, properties of excited states, mechanism of excited state processes and methods of preparative photochemistry. Photochemistry of alkenes and aromatic compounds:Isomerization, Di-p-methane rearrangement and cycloadditions, Ring isomerization and cyclization reactions.

UNIT-5 16 Hours PHOTOCHEMISTRY OF CARBONYL COMPOUNDS:

Norrish type-I cleavage of acyclic, cyclic and a, b and b, g unsaturated carbonyl compounds, Norrish type-II cleavage. Hydrogen abstraction: Intramolecular and intermolecular hydrogen abstraction, photoenolization. Photocyclo-addition of ketones with unsaturated compounds: Paterno-Buchi reaction, photodimerisation of α, β- unsaturated ketones, rearrangement of enones and dienones.

SUGGESTED READING BOOKS

1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman Ltd., New Delhi.
4. G. S. Zweifel and M. H. Nantz, Modern Organic Synthesis, (2007), Freeman and Company, New York.
5. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, 1st Edition 1990), Macmillan India Ltd., New Delhi.
6. T.H. Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry, 3rd Edition (1998), Addison – Wesley Longman Inc. (IS Edition).
7. S.M. Mukherjee and S.P. Singh, Pericyclic Reactions, MacMillan India, New Delhi.
8. Jagdamba Singh and L D S Yadav, Advanced Organic Chemistry / Organic Synthesis, PragatiPrakashan, 2011.
9. I. Fleming, Pericyclic Reactions, Oxford University Press, Oxford (1999).

M.Sc. CHEMISTRY SECOND SEMESTER			
COURSE CODE: MSC 203			**COURSE TYPE: CCC**
COURSE TITLE: **PHYSICAL CHEMISTRY-II**			
CREDIT: **THEORY: 6**	**PRACTICAL:**	**HOURS:** **THEORY: 90**	**PRACTICAL: 00**
MARKS: **THEORY: 70+30**	**PRACTICAL:**	**MARKS** **THEORY:**	**PRACTICAL:**

OBJECTIVE:

To learn Angular Momentum in quantum mechanics, variation and perturbation theory, statistical thermodynamics. Theory of semiconductor-electrolyte interfaces, Butler-Volmer equation. Chemical dynamics-study of fast reactions, theory of unimolecular reaction. Study of corrosion and cyclic voltammetry.

UNIT- 1 16 Hours

A. APPLICATION OF MATRICES IN QUANTUM CHEMISTRY:

Addition and multiplication, inverse and transpose of matrices. Determinants in Quantum Chemistry.

B. ANGULAR MOMENTUM IN QUANTUM CHEMISTRY:

Angular momentum, angular momentum Operators. Eigen functions and Eigen values for Angular momentum, Ladder operators.

C. APPROXIMATE METHODS:

The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Applications of variation method and perturbation theory to the Helium atom.

UNIT -2 18 Hours

STATISTICAL THERMODYNAMICS:

Probability, permutations and combinations, concepts of probability, Maxwell Boltzmann distribution. Different ensembles and Partition functions-translational, rotational, vibrational and Electronic partition functions. Thermodynamic function using appropriate Partition functions. Fermi- Dirac and Bose-Einstein Statistics and statistical basis of entropy. Heat capacity of solids, Debye and Einstein Models.

UNIT -3 16 Hours

ELECTROCHEMISTRY –II:

Structure of electrified interfaces. Gouy-Chapman and Stern models. Over potentials and exchange current density, Derivation of Butler – Volmer equation, Tafelplot. Semiconductor interfaces, Theory of double layer at semiconductor- electrolyte. Solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interfaces. Electro catalysis influence of various parameters.

UNIT-4 18 Hours

CHEMICAL DYNAMICS –II:

General features of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of molecular motions, probing the transition state, dynamics of barrier less chemical reactions in solutions, dynamics of unimolecular reaction. [Lindemann –Hinshelwood, RRK and Rice-Ramsperger-Kassel-Marcus {RRKM}] theories of unimolecular reactions.

UNIT -5 22 Hours

CORROSION:

Types of corrosion, electrochemical theories of corrosion, kinetics of corrosion (corrosion current and corrosion potential), corrosion measurements (weight loss, OCP measurement, and polarization methods), passivity and its breakdown, corrosion prevention techniques (electrochemical, inhibitor, and coating methods).

CYCLIC VOLTAMMETRY:

Instrumentation, current-potential relation applicable for Linear Sweep Voltammetry (LSV) and Cyclic Voltammetry (CV), interpretation of cyclic voltammograms and parameters obtainable from voltammograms.

SUGGESTED READING BOOKS

1. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Sutclilffe, Longman.
3. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hall.
4. Chemical Mathematics, D.M, Hirst, Longman.
5. Applied Mathematics for Physical Chemistry, J.R. Barrante, Prentice Hall.
6. Basic Mathematics for Chemists, Tebbutt, Wiley.
7. Physical Chemistry, P.W. Atkins, ELBS.
8. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
9. Quantum Chemistry, Ira N. Levine, Prentice Hall.
10. Coulson's Valence, R. McWeeny, ELBS.
11. Chemical Kinetics, K. J. Laidler, Pearson.
12. Kinetics and Mechanism of Chemical Transformations, J . Rajaraman and J. Kuriacose, McMillan.
13. Modern Electro chemistry Vol.I and Vol.II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
14. Thermodynamics for Chemists, S. Glasstone EWP.
15. An Introduction to Electrochemistry S. Glasstone EWP.
16. Physical Chemistry, Ira N. Levine McGraw Hill.
17. Physical Chemistry, Silbey, Alberty, Bawendi, John-Wiley.

M.Sc. CHEMISTRY SECOND SEMESTER			
COURSE CODE: MSC 204			**COURSE TYPE: CCC**
COURSE TITLE: **THEORY AND APPLICATION OF SPECTROSCOPY- II**			
CREDIT: **THEORY:** **6**	**PRACTICAL:**	**HOURS:** **THEORY:** **90**	**PRACTICAL:** **00**
MARKS: **THEORY:** **70+30**	**PRACTICAL:**	**MARKS** **THEORY:**	**PRACTICAL:**

OBJECTIVE:

To learn about UV and Visible spectroscopy, Electronic spectroscopy, Mass spectroscopy, NMR spectroscopy and their applications in structure elucidation.

UNIT- 1 16Hours

ULTRAVIOLET AND VISIBLE SPECTROSCOPY:

Various electronic transitions(185-800nm), Beer-Lambert Law, effect of solvent on electronic transitions, UV bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser-Woodwards rules for conjugated dienes and carbonyl compounds, UV spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

UNIT -2 INFRARED SPECTROSCOPY: 16 Hours

Instrumentation and sample handling. Characteristics vibrational frequencies of alkanes, alkenes, alkynes,aromatic compounds, alcohols , ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketons, aldehydes, esters, amides, acid, anhydride, lactones, lactams and conjugated carbonyl compounds). Effect of H bonding, conjugation and solvent effect on vibrational frequencies, overtones, combination band and Fermi resonance.

UNIT -3 14 Hours

MASS SPECTROMETRY:

Introduction, ion production, fragmentation, single and multiple bondcleavage, rearrangements, cleavage associated with common functional groups, molecular ionpeak, metastable ion peak, Nitrogen rule and interpretation of mass spectra.

UNIT-424Hours

NUCLEAR RESONANCE SPECTROPHOTOMETRY:

Theory of NMR spectroscopy, interaction of nuclear spin and magnetic moment, chemical shift, processional motion of nuclear particles in magnetic field, spin-spin splitting, coupling constants, factor affecting the chemical shift, shielding effect, effect of chemical exchange, hydrogen bonding, instrumentation of Fourier transform NMR spectrophotometer ; Carbon-13 NMR spectroscopy: General considerations, chemical shift, calculation of approximate chemical shift values, coupling constants. Interpretation of simple CMR spectra. DEPTspectrum. 2 DNMR: COSY, NOESY and HETCOR.

UNIT -5 20 Hours

Structure elucidation based on spectroscopic data (IR, UV, NMR and Mass).

SUGGESTED READING BOOKS

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell.
3. Spectroscopy, B.K. Sharma, Goel Publication.
4. Organic Spectroscopy: Principles and Application, Jag Mohan, Narosa Publication.
5. Spectroscopic Methods in Organic Chemistry, D.H. Williams & I. Fleming, Tata Mcgraw-Hill Publication.
6. Spectrophometric Identification of Organic Compounds, R.M. Silverstein & F.X. Webster, John Wiley Publications.

M.Sc. CHEMISTRY SECOND SEMESTER			
COURSE CODE: MSC 205			**COURSE TYPE: CCC**
COURSE TITLE: **LAB COURSE- I**			
CREDIT: **THEORY: 00**	**PRACTICAL:06**	**HOURS:** **THEORY: 00**	**PRACTICAL:135**
MARKS: **THEORY:**	**PRACTICAL: 100**	**MARKS** **THEORY:**	**PRACTICAL:**

One Experiment from each section is compulsory

Sec- A (10 Marks)

01. GENERAL METHODS OF SEPARATION AND PURIFICATION OF ORGANIC COMPOUNDS WITH SPECIAL REFERENCE TO:

Solvent Extraction

Fractional Crystallisation

02. DISTILLATION TECHNIQUIES:

Simple distillation, steam distillation, Fractional distillation and distillation under reduced pressure.

Sec- B (30 Marks)

01. ANALYSIS OF ORGANIC BINARY MIXTURE:

Separation and Identification of organic binary mixtures containing at least one component with two substituents.

(A student is expected to analyses at least 10 different binary mixtures.)

Sec- C (20 Marks)

01. PREPARATION OF ORGANIC COMPOUNDS: SINGLE STEP REPARATIONS.

a. **Acetylation:** Synthesis of β-Naphthyl acetate from β-Naphthol/Hydroquinone diacetate from Hydroquinone.

b. **Aldol condensation:** Dibenzal acetone from benzaldehyde.

c. **Bromination:** p-Bromoacetanilide from acetanilide.

d. **Cannizzaro Reaction:** Benzoic acid and Benzyl alcohol from benzaldehyde.

e. **Friedel Crafts Reaction:** O-Benzoyl Benzoic acid from phthalic anhydride.

f. **Grignard Reaction:** Synthesis of triphenyl methanol from benzoic acid.

g. **Oxidation:** Adipic acid by chromic acid oxidation of cyclohexanol.

h. **Perkin's Reaction:** Cinnamic acid from benzaldehyde.

i. **Sandmeyer Reaction:** p-Chlorotoluene from p-toluidine/o-Chlorobenzoic acid from anthranilic acid.

j. **Schotten Baumann Reaction:** β-Naphthyl benzoate from: β-Naphthol / Phenyl benzoate from phenol.

k. **Sulphonation Reaction:** Sulphanilic acid from aniline.

SUGGESTED BOOKS

1. Practical Organic chemistry by A. I. Vogel.
2. Practical Organic chemistry by Mann and Saunders.
3. Practical Organic chemistry by Garg and Saluja.
4. The Systematic Identification of Organic compounds, R.L. Shriner and D.Y. Curtin.
5. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entrikin and E.M. Hodnett.
6. Practical Physical chemistry by Alexander Findlay.
7. Experimental Physical chemistry, D. P. Shoemaker, G. W. Garland and J. W. Niber, McGraw Hill Inter science.
8. Findlay's Practical Physical chemistry.

Mark Scheme:-

Ex. 1	**10**
Ex 2	**30**
Ex 3	**20**
Sessional	**20**
Viva	**20**
Total	**100**

M.Sc. CHEMISTRY SECOND SEMESTER	
COURSE CODE: MSC 206	**COURSE TYPE: CCC PRJ/SSC**
COURSE TITLE: SOCIAL OUT REACH & SKILL DEVELOPMENT FIELD WORK	
CREDIT: 06 **THEORY: 00**	**HOURS: 135** **PRACTICAL:100**

Objective: The aim of the project work of field work is to introduce students with the research methodology in the subject and to prepare them for pursuing research in theoretical experimental or computational area of subject.

Preparation- 40

Report submission- 40

Presentation -20