Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Inorganic Chemistry-I (Coordination Chemistry)
Paper Code: CHEM5101
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: The subject matter assimilated in this course

- acquaints students with the nomenclature, geometry and isomerism of coordination compounds.
- provides an insight about photo inorganic chemistry.
- emphasizes on the mechanism of reactions of coordination compounds.

Course Contents:

Unit 1: Coordination compounds

Coordination numbers and coordination geometries; Types of ligands; Isomerism in coordination compounds: Geometrical , optical, ionization, linkage, coordination isomerism; Nomenclature of coordination compounds; Optical rotator dispersion (ORD) and Circular dichorism(CD) spectra; The stability of complexes : Factors affecting stability of complexes, thermodynamic aspects of complex formation, Stepwise and overall formation constants, stability correlations, statistical and chelate effects; Determination of stability constant: Polarographic, photometric and potentiometric methods.

Unit 2: Theories of metal ligand bond

Valence bond theory; Hybridization; Crystal field theory; Crystal field splitting; Crystal field stabilization energy; Thermodynamic, structural, spectral and magnetic characteristics; Jahn-Teller effect; Ligand field theory; Molecular orbital theory.

Unit 3: Spectra of coordination compounds

Spectral characteristics: Free ion terms, transformations in crystal field; Energy diagrams in weak and strong field; Tanabe-Sugano diagrams; Selection rules; Magnetic properties; Van Vleck equation; Magnetic susceptibility: Guoy and Faraday methods; ESR spectra of transition metal ions.

Unit 4: Reactivity of coordination compounds

Inert and labile complexes; Substitution reactions in square-planar and octahedral complexes; Factors affecting reactivities; Electron transfer reactions: The outer sphere and inner sphere mechanisms; Photochemical reactions of coordination compounds: Substitution, redox and rearrangement reactions.

Unit 5: Photoinorganic chemistry

Excited states of metal complexes; Energy transfer under conditions of weak interaction and strong interaction – exciplex formation; Photosubstitution, photooxidation and photoreduction; Photochemical reactions involving Ruthenium(II) –bipyridyl complex and comparison with $[Fe(bipy)_3]^{2+}$; Application to photovoltaics; Water photolysis – carbon dioxide reduction.

Unit 6: Metal-complexes

Metal carbonyls: Structure and bonding; Important reactions of metal carbonyls; Metal nitrosyls: Structure, bonding and important reactions; Metal dinitrogen and metal dioxygen complexes.

Text/Reference Books:

1. Inorganic Chemistry: D F Shriver and P W Atkins Oxford University Press, Oxford
2. Modern Inorganic Chemistry: W L Jolly Tata Mc Graw Hill Pub. Co., New York
3. Inorganic Chemistry, J E Huheey: E A Keiter and R L Keiter Peasron Education, New Delhi
4. Basic Inorganic Chemistry: F A Cotton, G Wikinson and P Gaus John Wiley and Sons, New York
5. Advanced Inorganic Chemistry: F A Cotton, G Wikinson, C A Murillo, M. Bochmann John Wiley and Sons, New York
6. Elements of Inorganic photochemistry: G L Ferraudi Wiley Inter-science, New York
7. Physical Inorganic Chemistry: A Coordination Approach, S F A Kettle Oxford University Press, New York

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organic Chemistry –I
Paper Code: CHEM5103
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: Study of the topics included in this course will enable the students to

- build a basic knowledge about the reactive intermediates of organic reactions.
- appreciate the developments in the field addition and substitution reactions.
- understand the mechanism of important named reactions.

Course Contents:

Unit 1: Reactive intermediates

(a) Carbenes: Stability, structure and spin states of carbenes; Cyclopropanation : Spin dependence and stereochemistry; Carbene insertion to C-H bonds; Rearrangement to alkenes; Wolff rearrangement of acylcarbenes and its synthetic applications.

(b) Nitrenes: Stability, structure and spin states of nitrenes; C-H bond insertions and aziridine formation; Rearrangement of acylnitrenes (Hoffmann, Curtius and Schmidt reactions with applications in organic synthesis).

Unit 2: Addition reactions

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals for the following reactions are to be discussed. Addition to carbon- carbon double bond: Addition of hydrogen, halogen, hydrogen halides, hydroxylation, ozonization, hydroboration, Addition to carbon - oxygen double bond: Addition of HCN, sodium bisulphite, alcohols, water, ammonia.

Unit 3: Substitution reactions-I

Aliphatic nucleophilic substitutions : S_N1, S_N2 and S_Ni mechanisms ; Effects of substrate, attacking nucleophile, leaving group and solvent; Stereochemistry of nucleophilic substitution reactions; Factors influencing the mechanism of nucleophilic substitution reactions; Distinction between $S_N1$and S_N2 reactions; Nucleophilic substitution with complete retention of configuration; Neighbouring group participation and retention of configuration.

Unit 4: Substitution reactions-II

Norbornyl cation and other non-classical carbocations; Ambident nucleophiles; O versus C alkylation; Aromatic nucleophilic substitution: Mechanisms, effects of substrate, structure, leaving group and attacking nucleophile; Various methods of benzyne generation and reactions of benzyne; Reactions of aryl diazonium salts; Vicarious nucleophilic substitution (VNS); Aromatic electrophilic substitution reactions and mechanisms; Substitution in monosubstituted benzenes: Orienting influence and O/p ratio.

Unit 5: Named reactions –I

Arndt Eistert synthesis; Dakin reaction; Fitting reaction; Dieckmann; Darzens; Chugaev and Cope eliminations ; Chichibabin reaction ; Hunsdiecker reaction ; Robinson annulation ; Hell-Volhard-Zelinsky reaction ; Japp-Klingemann reaction; Stork enamine alkylation; Vilsmeier-Haack reaction ; Polonovski reaction ; Hofmann-Loffler-Freytag reaction.

Unit 6: Named reactions –II

Reformatsky reaction ; Reimer Tiemann reaction; Simmons-Smith reaction ; Gattermann-Koch reaction ; Schiemann reaction ; Von Braun reaction; Ullmann reaction ; Thorpe reaction; Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions; Hydrolysis of esters and amide; Ammonolysis of esters.

Text/Reference Books:

1. Advanced Organic Chemistry-Reactions, Mechanisms and Structure: J March
   Wiley Inter-sciences, New York
2. Advanced Organic Chemistry-Part A and Part B: F A Carey and R J Sundberg
   Plenum Press, New York
3. Organic Chemistry: T W G Solomons John Wiley and Sons, New York
4. Organic Chemistry: R T Morrison and R N Boyd Prentice Hall of India Pvt. Ltd, New Delhi
5. Organic Chemistry: P Y Bruice Prentice Hall, New Delhi
6. Organic Chemistry: S Pine McGraw Hill Book Company, New York
7. Advanced Organic Chemistry-Reaction Mechanism: R Bruckner Elsevier, New Delhi

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Quantum Chemistry **Sessional Marks: 30**
Paper Code: CHEM5105 **Theory Paper Mark: 60**
Lectures: 4 Tutorial: 1 **Total Marks: 100**
Credits: 4.5 **Duration of Examination: 3Hrs**

Course Objective: The subject matter assimilated in this course

- acquaints students with the Bohr's theory and its limitations.
- provides explanation regarding postulates of quantum mechanics.
- explains general orbital theory of conjugated systems.

Course Contents:

Unit 1: Quantum theory-I

Black body radiations; Planck's radiation law; Photoelectric effect, Compton effect, Comparison of the photoelectric effect and Compton scattering; Dual nature of light and matter; De- Broglie hypothesis, Heisenberg's uncertainty principle; Examples of position momentum uncertainty; Rydberg relation for explaining atomic spectrum of hydrogen; Bohr's theory and its limitation.

Unit 2: Quantum theory-II

Solution of classical wave equation by separation of variables method; Operators and observations; Normal and orthogonal functions; Hermitian and unitary operators; Eigen value equation; Hamiltonian operator; Interpretation of wave function; Postulates of quantum mechanics.

Unit 3: Applications of quantum postulates

The free particle; Solution of particle in one and three dimensional box; Degeneracy; One dimensional linear harmonic oscillator; The rigid rotators; Quantization of vibrational and rotational energy levels; Hydrogen and hydrogen like atoms.

Unit 4: Angular momentum and their properties

Need of polar coordinates; Transformation of Cartesian coordinate into polar coordinate; Angular momentum operator in positional representation; The rotation operator and angular momentum; Spin angular momentum; The total angular momentum operators; Commutation relations of total angular momentum with components.

Unit 5: General orbital theory of conjugated systems

Chemical bonding; Linear combination of atomic orbital; Overlap integral; Coulomb's integral; Bond order; Charge density calculations for ethylene, allyl system, butadiene system, cyclo butadiene, cyclo propenyl system.

Unit 6: The time independent quantum approximate methods

Need for approximation methods; Stationary perturbation theory; The variation (Rayleigh- Ritz) methods; Physical applications of variation methods to helium atom

Text/Reference Books:

1. Physical Chemistry-A Molecular Approach: D A McQuarrie and J D Simon
   University Science Books, California
2. Quantum Chemistry: Ira N Levine
   Prentice Hall, New Delhi
3. Molecular Quantum Mechanics: P W Atkin
   Oxford University Press, Oxford
4. Fundamentals of Quantum Chemistry: R Anantharaman
   Macmillan Publishers, India

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Molecular Spectroscopy
Paper Code: CHEM5106
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: Analysis of the given chemical compound is most important and tedious task in chemistry. In this course the students will be exposed to the

- principles, instrumentation and applications of infrared spectroscopy which is helpful in identification of functional groups.
- laws of spectro-photometry and applications of ultraviolet spectro-photometry for analysis of unsaturated organic compounds.
- nuclear magnetic resonance and mass spectroscopy for structure elucidation and molecular weight determination respectively.

Course Contents:

Unit 1: UV and visible spectroscopy

Beer – Lambert's law and molar extinction coefficient; Oscillator strength and intensity of the electronic transition; Frank Condon principle; Ground and first excited electronic states of diatomic molecules; Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect; Transitions in organic molecules; Woodward rules for conjugated dienes, unsaturated carbonyl groups and extended conjugation aromatic systems; Electronic spectra of transition metal complexes..

Unit 2: Infrared spectroscopy

Introduction to spectroscopy; Nature of radiation; Energies corresponding to various kinds of radiation; Experimental techniques; Intensities of spectral lines; Selection rules and transition moments; Characteristic vibrational frequencies of different functional groups and factors influencing vibrational frequencies; Application of IR for structural elucidation.

Unit 3: Nuclear magnetic resonance spectroscopy-I

Natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei; ^{1}H NMR: The spinning nucleus; Effect of external magnetic field; Precessional motion and frequency; Energy transitions; Chemical shift and its measurements; Factors influencing chemical shift; Anisotropic effect; Spin-spin coupling and spin-spin splitting; Theory of spin- spin splitting; Magnitude of coupling- coupling constant; Factors affecting the coupling constant; Chemical and magnetic equivalence; First and second order spectra: A_2, AB, AX, AB_2, AX_2, A_2B_2 and A_2X_2 spin systems; Simplification of complex spectra (solvent effect, field effect, double resonance and lanthanide shift reagents); CW and FT NMR; Relaxation processes; T1 and T2 measurements; Applications of PMR in structural elucidation of simple and complex compounds.

Unit 4: Nuclear magnetic resonance spectroscopy-II

^{13}C-NMR: Resolution and multiplicity of ^{13}C NMR; ^{1}H-decoupling, Noise decoupling; Broad band decoupling; Deuterium, fluorine and phosphorus coupling; Nuclear overhauser effect(NOE); Off-resonance, proton decoupling; Structural applications of ^{13}C-NMR.; Pulse sequences, pulse widths, spins and magnetization vectors; Distortionless enhancement by polarization transfer (DEPT) ; Insensitive nuclei enhanced by polarization transfer (INEPT) Introduction to 2D-NMR: Corelation spectroscopy (COSY) and nuclear overhauser effect spectroscopy (NOESY) .

Unit 5: Mass spectra

Introduction and methods of ionization; Ion analysis methods (in brief); Isotope abundance; Metastable ions; General rules predicting the fragmentation patterns; Nitrogen rule; Determination of molecular ion peak; Fragmentation patterns for aliphatic compounds, amines, aldehydes, ketons, esters, amides, nitriles, carboxylic acids, ethers, aromatic compounds etc.

Unit 6: Solution of structural problems by combined use of following spectroscopic techniques:

(a) Electronic spectra
(b) Vibrational spectroscopy
(c) NMR (^{1}H and ^{13}C) spectroscopy
(d) Mass Spectroscopy

Text/Reference Books:

1. Fundamentals of Molecular Spectroscopy: C N Banwell and E M McCash Tata McGraw Hill, New Delhi
2. Spectroscopic Identification of Organic Compounds: R M Silverstein, G C Basseler and T C Morrill John Wiley and Sons, Inc., New York
3. 3. Organic Spectroscopy, W Kemp McMillan Press Ltd, London

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Inorganic Chemistry Lab–I **Sessional Marks: 15**
Paper Code: CHEM5102 **Practical Exam Marks: 35**
Practical: 6 **Total Marks: 50**
Credits: 3.0

List of Experiments:

I. Oxidation-Reduction Titrations

1. Standardization of sodium oxalate with $KMnO_4$ and determination of Ca^{2+} ion.
2. Standardization of ceric sulphate with Mohr's salt and determination of Cu^{2+}, NO_3^{-1} and $C_2O_4^{-2}$ ions.
3. Standardization of $K_2Cr_2O_7$ with Fe^{2+} and determination of Fe^{3+} (Ferric alum).
4. Standardization of hypo solution with potassium iodate / $K_2Cr_2O_7$ and determination of available Cl_2 in bleaching powder.
5. Determination of hydrazine with KIO_3 titration.

II. Gravimetric Analysis

1. Determination of Ba^{2+} as its chromate.
2. Determination of Ba^{2+} as its sulphate.
3. Estimation of Pb^{2+} as its lead molybdate.

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis, J Mendham, R C Danney, J D Barnes , M Thomas and B Sivasankar
   Pearson Education, Chennai
2. Practical Inorganic Chemistry, G Marr and B W Rockett
   Van Nostrand Reinhold Company, London
3. Practical Inorganic Chemistry, G Pass and H Sutcliffe
   Chapman and Hall, London

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organic Chemistry Lab –I **Sessional Marks: 15**
Paper Code: CHEM: 5104 **Practical Exam Marks: 35**
Practical: 6 **Total Marks: 50**
Credits: 3.0

List of Experiments:

1. **Purification techniques** of organic compounds and their spectroscopic identifications.
    a. Purification of binary mixtures by Thin Layer Chromatography (TLC) and Column chromatography (CC).
    b. Purification of tertiary mixtures of amino acids by paper chromatography.

2. **Extraction of natural products:** Any one of the following – solasodine, caffeine, nicotine, piperine, rosine, carotenoids.

3. **Single stage organic preparations** involving various types of reactions
    a. Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol/P-benzoquinone from hydroquinone
    b. Cannizzaro reaction: 4-chlorobenzyldehyde as a substrate.
    c. Aldol condensation: Dibenzal acetone from benzaldehyde.
    d. Sandmeyer reaction: p- Chlorotoulene from p-toluidine/ o-chlorobenzoic acid from anthranillic acid
    e. Preparation of cinnamic acid by perkin's reaction
    f. Knoevenagel condensation reaction
    g. Coumarin Synthesis
    h. Synthesis of p-Nitroaniline and p- bromoaniline(Aromatic electrophilic substitutions) Synthesis of heterocyclic compounds.
    i. Synthesis of dyes
    j. Addition: benzophenone oxime from benzophenone
    k. Acetylation: glucose pentaacetate from glucose / resorcetophenone from resorcinol

4. **Qualitative Analysis** of Binary Mixtures (only two)

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Vogels Textbook of Practical Organic Chemistry: B S Furniss, A J Hannaford, P W G Smith and A R Tatchell ELBS with Longman, Longman Singapore Publishers Pvt. Ltd, Singapore
2. Practical Organic Chemistry: F G Mann and B C Saunders Dorling Kindersley (India) Pvt. Ltd., New Delhi
3. A Handbook of Organic Analysis: Qualitative and quantitative, H T Clarke E Arnold and Co., London

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organometallic Chemistry | **Sessional Marks: 30**
Paper Code: CHEM5107 | **Theory Paper Marks: 60**
Lectures: 4 Tutorial: 1 | **Total Marks: 100**
Credits: 4.5 | **Duration of Examination: 3Hrs**

Course Objective: Study material incorporated in this course will enable the students to

- acquire basic knowledge of the essential and trace elements in biological systems, and their functions.
- understand the developments in the field organometallic chemistry.

Course Contents:

Unit 1: Main group organometallics

Synthesis and reactions of organolithium, organomagnesium compounds, Organometallics of zinc and mercury; Preparation, structure, bonding and reactions of aluminum organyls; Synthesis of Thallium(I) organyls (TlCp);Synthesis of organyls of sodium (NaCp); Silicon and tin organyls of coordination number 4.

Unit 2: Transition metal–carbon bond

Metal alkyl compounds; Transition metal- carbene and transition metal-carbyne compounds; Transition metal vinylidene and transition metal allenylidene compounds; Cyclopropenyl cation ($C_3R_3^+$) and C_4R_4 as a ligand (R = H, Me, Ph)

Unit 3: Syntheses of cyclopentadienyl and arene metal analogues

Synthesis and reactions of cyclopentadienyl metal carbonyls, cyclopentadienyl metal hydrides, cyclopentadienyl metal halides, arene metal carbonyls, η6-arene-chromium tricarbonyl .

Unit 4: Applications to organic synthesis and homogeneous catalysis

Hydrozirconation of alkenes and alkynes; Carbonylation of Colman's reagent; η4-diene iron-tricarbonyls in organic synthesis; Asymmetric hydrogenation; Synthesis of acetic acid and glycol (Monsanto acetic acid process); Arylation/vinylation of olefins (Heck reaction); Wacker process (olefin oxidation); Asymmetric epoxidation.

Unit 5: Some reagents of synthetic importance

Preparation, properties and use of the following reagents in organic synthesis and functional group transformations, Dicyclohexylcarbodiimide (DCC) ; Polyphosphoric acid; Diazomethane; Ethyldiazoacetate; Borontrifluoride; trifluoroacetic acid; N- bromosuccinamide(NBS); Mont k-10(clay); phase transfer catalyst; Sodium boro hydride; Selenium dioxide ; Osmium tetroxide ; Phenyl isothiocyanate ; platinum and palladium catalyst; 1,3-Dithiane.

Unit 6: Organometallic reagents

Preparation, properties and use of the following reagents in organic synthesis and functional group transformations: Organocadmium compounds, organolead compounds and organofluorine compounds.

Text/Reference Books:

1. Organometallics: C Elschenbroich. Wiley-VCH, Weinheim
2. Molecular Chemistry of the Transition Elements: F Mathey and A Sevin. John Wiley and Sons, New York
3. Organometallic Chemistry: A Unified Approach, R C Mehrotra and A Singh NewAge International (P) Ltd, New Delhi
4. Organotransition Metal Chemistry: A Yamamoto, JohnWiley and Sons, New York
5. The Organometallic Chemistry of the Transition Metals: R H Crabtree John Wiley and Sons, New York

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organic Chemistry –II | **Sessional Marks: 30**
Paper Code: CHEM5108 | **Theory Paper Marks: 60**
Lectures: 4 Tutorial: 1 | **Total Marks: 100**
Credits: 4.5 | **Duration of Examination: 3Hrs**

Course Objective: The contents included in this course will enable the students to

- build a basic knowledge of ylides which are used in organic synthesis.
- appreciate the developments in the field oxidation and reduction reactions.
- understand the mechanism of various rearrangement reactions.

Course Contents:

Unit 1: Ylides

General methods of formation; General study of reactions with their mechanism of nitrogen (ammonium, immonium, diazonium and nitrile), phosphorus and sulphur ylides and their applications.

Unit 2: Elimination reactions

Mechanisms of elimination ; Stereochemistry of bimolecular elimination ; Hofmann and Saytzeff rule ; Competition between elimination and substitution reaction; Orientation effects in elimination reactions; Effects of substrate structures, attacking base, leaving group and medium on E_1 and E_2 reactions ; Pyrolytic eliminations ; Bredt's rule.

Unit 3: Oxidation reactions

Introduction; Different oxidative processes: Alkenes, aromatic rings, alcohols, diols, aldehydes, ketones, ketals , carboxyalic acids, amines, hydrazines, and sulphides; Oxidizing agents: Ceric ammonium nitrate(CAN), peroxyacids, chromium trioxide and lead tetraacetate; Oxidation reactions with special emphasis on Baeyer- villeger reaction and Cannizarro oxidation-reduction reaction.

Unit 4: Reduction reactions

Different reductive processes; Hydrocarbons: alkanes, alkenes, alkynes and aromatic rings; Carbonyl compounds: aldehydes, ketones, acids, ester ; Nitriles; Epoxides; Nitro; Nitroso; Azo and oxime groups; Hydrogenolysis; Reducing agents: sodium cyano borohydride, Isobutyl aluminium hydride, alkoxy substituted LAH, diisoamyl borane, hexyl borane; Reduction reactions: Wolf-Kishner reduction, Clemensen reduction, Birch and Meerwein- Ponndorf-Verley reduction.

Unit 5: Rearrangements -I

General mechanistic consideration: Nature of migration, migratory aptitude, memory effects etc.; Detailed study of the following rearrangements. Rearrangement to electron deficient carbon: Pinacol-pinacolone, Wagner-Meerwein, Benzil-benzilic acid; Rearrangement to electron deficient nitrogen: Schmidt, Beckmann, Hofman and Curtius rearrangement.

Unit 6: Rearrangements -II

Rearrangement to electron deficient oxygen:Cumene hydroperoxide rearrangement, Daikin reaction; Rearrangement to electron rich atom: Favorskii, Wittig; Stevens rearrangement; Aromatic rearrangements: Orton, Hofmann –Martius, Claisen, Benzidine and Fries rearrangement.

Text/Reference Books:

1. Advanced Organic Chemistry, Reactions, Mechanisms and Structure: J March
   John Wiley and Sons Asia Pvt. Ltd., Noida
2. Advanced Organic Chemistry, Part A and Part B: F A Carey and R J Sundberg
   Plenum Press, New York
3. Mechanism and Theory in Organic Chemistry: T H Lowry and K S Richardson
   Harper and Row Publishers, New York
4. Guide book to Organic Synthesis: R K Mackie and D M Smith
   ELBS Publications, London
5. Some Modern Methods of Organic Synthesis: W Carruthers
   Cambridge University Press, Cambridge
6. Organic Synthesis: B I Smith
   Chapman and Hall, New York
7. Organic Synthesis: Special Techniques, V K Ahluwalia and R Aggarwal
   Narosa Publishing House, New Delhi

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: (Thermodynamics)
Paper Code: CHEM5109
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: Study of the topics included in this course will enable the students to

- build a basic concepts about classical thermodynamics.
- understand about statistical and non equilibrium thermodynamics.

Course Contents:

Unit 1: Classical thermodynamics-I

Concepts of thermodynamics: Free energy, chemical potential and entropy; Partial molar properties: Partial molar free energy, partial molar volume, partial molar heat content and their significances, determination of these quantities; Concept of fugacity and its determination.

Unit 2: Classical thermodynamics-I

Non-ideal systems; Excess functions for non-ideal solutions; The concept of activity and activity coefficient; Debye-Huckel theory for activity coefficient of electrolytic solutions; Determination of activity and activity coefficients; Ionic strength. Application of phase rule to three component system (acetic acid-chloroform –water system).

Unit 3: Statistical thermodynamics-I

Concept of microstates and macrostates, Types of statistics: Maxwell- Boltzman statistics, Bose-Einstein statistics, Fermi-Dirac statistics; Concept of distribution law; Thermodynamic probability and most probable distribution; Postulates of ensemble averaging; Canonical, grand canonical and microcanonical ensembles and corresponding distribution laws (using Lagrange's method of undetermined multipliers).

Unit 4: Statistical thermodynamics-II

Partition functions: Translational, rotational, vibrational, electronic and nuclear partition function; Calculation of thermodynamic properties in terms of partition functions; Thermodynamic properties of an ideal monoatomic and diatomic gas;Molar partition function of a system; Partition function for a real gas; Equilibrium constants of an ideal gas in terms of partition functions; Heat capacity of monoatomic crystals; Einstein's theory of heat capacity of a solid.

Unit 5: Non equilibrium thermodynamics-I

Thermodynamic criteria for non-equilibrium states; Entropy production and entropy flow; Entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.); Transformations of generalized fluxes and forces.

Unit 6: Non equilibrium thermodynamics-II

Non-equilibrium stationery states; Phenomenological equations; Microscopic reversibility and Onsager's reciprocity relations; Electro kinetic phenomena: Diffusion, electric conduction; Irreversible thermodynamics for biological systems; Coupled reactions.

Text/Reference Books:

1. Non-Equilibrium Thermodynamics – Principles and Applications:
   C Kalidas and M V Sanganarayana Macmillan, India
2. Elements of Classical and Statistical Thermodynamics:
   I F Nash Dover Publications, Inc, Mineola, New York

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Instrumental Methods of Analysis **Sessional Marks: 30**
Paper Code: CHEM5111 **Theory Paper Marks: 60**
Lectures: 4 Tutorial: 1 **Total Marks: 100**
Credits: 4.5 **Duration of Examination: 3Hrs**

Course Objective: The subject matter assimilated in this course

- acquaints students with the theory, instrumentation and applications of thermal methods of analysis.
- provides explanation regarding fundamental laws of spectrophotometry, instrumentation regarding flame photometry and atomic fluorescence spectrometry.
- emphasizes on enzymes and immunoassay.

Course Contents:

Unit 1: Optical methods- I

Fundamental laws of spectrophotometry; Nephelometry, turbidometry and fluorimetry; UV-visible and IR spectrophotometry : Instrumentation, single and double beam instruments; Fourier transform infrared spectroscopy,calibration of the frequency scale, absorbance and transmittance scale; Atomic emission spectrometry : Excitation sources (flame, AC and DC arc), spark, inductively coupled plasma, glue discharge, laser microprobes, flame structure, instrumentation, and qualitative and quantitative analysis; Atomic absorption spectrometry: Sample atomization techniques, instrumentation, interferences, background correction, and analytical applications.

Unit 2: Optical methods- II

Atomic fluorescence spectrometry: Theory, instrumentation and applications; X-ray methods : X-ray absorption and X-ray diffraction photoelectron spectroscopy, Auger, ESCA, scanning electron microscopy(SEM),transition electron microscopy(TEM) and atomic force microscopy(AFM).

Unit 3: Electroanalytical methods

Basic theory, instrumentation and applications of electrogravimetry, coulometry, polarography, amperometry, biamperometry, cyclic voltametry and chronopotentiometry.

Unit 4: Separation techniques

Liquid-liquid extraction; Use of oxine, dithiazone, high molecular weight amines, thiocarbamates and crown ethers in extraction. Chromatograpy: Classification, theory, basic instrumentation and use of paper, thin layer, liquid, column, gas, ion -exchange chromatography; Gas chromatography columns, stationary phases and applications; Theory and applications of High performance liquid chromatography-mass spectrometry (HPLC-MS) and gas chromatography-mass spectrometry (GC-MS);Theory and applications of size exclusion, affinity, antichiral chromatographic techniques.

Unit 5: Thermal methods

Theory, instrumentation and applications of Thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC), thermometric titrations, thermo mechanical analysis (TMA) and dialatometric analysis (DMA).

Unit 6: Enzymes and immunoassay

General principles; Antigen-antibody interactions; Quantitative and qualitative analysis of antigen; Hapten inhibition test; Immunodiffusion; Immunoelectrophoresis. Enzyme immunoassay: ELISA and RIA; Fluorescence immunoassay techniques: Substrate labeled and delayed enhanced lanthanide fluorescence immunoassay, flow cycto flourimetry and fluorescence activated cell sorting; Western blotting; Biosensors and chemosensors; amperometeric, potentiometric and colorimetric biosensors.

Text/Reference Books:

1. Basic Concepts in Analytical Chemistry: S M Khopkar
   Wiley Eastern, New Delhi
2. Vogel's Textbook of Quantitative Inorganic Analyses: A I Vogel
   Longmans, Green and Co., London
3. Principles of Instrumental Analysis: D A Skoog and D M West
   Saunders College Pub, Philadelphia
4. Instrumental Methods of Analysis: H H Willard, L L Merrit, J A Dean and F A Settle
   CBS Publishers and Distributors, Delhi
5. A Textbook of Environmental Chemistry: A Singh
   Compus books International, New Delhi
6. Food and Bioprocessing Engineering: S Moorthy and Kaliappan
   Anamaya publishers, New Delhi
7. Principles and Techniques of Practical Biochemistry: K Wilson and J Walker (Eds)
   Cambridge University Press, Cambridge

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Physical Chemistry Lab–I
Paper Code: CHEM5110
Practical: 6
Credits: 3.0

Sessional Marks: 15
Practical Exam Marks: 35
Total Marks: 50

List of Experiments:

1. Conductometry

a. Determination of order of reaction, rate constant and energy of activation for saponification of an ester by NaOH, conductometrically.
b. Determination of strength of strong and weak acids in a mixture, conductometrically.
c. Determination of critical micellar concentration (CMC) of sodium lauryl sulphate from the measurement of conductivities at different concentrations.
d. Determination of solubility product of a sparingly soluble salt (PbSO4, BaSO4 etc.) conductometrically and verification of Debye-Huckel theory.
e. Titration of weak acid conductometrically
f. Titration of strong acid conductometrically
g. Determine the dissociation constant of acetic acid in DMSO, DMF, dioxane by titrating it with KOH.
h. Determine the activity coefficient of an electrolyte at different molalities by e.m.f. measurements.
i. Compare the relative strength of CH3COOH and CICH2COOH from conductance measurements.
j. Determine the solubility (g/litre) of sparingly soluble lead sulphate from conductance measurements.

2. Potentiometry

a. To determine the strength of given acid by PH metrically.
b. To determine dissociation constant of given acid pH metrically
c. Determination of strengths of halides in a mixture, potentiometrically.
d. Determination of pH of buffer solutions and hence to calculate the E0 of quinhydrone electrode.
e. Determination of stoichiometry and formation constant of silver-ammonia complex, potentiometrically.

3. Polarimetry

a. Compare the relative strength of: i) HCl and ii) H2SO4 by following the kinetics of inversion of cane sugar polarimetrically.
b. Determination of specific rotation of sucrose and rate constant of its hydrolysis using a polarimeter.

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Findlay's Practical Physical Chemistry: B P Levitt (eds)
   Longman, London
2. Experiments in Physical Chemistry, D P Shoemaker, C W Garland and J W Nibler
   McGraw Hill, New York
3. Experimental Physical Chemistry, V D Athawala and P Mathur
   New Age International, New Delhi
4. Advanced Practical Physical Chemistry, J B Yadav,
   Krishna Pakashan Media Pvt Ltd., Meerut
5. Advanced Experimental Chemistry Vol. I., J N Gurtur and R Kapoor,
   S Chand and Co. Ltd., New Delhi

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Analytical Chemistry Lab | **Sessional Marks: 15**
Paper Code: CHEM5112 | **Practical Exam Marks: 35**
Practical: 6 | **Total Marks: 50**
Credits: 3.0

List of Experiments:

1. To verify Beer-Lambert's Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample colorimetrically
2. To determine the solubility of calcium oxalate in presence of KCl (Ionic Strength Effect)
3. To determine the solubility of calciuum oxalate in presence of HCl (H+ ion Effect)
4. Analysis of pharmaceutical tablets.
5. To verify the Beer-Lamberts Law and determine the concentration of given dye solution colorimetrically.
6. To estimate the amount of D-glucose in given solution colorimetrically.
7. To determine the acid value of given oil
8. Determination of sodium from the fertilizer sample using cation exchange resin chromatographically.
9. Determination of calcium from the given drug sample.
10. Determination of hardness, alkalinity and salinity of water sample.
11. Separation and estimation of chloride and bromide on anion exchanger.

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Findlay's Practical Physical Chemistry: B P Levitt (eds)
   Longman, London
2. Experiments in Physical Chemistry: D P Shoemaker, C W Garland and J W Nibler
   McGraw Hill, New York
3. Practical Organic Chemistry: F G Mann and B C Saunders
   Dorling Kindersley (India) Pvt. Ltd, New Delhi

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
MSc Chemistry
Course Code: B502

Course Title: Solid State Chemistry | **Sessional Marks: 30**
Paper Code: CHEM6101 | **Theory Paper Marks: 60**
Lectures: 4 Tutorial: 1 | **Total Marks: 100**
Credits: 4.5 | **Duration of Examination: 3Hrs**

Course Objective: The subject matter incorporated in this course will enable students to

- acquire knowledge about the nature of the solid electrolytes, defects in solids and the magnetic and optical properties of solids.

Course Contents:

Unit 1: Solid State Reactions

Preparative Methods: Vapor phase transport; Preparation of thin films: Electrochemical methods, chemical vapour deposition; Crystal growth: Bridgman and Stokbarger methods, zone melting; Characterization of Solids: Crystal diffraction of X-rays; X-ray diffraction methods; Powder method: Principles and uses; Scattering of X-rays by crystals: Systematic absences; Electron diffraction; Neutron diffraction.

Unit 2: Powder compact reactions and solid-state defects

Diffusion Model: Parabolic rate law; Jander's rate equation, Kroger-Zeigler equation, Ginstling-Brounshtein rate equation; Stoichiometric defects; Point defects in crystals: Schottky and Frenkel defects; The photographic process - light sensitive crystals, mechanism of latent image formation, lithium iodide battery; Non-Stoichiometric defects: Origin of non-stoichiometry, consequences of non-stoichiometry; Equilibria in non-stoichiometric solids, Color centres: F-centre, electron and hole centre; Colour centre and information storage.

Unit 3: Solid electrolytes

Typical Ionic Crystals: Alkali metal halides (vacancy conduction), silver chloride (interstitial conduction); Solid electrolytes - β-alumina, silver iodide, halide and oxide ion conductors; Application of solid electrolytes. Thermoelectric effects: Seebeck effect and Hall Effect.

Unit 4: Properties of solids

Behaviour of substances in magnetic field; Effects of temperature (Curie and Curie-Weiss laws); Magnetic moments; Mechanism of ferro- and antiferromagnetic ordering: Super exchange; Luminescence and phosphors; Configurational coordinate model; Lasers: Ruby and neodymium.

Unit 5: Inorganic rings, chains and metal cluster –I

Borazines, phosphazenes and other heterocyclic inorganic ring systems; Homocyclic inorganic systems; Cages of phosphorous and sulphur oxides and sulphides; Higher boranes and carboranes.

Unit 6: Inorganic rings, chains and metal cluster –II

Methods of classifying boranes; Molecular orbit view of chlorohydroborane ions and carboranes; Metallocarboranes; Isopoly and heteropoly acids and salts; Metal-metal bonds and bi-, tri-, tetra-, penta-, and hexanuclear clusters; Electron counting schemes for HNCC's;. Approaches to systematic cluster synthesis: Seven, eight and nine atom clusters; Isolobal analogy and examples of application of analogy.

Text/Reference Books:

1. Solid State Chemistry and its Applications: A R West
   John Wiley and Sons, New York
2. Organic Semiconductors: F Gutmann and L E Lyons
   John Wiley and Sons, New York
3. Solid State Chemistry: N B Hannay
   Prentice Hall of India (P) Ltd, New Delhi
4. Defect Crystal Chemistry and its Applications: R J D Tiley
   Chapman and Hall, New York
5. Crystallography: E J W Whittaker
   Pergamon Press, Oxford
6. Inorganic Chemistry: K P Purcell and J V Kotz
   W B Saunders Co, London
7. Inorganic Chemistry: G L Miessler and D A Tarr
   Pearson Education, Delhi
8. Inorganic Chemistry: F A Cotton and G Wilkinson
   John Willy and Sons, New York
9. Inorganic Chemistry: J E Huheey
   Pearson Education, Asia

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Theoretical Chemistry
Paper Code: CHEM6101
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: The subject matter incorporated in this course will help students to

- understand basic principles of group theory and molecular symmetry.
- acquire knowledge about applications of group theory to molecular spectroscopy and chemical bonding.
- learn about various application of quantum mechanism.

Course Contents:

Unit 1: Foundations of group theory and molecular symmetry

Basic principles of group theory: The defining properties of mathematical groups, finite and infinite groups; Abelian and cyclic groups; Group multiplication tables (GMT); Similarity transformation, sub groups and classes in a group; Molecular Symmetry and point groups: Symmetry elements and symmetry operations in molecules, relations between symmetry operations, complete set of symmetry operations of a molecule, point groups and their systematic identification.

Unit 2: Representations of point groups-I

Representations of point groups: Basis for a representation, representations using vectors, atomic orbitals and cartesian coordinates positioned on the atoms of molecule (H_2O as example) as bases, reducible representations(reps) and irreducible representation(Irreps) of point groups; Construction of Irreps by reduction (qualitative demonstration only); Great orthogonality theorem (GOT) (no derivation) and its consequences;.

Unit 3: Representations of point groups-II

Derivation of characters of Irreps using GOT; Construction of character tables of point groups (C_{2v}, C_{3v}, C_{2h} and C_{4v} as examples); Nomenclature of Irreps: Mulliken symbols, symmetry species; Reduction formula: Derivation of reduction formula using GOT, reduction of reducible representations; Relation between group theory and quantum mechanics: Wave functions (orbitals) as bases for Irreps of point groups.

Unit 4: Applications of group theory to molecular spectroscopy-I

Spectral transition probabilities: Direct product of irreducible representations and its use in identifying vanishing and non –vanishing integrals, transition moment integral and spectral transition probabilities; Overlap integrals and conditions for overlap; Molecular vibrations: Symmetry species of normal modes of vibration; Construction of cart, normal coordinates and drawings of normal modes (e.g. H_2O and NH_3).

Unit 5: Applications of group theory to molecular spectroscopy-II

Selection rules for IR and Raman activities based on symmetry arguments; Determination of IR active and Raman active modes of molecules (e.g., H_2O, NH_3, CH_4 , SF_6); Complementary character of IR and Raman spectra; Electronic Spectra: Electronic transitions and selection rules; Laporte selection rule for centro symmetric molecules.

Unit 6: Applications of group theory to chemical bonding

Hybridisation: Treatment of hybridization in BF_3 and CH_4, inverse transformation and construction of hybrid orbitals; Molecular orbital theory: H_2O and BH_3 as examples, classification of atomic orbitals involved into symmetry species, group orbitals, symmetry adapted linear combinations (SALC), projection operator; Construction of SALC using projection operator; Use of projection operator in constructing SALCs for the π MOs in cyclopropenyl ($C_3H_3^+$) cation.

Text/Reference Books:

1. Chemical Applications of Group Theory: F A Cotton
   John Wiley and Sons Inc., New York
2. Symmetry in Chemistry: H H Jaffe and M Orchin
   John Wiley and Sons Inc., New York
3. Group Theory and Symmetry in Chemistry: L H Hall
   McGraw Hill, New York
4. Symmetry-An Introduction to Group Theory and its Applications: R McWeeny
   Pergamon Press, London
5. Beginning Group Theory for Chemistry: P H Walton,
   Oxford University Press Inc., New York
6. Group Theory and its Applications in Chemistry: A S Kunju and G Krishnan,
   PHI Learning Pvt. Ltd New Delhi
7. Introduction to Symmetry and Group theory for Chemists: A M Lesk
   Kluwer Academic Publishers, New York
8. Symmetry and Spectroscopy of Molecules: K V Reddy
   New Age International (P) Ltd, New Delhi

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Medicinal Chemistry | **Sessional Marks: 30**
Paper Code: CHEM6101 | **Theory Paper Marks: 60**
Lectures: 4 Tutorial: 1 | **Total Marks: 100**
Credits: 4.5 | **Duration of Examination: 3Hrs**

Course Objective: The course content included in this course will enable the students to

- understand the concept of drugs and their classification.
- build a basic knowledge of the theory of drug activity.
- provides an insight about isolation, structure elucidation and preparative methodologies of some of the important drugs.

Course Contents:

Unit 1: Introduction

Concept of drug, prodrugs and soft drugs; Lead compound and lead modification; Structure-activity relationship (SAR); Quantitative structure-activity relationship (QSAR); Factors affecting bioactivity – resonance, inductive effect, isosterism, bio-isosterism, spatial considerations; Theories related to drug activity. Concept of drug receptors: Elementary treatment of drug-receptor interactions; Physico-chemical parameters: Lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials; Factors affecting modes of drug administration, absorption, metabolism and elimination; Significance of drug metabolism in medicinal chemistry.

Unit 2: Antibiotics

Cell wall biosynthesis; Inhibitors of β-lactam rings; Antibiotics inhibiting protein synthesis; Isolation, structure elucidation, synthesis, SAR and mode of action of penicillins; Synthesis of penicillin G, ampicillin and amoxicillin; Isolation, structure determination, synthesis, SAR and mode of action of streptomycin, tetracyclines and chloroamphanicol.

Unit 3: Antineoplastic and cardiovascular drugs

Antineoplastic drugs: Cancer chemotherapy; Role of alkylating agents and antimetabolites in the treatment of cancer; Carcinolytic antibiotics and mitotic inhibitors; Synthesis of mechlor-ethamine, melphalan, 5-bromouracil and 6-mercaptopurine; Anticancer action of taxol; Cardiovascular drugs: Classification, preparation and mode of action of quinidine and verapamil.

Unit 4: Local anaesthetics and sedatives

Tranquilisers, hypnotics and sedatives; SAR, activity mode and preparation of diazepam, oxazepam, barbiturates; Local anaesthetics: Classification, SAR, mode of action and synthesis of procaine, α-eucaine and β-eucaine, cinchocaine and quinisocaine.

Unit 5: Antinfective and antipyretic drugs

Antiinfective drugs: Mode of action and preparation of sulphonamides, norfloxacin; Antipyretic and analgesics: Classification and mode of action of antipyretic analgesics; Synthesis of paracetamol and mefenamic acid. Hypoglycemic agents: Detection of sugar in urine; Cause and control of diabetes; Oral hypoglycemic agents.

Unit 6: Antihistamines, antimalarial drugs and blood chemistry

Antihistamines: SAR and mode of action of H1-receptor antagonists; Synthetic methods of preparation of bromazine, and phenindamine; Antimalarial drug: Nitrogen heterocycles as antimalarial agents, their classification, mode of action and synthesis of chloroquine and pyrimethamine. Blood: Blood groups, Rh factor; Blood pressure: Normal, high and low; Control of pressure; Causes and control of anaemia: Antianaemic drugs; Coagulants and anticoagulants; Causes and control of AIDS.

Text/Reference Books:

1. Burger Medicinal Chemistry and Drug Discovery Vol-1: M E Wolff (Eds)
   Wiley Interscience, New York
2. Goodman and Gilman-The Pharmacological Basis of Therapeutics:
   L L Brunton, D K Blumenthal, N Dandan, R H Murri and B C Knollmann
   McGraw Hill, New York
3. Introduction to Drug Design: S S Pandeya and J R Dimmock
   New Age International (P) Ltd, New Delhi
4. Introduction to Medicinal Chemistry: Graham and Patrick
   Oxford University Press, Oxford
5. Medicinal Chemistry: T Nogrady and D F Weaver
   Oxford University Press, Oxford

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Inorganic Chemistry-III
(Lanthanide, Actinide & Nuclear Chemistry)
Paper Code: CHEM6102
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: The subject matter incorporated in this course will help students to

- understand nuclear fission and fusion.
- gain knowledge about the radiation detection techniques and radiation decay.
- appreciate developments in the field of nuclear medicines.
- learn about chemistry of inner transition elements.

Course Contents:

Unit 1: Lanthanide and actinides

Lanthanide occurrence and isolation; Lanthanide contraction; Oxidation states; Spectral and magnetic properties; Coordination complexes; Actinides: Extraction, general properties and oxidation states.

Unit 2: Nuclear binding energy

Nuclear stability and decay of unstable nuclei; Nuclear forces; Liquid drop model; Shell model.

Unit 3: Detection of nuclear radiation

Various methods of detecting nuclear radiations; Proportional and G M counters; Scintillation counters; Solid state detectors.

Unit 4: Radio analytical techniques

Interaction of radiation with matter; Photoelectric effect; Radiation dosimetry; Isolation dilution techniques-principle, instrumentation advantages and limitations; Neutron activation analysis(NAA): Principle, instrument, advantages and limitations.

Unit 5: Nuclear reactors

Various types of nuclear reactors including photonuclear, thermonuclear and spallation reactors; Nuclear fission and fusion.

Unit 6: Nuclear medicines

Diagnostic medical imaging; Common nuclear medicines: Iodine-131, yettrium-90, strontium-89; Commonly used radiation sources in health care.

Text/Reference Books:

1. Introduction to Radiochemistry: Friedlander and J W Kennedy
   John Wiley and Sons, New York
2. Essentials of Nuclear Chemistry: H J Arnikar
   New Age International Publishers, New Delhi
3. Modern Nuclear Chemistry: W D Loveland, D J Morrissey and G T Seaborg
   Wiley, New York
4. Nuclear Physics: D C Tayal
   Himalaya Publishing House, Mumbai

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organic Chemistry-III **Sessional Marks: 30**
(Hetero Cyclic, Photochemistry and Pericyclic Chemistry)
Paper Code: CHEM6102 **Theory Paper Marks: 60**
Lectures: 4 Tutorial: 1 **Total Marks: 100**
Credits: 4.5 **Duration of Examination: 3Hrs**

Course Objective: The topics included in this course will help students to

- understand basic concepts involved in photochemistry.
- learn classification and nomenclature of heterocyclic compounds, their synthesis and reactions.
- appreciate the concept of photochemistry of alkenes and carbonyl compounds..

Course Contents:

Unit 1: Heterocycles-I

Hantzsch-Widman nomenclature for monocyclic, fused and bridged heterocycles; General approaches to heterocyclic synthesis; Aliphatic and aromatic heterocycles; Basicity and aromaticity of heterocycles; Synthesis and reactions of Indole; Synthesis, structure and properties of pyridine.

Unit 2: Heterocycles-II

Structure, methods of preparation and properties of pyrones; Methods of synthesis, structure and properties of quinoline and isoquinoline.

Unit 3: Five membered ring containing two hetero atoms (Azoles)

Structural and chemical properties of azoles; Synthesis of pyrazoles, oxazoles, thiazoles, benzopyrazoles and imidazoles.

Unit 4: Six membered ring containing two hetero atoms (Azines)

Structure, chemical properties (Nucleophilic and electrophilic substitutions) and synthesis of pyridazines, pyrimidines, pyrazines, benzofused diazines, oxazines and thiazines.

Unit 5: Photochemistry

Interaction of electromagnetic radiation with matter; Types of excitations; Fate of excited molecule; Quantum yield; Transfer of excitation energy; Actinometry; Photoreduction; phtoaddition; photoisomerisation; photolysis of carbonyl compounds; photo-oxidation; Photo-Fries rearrangement of ethers and anilides; Barton reaction; Hoffmann-Loeffler-Freytag reaction; Di-π-methane rearrangement; Singlet molecular oxygen reactions; Photo-cleavages.

Unit 6: Pericyclic Reactions

Molecular orbitals: MOs of acyclic and cyclic polyenes and arenes; Classification of pericyclic reactions; Thermal and photochemical reactions; Three approaches: Conservation of orbital symmetry and correlation diagram, frontier molecular orbital approach [FMO] and aromatic (Huckel and Mobius) transition state approach; (4+2) Cycloadditions; (2+2) Cycloadditions; Electrocyclic reactions; Explaination of Woodward-Hoffman rule and orbital symmetry; Sigmatropic rearrangements: Sigmatropic migration of hydrogen and carbon, supra and antarafacial migrations; Cope and Claisen rearrangements; Degenerate Cope rearrangement; Fluxional tautomerism; Wittig rearrangement; 2,3-sigmatropic shifts.

Text/Reference Books:

1. Principles of Modern Heterocyclic Chemistry: L A Paquette
   W A Benjamin Inc., New York
2. Organic Chemistry: Stereochemistry and Chemistry of Natural Products, Vol. II, I L Finar.
   ELBS with Longman, London
3. Heterocyclic Chemistry: T L Gilchrist
   Dorling Kinderslay (India) Pvt. Ltd., New Delhi
4. Principles and Applications of Photochemistry: C E Wayne and R P Wayne
   Oxford University Press, Oxford
5. Modern Molecular Photochemistry: N J Turro
   University Science Books, Calfornia
6. Molecular Reactions and Photochemistry: C H Depuy and O L Chapman
   Prentice Hall of India (P) Ltd., New Delhi

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Physical Chemistry-III (Chemical Kinetics)
Paper Code: CHEM6102
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: Study of the topics included in this course will enable the students to

- build a basic knowledge regarding determination of rate laws and their experimental verification.
- appreciate the developments in the field.
- understand about the theory of reaction rates..

Course Contents:

Unit 1: Basic kinetic concepts

Chemical kinetics and its scope; Order and molecularity; Rate constants and rate coefficients; Rate laws; Factors affecting rates: Concentration, temperature, pressure, solvent, light and catalyst. Methods of determination of rate laws: Differential method, method of integration, first order, second order and third order reactions with examples; Half lives; Pseudo-molecular reactions; Isolation method; Reaction of nth order; Comparison of methods; Influence of temperature on reaction rates; The Arrhenius equation.

Unit 2: Experimental methods of chemical kinetics

Experimental methods of chemical kinetics : Conductometric, potentiometric, optical methods, polarimetry and spectrophotometry; Kinetics of Reactions: Reversible or opposing reactions, consecutive or series reactions, parallel reactions; The collision theory of bimolecular reactions; Steric factor ; Lindemann's mechanism; The transition state theory. Thermodynamic treatment and statistical mechanical approach; Eyring treatment; Transmission coefficient; Tunneling effect; Kinetic theory of intermolecular reactions.

Unit 3: Gas-phase reactions

Elementary gas-phase reactions; Lindemann- Christiansen hypothesis; Hinshelwood's treatment; Rice-Ramsperger-Kassel (RRK) treatment; Slater's treatment; Rice-Ramsperger-Kassel Marcus (RRKM) treatments of unimolecular gas phase reactions.

Unit 4: Reactions in solutions

Reactions in solutions: Factors affecting reactions in solutions; Ionic reactions in solutions; Effect of solvent; Effect of ionic strength; Primary and Secondary salt effects.
Composite/Complex Reactions; Types of composite mechanisms; Rate equations for composite mechanisms; Simultaneous and Consecutive reactions; Steady-state treatment; Rate-determining steps; Microscopic reversibility and detailed balance.

Unit 5: Catalysis

Simple catalysed reactions; General acid base catalysis; Kinetics of acid base catalysis; Catalysis by enzymes; Influence of substrate concentration, pH and temperature; Transient – phase kinetics.

Unit 6: Kinetics of fast reactions

Reaction in flow systems: Techniques for very fast reactions; General features of fast reactions; Stopped-flow method; Relaxation methods; Shock tube methods; Flash photolysis; Nuclear- magnetic resonance methods; Kinetics of dynamic chain reactions: Hydrogen- bromine reactions and hydrogen- chlorine reaction; Pyrolysis of acetaldehyde; Organic decomposition; Decompositon of ethane.

Text/Reference Books:

1. Chemical Kinetics: K J Laidler
   Tata McGraw Hill, Inc., New Delhi
2. Kinetics and Mechanism: A A Frost and R G Pearson
   John Wiley and Sons, New York
3. Comprehensive Chemical Kinetics Vol. 2: C H Bamford and C F H Tipper (Eds)
   Elsevier, Amsterdam
4. Principles of Physical Chemistry: S H Maron and C F Prutton
   Macmillan, Delhi
5. Kinetics and Mechanism of Chemical Transformations: J Rajaraman and J Kuricose
   Tata McGraw Hill Publishing Company Limited, New Delhi
6. Kinetics and Catalysis in Microheterogeneous Systems, M Gratzel and K Kalyanasundaram
   Academic Press, New York

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Physical Chemistry-III (Spectroscopy)
Paper Code: CHEM6103
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Contents:
Molecular Structure: Spectroscopic and Diffraction Methods

Spectroscopic methods: Characterization of electromagnetic radiation. Born-oppenheimer approximation. Heisenberg's Uncertainty Principle. Basic elements of spectroscopy. Time dependent perturbation. Einstein coefficients. Lambert-beer's law. Integrated absorption coefficients. Transition dipole moments and general selection rules based on symmetry ideas.

Atomic spectra: Characterization of atomic states. Microstate and spin factoring methods. Hund's rules. Derivation of spin and orbital selection rules (based on recursion relations of Legendre polynomials). Spectra of complex atoms. Zeeman and stark effects. Atomic photoelectron spectroscopy.

Introduction to molecular spectroscopy: Rotational spectroscopy of diatomic molecules based on rigid rotator approximation. Determination of bond lengths and/or atomic masses from microwave data. Effect of isotopic substitution. Non-rigid rotator. Classification of polyatomic molecules. Energy levels and spectra of symmetric top molecules and asymmetric top molecules. First order stark effect.

Vibrational spectroscopy: Normal coordinate analysis of homolnuclear and heteronuclear diatomic molecules. Extension to polyatomic linear molecules. Derivation of selection rules for diatomic molecules based on Harmonic oscillator approximation. Force constant and amplitudes. Anharmonic oscillator. Overtones and combination bands.

Dissociation energies from vibrational data. Vibration – rotation spectra, P, Q and R branches. Breakdown of the Born- Oppenheimer approximation. Nuclear spin effect.

Symmetry of normal coordinates. Use of group theory in assignment of spectra and selection rule for simple molecules.

Raman spectroscopy: Stocks and anti - stocks lines. Polarizability ellipsoids. Rotational and Vibrational Raman spectroscopy. Selection rules. Polarisation of Raman lines.

Electronic spectroscopy: Diatomic molecules. Selection rules. Breakdown of selection rules. Frank-Condon factors. Dissociation energies. Photoelectron spectroscopy of diatomic (N2) and simple polyatomic molecules (H2O, formaldehyde). Adiabatic and vertical ionization energies. Koopman's theorem.

Polyatomic molecules. Oscillator strengths. Use of Free Electron Model, HMO theory and Group theory for polyenes and carbonyl compounds (formaldehyde). Qualitative ideas of solvent effects – viscosity, polarity, hydrogen bonding.

Excited states: Deactivation. Jablonskii diagram. Fluorescence and phosphorescence and factors affecting these. Calculation of excited state life-times from absorption data. Quenching of fluorescence, Stern-Volmer equation.

NMR spectroscopy: Larmor precession. Mechanisms of spin-spin and spin-lattice relaxations and quantitative treatment of relaxation. Quantum mechanical treatment of the AB system. Selection rules and relative intensities of lines.

Principle of mossbauer spectroscopy: Isomer shifts. Quadrupole and Nuclear Zeeman splittings. Applications in structure determination.

Diffraction method: Atomic scattering factors. Scattering by a small crystal. Direct and reciprocal lattice. Miller indices. Bragg's law and Laue's equations. Structure factors. Systematic absences for different types of unit cells (primitive, face-centered, body-centered, side-centered) and application to some common metal and metal salt structures (rock salt, zinc

Blende). Space groups. Glide planes and screw axes. Structure determination for organic crystals like naphthalene. Fourier series.

Patterson's functions. Heavy atom method. Comparison of X-ray method with electron and neutron diffraction methods.

Recommended Texts:

1. Hollas.J.M. Modern spectroscopy 4th Ed. John Wiley & Sons (2004)
2. Barrow.G.M. Introduction to Molecular Spectroscopy McGraw-Hill(1962)
3. Brand .J.C.D.& Speakman.J.C. Molecular Structure: The Physical Approach 2nd Ed.,Edward Arnoid: London(1975)
4. Chang.R.Basic Principles of Spectrscopy McGraw-Hill, New York, N.Y.(1970)
5. Moore, W.J.Physical Chemistry 4th Ed. Prentice-Hall (1972)
6. Warren,B.E.X-Ray Diffraction Dover Publications (1990)
7. Bacon, G.E.Fifty Years of Neutron Diffraction Hilger (1987)

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Inorganic Chemistry-IV
(Chemistry of nano-materials and Sensors)
Paper Code: CHEM6201
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: The content matter incorporated in this course is based on emerging technologies in the field of chemical sciences which will help students to

- learn about synthesis , properties and structural characterization of nanomaterials such as carbon nanotubes and fullerenes.
- acquire knowledge about importance of various types of sensors and their applications.

Course Contents:

Unit 1: Nanotechnology

Scope and emerging trends; Bottom-up and top-down approaches; Chemistry of solid surfaces: Surface energy; Chemical potential of curved surfaces; Stabilization of colloidal dispersions by electrostatic and steric interactions; Different types of nano materials.

Unit 2: Carbon nanotubes

Synthetic methods for single walled and multi walled nanotubes; Physical properties: Optical, mechanical, magnetic and electrical properties; Quantum size effects; Structural characterization by scanning electron microscopy, x-ray diffraction and raman spectroscopy.

Unit 3: Nanowires

One-dimensional nanowires and nanorods; Two-dimensional thin films; Nano composites and nano-structured polymers; Nano catalysts; Nano clusters: Preparation and properties; Synthesis, properties and applications of fullerenes.

Unit 4: F**abrication of nanostructures**

Photolithography, electron beam lithography and related techniques; Nanolithography by scanning tunneling microscopy and atomic force microscopy; Assembly of nano particles and nanowires; Applications of nano materials in electronic and optoelectronic devices

Unit 5: Sensors

Importance of Sensors; Biomolecular recognition elements; Artificial molecular-recognition materials; Molecular imprinted polymers; Electrode modification.; Fluorescence, chemi and bio-luminescence sensors and their applications; Fluorescent tag molecules; Conductometric , coulometric and voltammetric sensors and their applications.

Unit 6: E**lectrochemical and biosensors**

Neurotransmitters; Amperometric sensors; Chronoamperometric analysis; Multichannel sensors; Microelectrode sensors; Electrochemical impedance sensors; Quartz crystal nanobalance sensors; Molecular recognition; Applications. Surface plasmon resonance based sensors; Fiber optic sensors; Two dimensional microarray based sensors; Applications for food safety - Mycotoxins, adultrants ; Biomedical diagnosis - Cancer markers.

Text/Reference Books:

1. Nanostructures and Nanomaterials- Synthesis, Properties and Applications: G Cao
   Imperial College Press, London
2. The Chemistry of Nano structured Materials: P Yang
   World Scientific Publishing, Singapore
3. Textbook of Nanoscience and Nanotechnology:
   B S Murty, P Shankar, B Rai, B B Rath and J Murday
   Univ. Press, Hyderabad
4. Chemical Sensors and Biosensors, Analytical Techniques in the Sciences (AnTS):
   B R Eggins
   Wiley, London
5. Sensors in Biomedical Applications - Fundamentals, Technology and Applications:
   G Harsanyi,
   CRC Press, New York
6. Electrochemical Sensors in Bioanalysis: Raluca-Ioana Stefan
   CRC Press, New York

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Bioorganic Chemistry-IV | **Sessional Marks: 30**
Paper Code: CHEM6204 | **Theory Paper Marks: 60**
Lectures: 4 Tutorial: 1 | **Total Marks: 100**
Credits: 4.5 | **Duration of Examination: 3Hrs**

Course Objective: Study of the topics included in this course will enable the students to

- appreciate the developments in the field of carbohydrates chemistry.
- understand characteristics and mechanism of enzyme action.
- acquire knowledge about structure and functions of amino acids , protein and peptides.

Course Contents:

Unit 1: Enzymes

Nomenclature; Characteristics (mention of ribozymes); Classification; Active site; Mechanism of enzyme action; Derivation of Michelis Mentis Equation; Stereospecificity of enzymes, coenzymes and cofactors; Enzyme inhibitors; Introduction to biocatalysis: Importance in Green Chemistry and chemical industry.

Unit 2: Carbohydrates-I

Conformation of monosaccharides; Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars; Disaccharides and polysaccharides. Structural polysaccharides: cellulose and chitin; Storage polysaccharides: Starch and glycogen.

Unit 3: Carbohydrates-II

Structure and biological functions of glucosaminoglycans or mucopolysaccharides; Carbohydrates of glycoprotines and glycolipides; Role of sugars in biological recognition; Carbohydrate metabolism: Kreb's cycle; Glycolysis, glycogenesis and glycogenolysis; Pentose phosphate pathway.

Unit 4: Lipids

Fatty acids; Essential fatty acids; Structures and function of triglycerides, glycerophspholipids, sphingolipids, cholesterol, bile acids, prostaglandins; Lipoproteins composition, function and role in arthrosclerosis; Properties of lipid aggregates: Micelles, bilayers, liposomes and their possible biological functions; Biological members: Fluid mosaic model of membrane structure; Lipid metabolism: Oxidation of fatty acids.

Unit 5: Amino acids, peptides and proteins

Chemical and enzymatic hydrolysis of proteins to peptides; Amino acid sequencing; Secondary structure of protein; Forces responsible for holding of secondary structures; alpha helix and beta sheets; Super secondary structure; Triple helix structure of collagen; Tertiary structure of protein; Quaternary structure. Amino acid metabolism: Degradation and biosynthesis of amino acids; Sequence determination: chemical/ enzymatic/ mass spectral, racemization/ detection; Chemistry of oxytocin and tryptophan releasing hormone (TRH).

Unit 6: Nucleic acids and Dyes

Purine and pyrimidine of nucleic acids; Base pairing via H – bonding; Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA); Double helix model of DNA and forces responsible for holding it; Chemical and enzymatic hydrolysis of nucleic acids; The chemical basis for heredity; An overview of replication of DNA, transcription, translation and genetic code; Chemical synthesis of mono and poly nucleosides. **Dyes:** Indigo and alizarin including their structure elucidation; Interaction between dyes and fibres; Various classes of synthetic dyes including heterocyclic dyes.

Text/Reference Books:

1. Biochemistry: J M Berg, J L Tymoczko and L Stryer
   W H Freeman and Co., New York
2. Principles of Biochemistry: D L Nelson, M M Cox, and A L Lehninger
   W H Freeman and Co., New York
3. Green Chemistry-Environmentally Benign Reactions: V K Ahluwalia
   Ane Books India, New Delhi
4. Outlines of Biochemistry: E E Conn and P K Stumpf
   John Wiley and Sons, New York

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Physical Chemistry -IV (Corrosion and Spectroscopy)
Paper Code: CHEM6207
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: The content matter incorporated in this course is based on emerging technologies in the field of chemical sciences which will help students to

- learn about electrochemistry of corrosion
- acquire knowledge about kinetics of passivity and protection methods against corrosion.
- understand about theory and applications of mossbeaur spectroscopy.
- appreciate the developments in the field of nuclear quadrupole resonance spectroscopy.

Course Contents:

Unit 1: Electrochemistry of corrosion

Corrosion, importance and cost of corrosion; Classification of corrosion; Electrode reactions; Electrode potential and electrochemical cell formation; Nernst equation; Exchange current density; Polarization of electrode (resistance, concentration and activation); Mixed potential theory; Polarization diagrams; Pourbaix diagrams; Corrosion rate expression and weight loss method for corrosion rate; Galvanic series; Electrochemical techniques to study corrosion – Galvanostatic and potentiostatic techniques; Stern –Geary equation; Tafel slopes; Measurement of corrosion potential and corrosion current density; Tafel extrapolation and Linear polarization resistance methods; Recording and interpretation of anodic and cathodic polarization curves.

Unit 2: Kinetics of passivity and protection methods against corrosion

Introduction and electrochemical behaviour of active/passive metals; Flade potential; Criteria for selecting a metal exhibiting passivity; Factors influencing electrochemical passivity and corrosion rate; Theories of passivity. Metal and design improvement; Change of environment; Anodic protection; Cathodic protection and protective coatings; Corrosion inhibitors: classification, mechanism, selection of corrosion inhibitors, inhibition efficiency and factors influencing inhibition efficiency, measurement of inhibition efficiency.

Unit 3: Industrial corrosion problems

Uniform corrosion; Galvanic corrosion; Pitting corrosion; Crevice corrosion; Intergranular corrosion; Stress corrosion, Corrosion fatigue; Fretting corrosion; Dealloying; Hydrogen embrittlement; Erosion and microbial induced corrosion: Filliform corrosion and exfoliation.

Atmospheric corrosion and high temperature oxidation; Corrosion in industrial cooling water system; Corrosion in boilers and condensate pipe lines; Corrosion due to acids; Corrosion during metal surface cleaning and descaling; Corrosion during storage and transportation of metallic articles; Corrosion in various industries.

Unit 4: Moss bauer spectroscopy

The theory of Moss-Bauer spectroscopy; The chemical shift; Quadrupole effects; The effect of magnetic field; Application of Moss-Bauer spectroscopy.

Unit 5: Electron spin resonance spectroscopy

The theory of E.S.R; The position of E.S.R. absorption; The g factor; The fine and hyperfine structures of E.S.R. absorption; Applications of E.S.R. spectroscopy.

Unit 6: Nuclear quadrupole resonance spectroscopy

Introduction; Energies of quardrupole transitions; Effect of magnetic field on the spectra; Relationship between electric field gradient and molecular structure; Applications; Interpretations of structural information from NQR spectra.

Text/Reference Books:

1. Mossbaur Spectroscopy: N N Greenwood and T C Gibbs
   Chapmann Hall, London
2. Spectroscopy in Inorganic Compounds: C N R Rao and G R Ferraro
   Academic Press, New York
3. Introduction to Corrosion Science: E McCafferty
   Springer, New York
4. Principles and Prevention of Corrosion: D A Jones
   Macmillan Publishing Company, New York

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Inorganic Chemistry Lab –II **Sessional Marks: 15**
Paper Code: CHEM6202 **Practical Exam Marks: 35**
Practical: 5 **Total Marks: 50**
Credits: 2.5

List of Experiments:

1. Precipitation Titrations

a. $AgNO_3$ standardization by Mohr's method by using adsorption indicator.
b. Volhard's method for Cl^- determination.
c. Determination of ammonium / potassium thiocyanate.

2. Complex metric Titrations

a. Determination of Cu^{2+} and Ni^{2+} by EDTA method.
b. Determination of Ni^{2+} (back titration).
c. Determination of Ca^{2+} (by substitution method).

3. Gravimetric Analysis

a. Estimation of chromium (III) as its chromate.
b. Estimation of Cu^{2+} using ammonium/ sodium thiocyanate.
c. Estimation of silver as chloride.

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis: J Mendham, R C Danney, J D Barnes, M Thomas and B Sivasankar
   Pearson Education, Chennai
2. Practical Inorganic Chemistry: G Marr and B W Rockett
   Van Nostrand Reinhold Company, London
3. Practical Inorganic Chemistry: G Pass and H Sutcliffe
   Chapman and Hall, London

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organic Chemistry Lab –II **Sessional Marks: 15**
Paper Code: CHEM6205 **Practical Exam Marks: 35**
Practical: 5 **Total Marks: 50**
Credits: 2.5

List of Experiments:

1. Qualitative Analysis
Separation, purification and identification of compounds of binary mixture (one liquid and one solid) using the chromatography, chemical tests and spectroscopic methods.

2. Preparation of organic compounds (Double stage) At least eight preparations involving the following representative reactions

a. p-bromo acetanilide from aniline (acetylation and bromination).
b. acetyl salicylic acid from methyl salicylate (hydrolysis and acetylation).
d. p-nitroaniline from acetanilide (nitration and hydrolysis).
e. benzillic acid from benzoin (rearrangement).
f. p-amino benzoic acid from p-nitro toluene (oxidation and reduction).
g. benzanilide from benzophenone (rearrangement).
h. p-bromoaniline from acetanilide (bromination and hydrolysis).
i. m-nitroaniline from nitrobenzene (nitration and reduction).
j. 1, 2, 4-triacetoxy benzene from hydroquinone (oxidation and acylation).

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Laboratory Manual of Organic Chemistry: R K Bansal Wiley-Eastern Ltd., London
2. Vogels Textbook of Practical Organic Chemistry: B S furniss, A J Hannaford, P W G Smith and A R Tatchell ELBS with Longman, Longman Singapore Publishers Pvt Ltd, Singapore
3. Systematic Identification of Organic Compounds: R L Shriner and R C Fuson John Wiley and Sons, New York

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Physical Chemistry Lab –II **Sessional Marks: 15**
Paper Code: CHEM6208 **Practical Exam Marks: 35**
Practical: 5 **Total Marks: 50**
Credits: 2.5

List of Experiments:

1. Chemical Kinetics

a. To study the kinetics of iodination of acetone.
b. To study the kinetics of a second order reaction (saponification of ethyl acetate).
c. To study the distribution of benzoic acid between benzene and water.
d. Determine the equilibrium constant of reaction $KI + I_2 = KI_3$ by distribution law
e. To study the kinetics of acid hydrolysis of ester to compare of strengths of acids.
f. To study the kinetics of acid hydrolysis of ester to determine of energy of activation (Ea).

2. Spectrophotometry

a. Verification of Beer-Lambert's law and determination of pKa of an indicator, spectrophotometrically.
b. Spectrophotometric determination of pKa of an indicator in micellar and microemulsion media.
c. Absorption spectra of conjugated dyes.
d. To study the complex formation between Ni(II) ions and 1,10–Phenanthroline.
e. Determination of the stability constant of the complex formed between Cu(II) ions and 5- sulphosalicylic acid between pH 3-5 by colorimetric method and hence to calculate the free energy of formation of the complex.

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Findlay's Practical Physical Chemistry: B P Levitt (eds)
Longman, London
2. Experiments in Physical Chemistry: D P Shoemaker, C W Garland and J W Nibler
McGraw Hill, New York
3. Experimental Physical Chemistry: V D Athawala and P Mathur
New Age International, New Delhi
4. Advanced Practical Physical Chemistry: J B Yadav
Krishna Pakashan Media Pvt. Ltd, Meerut
5. Advanced Experimental Chemistry Vol. I.: J N Gurtur and R Kapoor,
S Chand and Co. Ltd., New Delhi

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences Department of Chemistry MSc Chemistry

Course Code: B502

Course Title: Inorganic Chemistry Lab–III
Paper Code: CHEM6203
Practical: 5
Credits: 2.5

Sessional Marks: 15
Practical Exam Marks: 35
Total Marks: 50

List of Experiments:

1. Semi-micro qualitative analysis of a mixture containing two common and two rare cations.

2. Estimation of copper, ferric, nickel, chromium and manganese using photoelectric colorimeter.

3. Preparation of $Co(acac)_3$, its characterization using NMR, IR, UV-Vis and analysis of Cobalt.

4. Preparation of cis- and trans- Potassiumdioxalatodiaquachromate(III), $K[Cr(C_2O_4)_2(H_2O)_2]$.
   a) Prepare cis- and trans- isomers.
   b) Record and interpret the electronic absorption spectra of the two isomers and assign the observed transitions.
   c) Analyse any of the isomers for oxalate by titration against standardized permanganate.

5. Synthesis and characterization of the Ni(II) complex of a schiff-base ligand derived from salicylaldehyde and ethylenediamine.
   a) Synthesis the schiff-base lignad.
   b) Interpret the ^1H NMR and IR spectra of the ligand.
   c) Synthesis the Ni(II) complex of the ligand and compare its IR spectrum with that of the ligand

6. Separation of the metal cations by
   a) Column chromatography with gradient elution Co(II) and Ni(II). Analyse qualitatively the colored fractions collected for separated cations.
   b) Paper chromatography [Fe(II), Co(II), Ni(II) and Cu(II). Determine the Rf values for the separate standard cations and use these to identify the cations present in the unknown mixture.

7. Quantitative estimation involving volumetric (redox and complexometry), gravimetric and spectrophotometric methods of constituents in three component mixtures/ and alloys.

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Faculty of Physical Sciences
Department of Chemistry
MSc Chemistry
Course Code: B502

Text/Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis:
   J Mendham, R C Danney, J D Barnes, M Thomas and B Sivasankar Pearson Education, Chennai
2. Practical Inorganic Chemistry: G Marr and B W Rockett Van Nostrand Reinhold Company, London
3. The Analysis of Minerals and Ores of the Rarer Elements, W R Schoeller and A R Powell Charles Griffin and Company Ltd., London

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
MSc Chemistry
Course Code: B502

Course Title: Organic Chemistry Lab –III **Sessional Marks: 15**
Paper Code: CHEM6206 **Practical Exam Marks: 35**
Practical: 5 **Total Marks: 50**
Credits: 2.5

List of Experiments:

Quantitative Analysis of Organic Compounds:

1. Estimation of phenol/aniline using bromate-bromide solution.
2. Determine the number of hydroxyl and amino groups in the given sample by the acetylation method.
3. Determination of mol. wt. of the given ketone by using 2, 4-DNP method.
4. Estimation of reducing sugar by fehling solution method.
5. Determination of the saponification value of the given fat or oil sample.
6. Determination of the iodine number of the given fat or oil sample.
7. Estimation of pesticides
8. Expt. on Hammett equation
9. Estimation of Amino acids
10. Colorimetric estimation of Dyes
11. Estimation of formalin.
12. Estimation of un-saturation

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. An Introduction to Modern Experimental Organic Chemistry:
   R M Roberts, J C Gilbert, L B Rodewald and A S Wingrove Holt Ranehart and Winston Inc New York
2. Introduction to Organic Laboratory Techniques–A Contemporary Approach:
   D L Pavia, G M Lampmana and G S Kriz W B Saunders Company, Philadelphia, London
3. Laboratory Experiments in Organic Chemistry: R Adams, J R Johnson and C F Wilcox
   The Macmillan Limited, London
4. Vogels Textbook of Practical Organic Chemistry: B S furniss, A J Hannaford, P W G Smith and A R Tatchell
   ELBS with Longman, Longman Singapore Publishers Pvt. Ltd, Singapore

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
MSc Chemistry
Course Code: B502

Course Title: Physical Chemistry Lab –III **Sessional Marks: 15**
Paper Code: CHEM6209 **Practical Exam Marks: 35**
Practical: 5 **Total Marks: 50**
Credits: 2.5

List of Experiments:

1. **Conductance:** To determine the equivalent conductance of weak electrolyte acetic at infinite dilution using Kohlrausch law.
   Determine equivalent conductance of strong electrolyte at several concentrations and hence verify onsagars equation.
   Determine equivalent conductance of weak electrolyte(acetic acid) at different concentrations and hence test validity of Oswald's dilution law. Also determine dissociation constant of the electrolyte.

2. **Potentiometry:** To determine dissociation constant of a dibasic acid potentiometrically.
   To determine the pH of a buffer solution (pH less than 8) using a quinhydrone electrode.
   To determine the pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence determine the dissociation constant of the acid. Titrate potentiometrically Zn (II) by K_4 Fe (CN) $_6$ and verify the composition of the complex K_2Zn_3 $[Fe(CN)_6]_2$.

3. **Spectrophotometry:** To study complex formation between Fe (III) and salicylic acid and find out the formula of the complex spectrophotometrically.
   To determine the formula of the complex ion formed between Fe (III) and thiocyante ion by Job's method.
   To study the kinetics of hydrolysis of crystal violet spectrophotometrically. Determination of nitrite in water spectrophotometrically.

4. **Turbiditymetery:** Determination of molecular weight of polymers by turbiditymetery. Determine concentration of sulphate ions with the help of turbidity meter. Determine the CMC by turbidimetric method.

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Findlay's Practical Physical Chemistry: B P Levitt (eds)
   Longman, London
2. Experiments in Physical Chemistry: D P Shoemaker, C W Garland and J W Nibler
   McGraw Hill, New York.
3. Experimental Physical Chemistry: V D Athawala and P Mathur
   New Age International, New Delhi.
4. Advanced Practical Physical Chemistry: J B Yadav,
   Krishna Pakashan Media Pvt Ltd., Meerut
5. Advanced Experimental Chemistry Vol. I., J N Gurtur and R Kapoor
   S Chand and Co. Ltd., New Delhi

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Bioinorganic Chemistry -V
Paper Code: CHEM6210
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: Study material incorporated in this course will enable the students to

- acquire basic knowledge of the essential and trace elements in biological systems and their functions.
- understand the concept of toxicity and detoxification due to transition metal ions.

Course Contents:

Unit 1: Metals in biological systems

Role of metal ions in biological systems; Ionophores; Active transport of catins across membranes; Sodium pump; Calcium carriers; Role of calcium in blood clotting and hormone release.

Unit 2: Oxygen carriers and nitrogen fixation

Heme proteins: Structure and function of hemoglobin and myoglobin; Model compounds for oxygen carriers; Nitrogenases and its model compounds; Metal dinitrogen complexes; Photosynthesis

Unit 3: Metalloenzymes

Carboxypeptidase A; Carbonic anhydrase, catalases and peroxidases; Superoxide dismutase; Coenzymes and its reactions

Unit 4: Metals in medicines

Various inorganic compounds as drugs; Platinum metal complexes as anticancer drugs; Metal complexes as anti-material and antiviral agents; Lithium drugs; Antithyroid drugs.

Unit 5: Metal toxicity

Toxicity due to transition metal ions; Heavy metal toxicity; Detoxification of heavy metals; Uses and abuses of selenium toxicity.

Unit 6: Ligand therapy

Carcinogenic ligands: Carcinostatic ligands; Thiosemicarbazones as anticancer drugs; Antiviral activity of chealing drugs; Aspirin.

Text/Reference Books:

1. Metallo-Organic Chemistry: A J Pearson
John Wiley and Sons, New York
2. Principles of Bioinorganic Chemistry: S J Lippard and J M Berg
University Science Books, California

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organic Chemistry-V
Paper Code: CHEM6213
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: Study of the topics included in this course will enable the students to

- build a basic knowledge of the general classification of natural products and their isolation.
- appreciate the developments regarding terpenoids and vitamins.
- understand the structure, synthesis and biosynthesis of common alkaloids.
- learn about isolation and study of important constituents of essential oils and aromatics.

Course Contents:

Unit 1: Terpenoids

Classification, nomenclature, occurrence and general methods of structural determination; Isoprene rule, structure determination, stereochemistry and synthesis of Citral, Farnesol, Zingibrene, Santonin, α-Cadinene, Camphor and Abietic acid, Biogenetic pathways and Biosynthesis.

Unit 2: Alkaloids

Classification, occurrence, general methods of isolation and structure elucidation. Structure, stereochemistry, synthesis, biosynthesis of the following: Papavarine, Nicotine, Quinine, Morphine, Lysergic acid and Reserpine.

Unit 3: Steroids

Occurrence and general methods of isolation. Structure elucidation and synthesis of Cholesterol, Bile acids.

Unit4: Hormones

Structure elucidation of Oestrogen, Testosterone, Progesterone, Oestrone and synthetic non steroidal Oestrogens. Structure elucidation and synthesis of Adrenaline and Thyroxine.

Unit 5: Antibiotics

Structure elucidation of Penicillin, Chloramphenicol, Streptomycin and Tetracycline.

Unit 6: Prostaglandins

Classification, physiological effects and synthesis of PGE_2 and $PGF_2\alpha$.

Text / Reference books

1. Natural products- Chemistry and biological significance by J.Mann, R.S.Davidson, J.B.Hobbs, B.V.Banthrope and J.B.Harborne.
2. Organic Chemistry by I.L.Finar.
3. Rodds chemistry of Carbon compounds by S. Coffey.
4. New trends in Natural Products Chemistry by Atta- ur- Rehman, M.I.Choudhary.
5. The Chemistry of Natural Products by P.S.Kalsi.
6. Chemistry of Natural Products by Nakamshi.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Physical Chemistry-V (Electrochemistry)
Paper Code: CHEM6216
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: The content matter incorporated in this course is based on emerging technologies in the field of chemical sciences which will help students to

- learn about electric and magnetic properties of molecules.
- acquire knowledge about electrochemistry of solutions and their applications.
- understand about fuel cells.

Course Contents:

Unit1: The Electric and magnetic properties

Electric properties of molecules; Permanent and induced electric dipole moments; Intermolecular forces; Interactions between dipoles: Repulsive and total interactions; Paramagnetic and diamagnetics; Magnetic susceptibility; Gouy balance; Permanent magnetic moment; Induced magnetic moments.

Unit 2: Electrochemistry of Solutions -I

Ion-solvent interactions; Born model; Electrostatic potential at the surface of a charged sphere; Born expression for the free energy of ion-solvent interactions; Structural treatment of ion-solvent interactions; Ion-dipole moment; evaluation in the ion-dipole approach to heat of salvation; solvation number; static and dynamic pictures of ion-solvent interactions; hydration number; dielectric constant of water and ionic solutions; Relation between dielectric constant and internal counter fields.

Unit 3: Electrochemistry of solutions -II

Debye equation for dielectric constants between dipoles ; Dielectric constant of liquids containing associated dipoles; Ion – solvent non electrolyte interactions; Change in solubility of non-electrolyte due to primary and secondary solvations.

Unit 4: Dynamic electrochemistry

Electrochemical cell reactions; Nernst equation; The rate of charge transfer; The activation Gibb's energy; Butler – Volume equation; Low and high overpotential limits; Polarization; Electrode kinetics; Electrical double layer; Electrode/electrolyte interface.

Unit 5: Applications of electrochemistry

The maximum intrinsic efficiency; Actual efficiency and current - potential relation in an electrochemical energy converter; Factors influencing the electrochemical energy conversion; The power output of an electrochemical energy converter; Amperometric titrations: Determination of activation energy for an irreversible electrode process.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Unit 6: Fuel cells

Electrochemical electricity generators (fuel cells): Brief idea about H_2- O_2, hydrocarbon - air and CO -air fuel cells. Electricity storage: Electricity storage density, energy density and power; Desirable conditions for an ideal storer; Storage of electricity using the lead- acid battery, dry cell, silver-zinc cell and sodium- sulfur cell.

Text/Reference Books:

1. Modern Electrochemistry Vol 2: J O'M Bockris
   Plenum Press, New York
2. Physical Chemistry: P W Atkin
   Oxford University Press, Oxford

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Inorganic Chemistry-VI (Chemistry of Materials)
Paper Code: CHEM6211
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: The content matter incorporated in this course is based on emerging technologies in the field of chemical sciences which will help students to

- learn about synthesis , properties and structural characterization of glasses, ceramics and refractiries.
- acquire knowledge about liquid crystals and their applications.
- Understand the preparation techniques for thin films and langmuir -blodgett films

Course Contents:

Unit 1: Magnetic materials

Introduction, structure and classification; Hard and soft ferrites; Synthesis of ferrites by precursor and combustion method; Characterization of ferrites by mossbauer spectroscopy; Significance of hysteresis loop and saturation magnetization in ferrites; Magnetic properties and applications of ferrites.

Unit 2: Glasses, ceramics and composites

Glassy state; Glass formers and glass modifiers and their applications; Ceramic structures; Mechanical properties of clay products; Characterizations, properties and applications of refractories.
Microscopic composites: Dispersion-strengthened and particle-reinforced and fibre-reinforced composites; Macroscopic composites.

Unit 3: Thin films and Langmuir -Blodgett films

Preparation techniques: Evaporation/sputtering, chemical processes, MOCVD, sol-gel etc; Langmuir-Blodgett (LB) film: Growth techniques and photolithography; Properties and applications of thin and LB films.

Unit 4: Liquid crystals

Mesmorphic behaviour; Thermotropic liquid crystals; Positional order, bond orientational order; nematic and smectic mesophases; smectic - nematic transition and clearing temperature - homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smectic A and smectic C phases; Optical properties of liquid crystals; Dielectric susceptibility and dielectric constants; Lyotropic phases and their description of ordering in liquid crystals.

Unit 5: Ionic conductors and high Tc materials

Types of ionic conductors; Mechanism of ionic conduction; Interstitial jumps (Frenkel); Vacancy mechanism; Diffusion superionic conductors; Phase transitions and mechanism of conduction in superionic conductors; Examples and applications of ionic conductors. Defect perovskites; High Tc materials; Superconductivity in cuprates; Optical phonon modes; Superconducting state; Applications of high Tc materials.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Unit 6: Opto electronic materials

Luminescence; Phosphor materials: Zn- S type, Lanthanide doped phosphors; Long persistant phosphors; LED materials: Applications of phosphors; Metal complexes as light emitters; Organic light emitting diodes and their applications.

Text/Reference Books:

1. Solid State Physics: N W Ashcroft and N D Mermin
   Saunders College Philadelphia, U S A
2. Material Science and Engineering-An Introduction: W D Callister
   Wiley, New York
3. Principles of the Solid State: H V Keer
   Wiley Eastern Ltd., New Delhi
4. Materials Science: J C Anderson, K D Leaver, J M Alexander and R D Rawlings,
   Chapman and Hall, London
5. Thermotropic Liquid Crystals: G W Gray (Eds.)
   John Wiley and Sons, New York
6. Handbook of Liquid Crystals: H Kelker and R Hatz
   Chemie Verlag, Weiheim
7. Ferrite Materials: V R K Murthy and B Viswanathan
   Sprniger Verlag, Berlin

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organic Chemistry-VI
(Advanced synthetic methods and Stereochemistry)
Paper Code: CHEM6214
Lectures: 4 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 6s0
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: Study of the subject matter incorporated in this course will enable the students to

- build an advanced knowledge about optical and geometrical isomerism exhibited by organic molecules.
- understand the chemistry of regioselective and stereoselective synthesis.
- learn about the techniques to plan retrosynthesis.

Course Contents:

Unit 1: Stereochemistry

Definition and classification into optical and geometrical isomerism; Projection formulae: Fischer, flying wedge, sawhorse and newman projection formulae; Notation of optical isomers: D-L notation, Cahn-Ingold-Prelog rules, R-S notations for optical isomers with one and two asymmetric carbon atoms, erythro and threo representations; Optical isomerism: optical activity, optical and specific rotations ; Characterstics of enantiomers; Conditions for optical activity: Asymmetric centre , chirality , achiral molecules, meaning of (+) and (-),elements of symmetry; Characterstics of diastereomers; Optical activity in compounds not containing asymmetric carbon atoms- Allenes, spirans, biphenyls; Racemisation: Methods of racemisation (by substitution and tautomerism); Resolution: Methods of resolution (mechanical, seeding, biochemical and conversion to diastereoisomers); Asymmetric synthesis (partial and absolute synthesis); Determination of absolute configuration; Synthesis of optically active compounds.

Unit 2: Geometrical isomerism

Geometrical isomerism : cis-trans, syn-anti and E-Z notations ; Determination of configuration of geometrical isomers; Interconversion of geometric isomers; Stereochemistry of cycloparaffins; Optical and geometrical isomerism in nitrogen compounds; Stereochemistry of sulphur phosphorous and arsenic compounds.

Unit 3: Selective synthetic methods-I

Need for protection of functional groups during chemical reactions: Protection of hydroxyl, mercapto, amino, carbonyl and carboxylic groups; Regioselective synthesis; Halogenation of alkanes; Ambident nucleophiles; Regiospecific synthesis: Reductions using Baker's yeast.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Unit 4: Selective synthetic methods-II

Stereo selective reaction: Bromination of dicarboxyacetylene, Shaarpless asymmetric epoxidation, synthesis of 2-butanol by using diisopinocampeylborane; Stereospecific reaction: Bromination of fumaric and maleic acids.

Unit 5: Retro synthesis-I

An introduction to retrosynthesis ; Synthon, synthetic equivalent and target molecule; Functional group inter-conversion; Linear and convergent method in organic synthesis; Disconnection approach: One group disconnection.

Unit 6: Retro synthesis–II

Two group disconnection : -1,2 -1,3 -1,4 -1,5- and 1,6-dioxygenated skeletons and dicarbonyls; Retro synthesis of alcohols; Retro Diels – Alder reaction; Retro synthesis of olefins, aliphatic and aromatic ketones; Protective groups in organic synthesis.

Text/Reference Books:

1. Stereochemistry of Organic Compounds-Principles and Applications: D Nasipuri
   New Age International (P) Ltd., New Delhi
2. Stereochemistry: P S Kalsi
   Wiley Eastern Limited, New Delhi
3. Organic Reaction Mechanisms: R K Bansal
   New Age International (P) Ltd., New Delhi
4. Advanced Organic Chemistry Part A: FA Carey and R J Sunberg
   Plenum, New York
5. Some Modern Methods in Organic Synthesis: W Carruthers
   Cambridge University Press, Cambridge

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Physical Chemistry-VI (Surface Chemistry)
Paper Code: CHEM6217
Lectures: 3 Tutorial: 1
Credits: 4.5

Sessional Marks: 30
Theory Paper Marks: 60
Total Marks: 100
Duration of Examination: 3Hrs

Course Objective: The content matter incorporated in this course is based on emerging technologies in the field of chemical sciences which will help students to

- acquire knowledge about different polymers, their stereochemistry and methods to determine their molecular weight
- acquire knowledge about phenomena of adsorption and role of surface active agents in facilitating adsorption .
- understand the theory and types of emulsions.

Course Contents:

Unit 1: Adsorption

Surface tension; Capillary action; Pressure difference across curved surface (Laplace equations); Vapor pressure of droplets (Kelvin equation); Gibbs adsorption isotherm; Estimation of surface area (BET equation); Surface films on liquids (Electro-kinetic phenomena).

Unit 2: Micelles

Surface active agents; Classification of surface active agents; Micellization; Hydrophobic interactions; Critical micelle concentration (CMC); Factors affecting CMC of surfactants; Counter ion binding to micelles; Thermodynamics of micellization – phase separation and mass action models; Solubilization; Reverse micelles.

Unit 3: Emulsion

Types of emulsion; Theories of emulsion and emulsion stability; Identification of emulsion types; Inversion emulsion; Microemulsions : Theory and application.

Unit 4: Solid - solid interfaces

Surface energy of solids; Adhesion and adsorption; Sintering and sintering mechanism; Tammann temperature and its importance; Surface structure and surface composition; Catalytic activity at surfaces.

Unit 5: Polymers-I

Classification of polymers and polymerization; Condensation and addition polymers; Kinetics of condensation polymerization; Size distribution in linear condensation polymers; Molecular size control; Degree of polymerization; Mechanism of vinyl radical polymerization; Molecular weight and its determination by osmometry, viscometry, light scattering and sedimentation method; Effect of temperature and pressure on chain polymerization; Stereochemistry of polymer chain and stereo regular polymerization.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Unit 6: Polymers-II

Kinetics of cationic, anionic and copolymerization; Criteria for polymer solubility; Mass number and mass average molecular weight; Statistical method of biopolymers: Chain configuration of polymer chains; Statistical distribution of end to end dimensions**;** Influence of bond angle restriction and radius of gyration; Thermodynamics of biopolymer solution (entropy of mixing and liquid state model along with limitation); Free volume theory; Heat and free energy of mixing; Crystalline melting point T_m -melting point of homogenous series; Effect of chain flexibility and steric factors; Entropy and heat of fusion; The glass transition temperature, T_g; Relationship between T_m and T_g.

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Text/Reference Books:

1. Physical Chemistry, P W Atkins
   Oxford University Press, Oxford
2. Textbook of polymer science, F W Billmeyer
   John Wiley and Sons, New York
3. Polymer Science: V R Gowariker, N V Viswanathan and J Sreedhar
   Wiley-Eastern, New Delhi

Note: The question paper will have seven questions in all. First question will be compulsory and will be of conceptual nature covering the entire syllabus. There will be six more questions, one from each unit and the candidate will be required to attempt any four questions out of these six questions. All questions will carry equal marks.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Inorganic Chemistry Lab –IV **Sessional Marks: 15**
Paper Code: CHEM6212 **Practical Exam Marks: 35**
Practical: 5 **Total Marks: 50**
Credits: 2.5

Preparation and characterization of at least eight compounds selected from the list given below. Characterization may include microanalysis, magnetic susceptibility, conductance measurements spectroscopicmethods.

1. Reinecke salt
2. Tris (oxalate) manganese (III)
3. Tetrapyridinesilver (II) peroxidisulphate,
4. Tris (acetylacetonato) iron (III)
5. Bis (N, N-diethyldithiocarbamato) nitrosyliron(I)
6. Optical isomers of tris (ethylenediamine) cobalt(III)chloride
7. Linkage isomers of nitro and nitritopentammine cobalt (III) chloride
8. Ferrocene or dibenzene chromium
9. Potassium trioxalatoaluminate (III).
10. Trithioureacopper (I) chloride.
11. Trithioureacopper (I) sulphate.
12. Dibenzyltin dichloride
13. Tri(acetylacetonato)manganese(III)
14. Tetramminecopper (II) sulphate.
15. Potassium trioxalatochromate (III)
16. Hydridochlorocarbonyl tris(triphenylphosphine)ruthenium(II)
17. Tris(2,2'-bipyridine)ruthenium(II) perchlorate
18. $[(p\text{-(cymene)}\ RuCl_2]_2$

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis:
   J Mendham, R C Danney, J D Barnes, M Thomas and B Sivasankar Pearson Education, Chennai
2. Practical Inorganic Chemistry: G Marr and B W Rockett
   Van Nostrand Reinhold Company, London
3. Practical Inorganic Chemistry, G Pass and H Sutcliffe
   Chapman and Hall, London
4. Instrumental Methods of Analysis, H H Willard, L L Merrit and J A Dean
   East-West Press Pvt. Ltd., New Delhi

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Organic Chemistry Lab –IV **Sessional Marks: 15**
Paper Code: CHEM6215 **Practical Exam Marks: 35**
Practical: 5 **Total Marks: 50**
Credits: 2.5

List of Experiments:

Multistep Organic Synthesis

1. Synthesis of 2-chloro-4-bromoaniline from aniline (Bromination and chlorination)
2. Synthesis of methyl orange from aniline (Aromatic electrophilic substitution and diazocoupling).
3. Synthesis of benzpinacol and its pinacolone rearrangement.
4. Synthesis of o-chlorobenzoic acid from phthalimide(Hofmann bromamide andSandmeyer's reaction).
5. Synthesis of acridone from o-chlorobenzoic acid. (Hofmann bromamide andSandmeyer's reaction).
6. Synthesis of 2,4-dinitrophenyl hydrazine from chloro benzene. (Electrophilic and nucleophilic substitution reactions on aromatic ring).
7. Synthesis of triphenylcarbinol from bromobenzene. (Grignard reaction)
8. Synthesis of 1,3,5-tribromobenzene from aniline (bromination, diazotization and hydrolysation).
9. Conversion of oxime to amide (Beckmann rearrangement) and oxazole
10. Synthesis of cyclohexene from cyclohexanol and its conversion to 1, 2- cis and1, 2- trans – cyclohexanediols.
    a. Epoxidation with peracid (cycloaddition) and anti- ring opening with sodium hydroxide to cis-cyclohexane -1, 2- diol.
    b. Dihydroxylation with $KMnO_4$

(Mechanism of syn- and anti-cyclohexane-1, 2-diol)

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. An Introduction to Modern Experimental Organic Chemistry:
   R M Roberts, J C Gilbert, L B Rodewald and A S Wingrove Holt
   Ranehart and Winston Inc., New York
2. Introduction to Organic Laboratory Techniques – A Contemporary Approach:
   D L Pavia, G M Lampmana and G S Kriz
   W B Saunders Company, Philadelphia, London
3. Laboratory Experiments in Organic Chemistry: R Adams, J R Johnson and C F Wilcox
   The Macmillan Limited, London
4. Vogels Textbook of Practical Organic Chemistry:
   B S Furniss, A J Hannaford, P W G Smith and A R Tatchell
   ELBS with Longman, Longman Singapore Publishers Pvt. Ltd, Singapore
5. Modern Projects and Experiments in Organic Chemistry: J R Mohrig, C N Hammonad, P F Schatz and TC Morrill
   W H Freeman and Company, New York

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Physical Chemistry Lab –IV **Sessional Marks: 15**
Paper Code: CHEM6218 **Practical Exam Marks: 35**
Practical: 5 **Total Marks: 50**
Credits: 2.5

List of Experiments:

1. Adsorption

a. Adsorption of oxalic acid/Acetic acid on charcoal using freundlich isotherm.

2. Cryoscopy

a. To determine molecular weight and state of benzoic acid in benzene.
b. To determine transport of H^+ ions by using moving boundary method.

3. Amperometry

a. To determine unknown concentration of iodine using amperometry.

4. Surface tension

a. Compare the cleansing powers of samples of two detergents from surface tension measurements.

5. Phase Equilibrium

a. Study of phase diagram of two components forming a simple eutectic.
b. Study of phase diagram of two compounds forming a compound.
c. Study of phase diagram of three components system.

6. Refractometry

a. Determination of molecular radius of molecule of organic compound.
b. Determine the specific refraction, molar refraction and atomic parachor with the help of Abbe's refractometer.
c. To determine the specific and molar refractivity of n-propanol, n- butanol, hexane and carbon tetrachloride and calculate refraction equivalents of C, H and Cl.
d. Determine the molar refraction of a solid substance by dissolving it in a solvent.

(Note: A candidate has to perform at least ten experiments in the lab. Any suitable experiment may be added.)

Text/Reference Books:

1. Findlay's Practical Physical Chemistry: B P Levitt (eds)
   Longman, London
2. Experiments in Physical Chemistry: D P Shoemaker, C W Garland and J W Nibler
   McGraw Hill, New York
3. Experimental Physical Chemistry: V D Athawala and P Mathur
   New Age International, New Delhi
4. Advanced Practical Physical chemistry, J B Yadav,
   Krishna Pakashan Media Pvt Ltd., Meerut
5. Advanced Experimental chemistry Vol. I., J N Gurtur and R Kapoor,
   S Chand and Co. Ltd., New Delhi

Note: The end semester practical examination, including viva-voce, shall be held jointly by the teacher taking the laboratory course (called internal examiner) and an external examiner appointed by the Controller of Examinations.

Faculty of Physical Sciences
Department of Chemistry
M Sc Chemistry
Course Code: B502

Course Title: Project **Internal Marks: 50**
Paper Code: CHEM6219 **External Marks: 100**
Credits: 7.5 **Total Marks: 150**

1. Topic of the project would be decided by the Supervisor himself. However, it would be among one of the thrust areas out lined by the Department of Science and Technology (DST) and related to the industry.
2. The supervisor, after the extensive survey and in collaboration with industry (if possible) shall state the problem for the M. Sc. Dissertation.
3. M. Sc. Student shall devote his time for solving this problem (which ultimately may be published as research work.)
4. Project title and/or problem would be such that it can be extended at Ph. D level (if the student whishes to pursue his Ph. D.)
5. Finally, the project report would be submitted in the form of M. Sc. Dissertation

OR

Course Title Organic Chemistry VII **Sessional Marks: 30**

Paper Code: CHEM6222 **Theory Paper Marks: 60**

Lectures: 4 **Tutorial: 1** **Total Marks: 100**

Credits: 4.5 **Duration of Examination: 3Hrs**

Course Contents:

Unit 1: Vitamins

Structure and synthesis of Vitamins A, B_1, B_2, B_6, C, D, E, Nicotinic acid, Pantothenic acid and Biotin.

Unit 2: Carotenoids

General methods of structure elucidation and synthesis of α-carotene, β-carotene, γ-carotene, lycopene .Biosynthesis of Carotenoids.

Unit 3: Porphyrins

Structure, special properties and synthesis of Porphyrins and Haemin. Structure of Chlorophyll (without synthesis).

Unit 4: Plant pigments

Occurrence, general chemical and spectroscopic methods for structure determination. Structure elucidation and synthesis of Flavone, Chrysin, Flavonol, Quercetin, Diadazin, Xanthone, Euxanthone, Cyanidin chloride, Malvidin chloride, Hirsudin chloride. Biosynthesis of Flavonoids: Acetate pathway and Shikimic acis pathway.

Unit 5: Enzymes and Co- enzymes

(a) Introduction to biological catalysis, nomenclature, classification and specificity. Kinds of reactions catalysed by enzymes: Oxidation- reduction, isomerisation, epimerization, hydrolysis, phosphorilation, acylation, methylation, decarboxylation and dehydration.

(b) Chemistry of co- enzymes, Co-I, Co-II, Co-A, Co-carboxylase, FMN, FAD and Pyridoxal phosphate.

Text/ Reference Books

1. Bioinorganic Chemistry: A Chemical Approach to Enzyme Action by Herman Duags and C.Penny.
2. Understanding Enzymes by Trevor Palmer.
3. Enzyme Chemistry, Impact and Applications by Ed. Collin J. Suckling.
4. Enzyme Mechanisms Ed, M.I.Page and A,Williams.
5. Fundamentals of Enzymology by N.C. Price and L.Stevens.
6. The Chemistry of Natural Products by P.S.Kalsi.
7. Organic Chemistry by I.L.Finar.

AND

Course Title: Organic Chemistry Lab- V **Sessional Marks: 15**

Paper Code: CHEM 6223 **Practical Exam Marks: 35**

Practical: 6 **Total Marks: 50**

Credits: 3

Qualitative analysis:

Identification of Organic Compounds using spectroscopic methods (UV, IR, NMR & Mass) followed by characterization by chemical methods.

Books recommended:

1. Experiments and Techniques in Organic Chemistry by D.Pasto, C.Johnson and M.Miller.
2. Systematic Qualitative Organic Analysis by H.Middleton.
3. Vogel's Text Book of Organic Chemistry by A.R.Tatchell.

Hand Book of Organic Analysis- Qualitative and Quantitative by H.Clark