SYLLABUS

FOR M.Sc. CHEMISTRY
(SEMESTER SYSTEM)

DEPARTMENT OF CHEMISTRY
SHOOLINI UNIVERSITY, BAJH OL, SOLAN, H.P
INDIA

OBJECTIVE OF THE COURSE
Syllabus M. Sc. (Chemistry)

The syllabus pertaining to M.Sc. (2 Year Course) Chemistry has been upgraded to teach the fundamental concepts of Chemistry and their applications as per provision of the UGC module and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

**M.Sc. Chemistry spread over four semester (I-IV) for the session 2010-11 and onwards**

**TOTAL CREDIT HOURS = 60**

**SEMESTER –I**

<table>
<thead>
<tr>
<th>Course No</th>
<th>Title</th>
<th>Credits Hours</th>
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<tbody>
<tr>
<td>Chem I-511</td>
<td>INORGANIC CHEMISTRY-I Group Theory &amp; Non Aqueous Solvent</td>
<td>3+1</td>
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<tr>
<td>Chem O-511</td>
<td>ORGANIC CHEMISTRY-I Organic Reaction Mechanism-I and Stereochemistry</td>
<td>3+1</td>
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<tr>
<td>Chem P-511</td>
<td>PHYSICAL CHEMISTRY-I Spectroscopy &amp; Kinetics</td>
<td>3+1</td>
</tr>
<tr>
<td>Chem Maths-511</td>
<td>MATHMATICS FOR CHEMISTS (For Medical students)</td>
<td>3 +0</td>
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**OR**

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<tr>
<th>Course No</th>
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<tbody>
<tr>
<td>Chem Bio – 511</td>
<td>CHEMISTRY OF LIFE (For Non Medical students)</td>
<td>3+0</td>
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**SEMESTER –II**

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<tr>
<th>Course No</th>
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<tbody>
<tr>
<td>Chem I-521</td>
<td>INORGANIC CHEMISTRY-II Metal Ligand Bonding &amp; Magnetochemistry</td>
<td>3+1</td>
</tr>
<tr>
<td>Chem O-521</td>
<td>ORGANIC CHEMISTRY-II Organic Reaction Mechanism-II and Pericyclic Reactions</td>
<td>3+1</td>
</tr>
<tr>
<td>Chem P-521</td>
<td>PHYSICAL CHEMISTRY-II Thermodynamics &amp; Electrochemistry -I</td>
<td>3+1</td>
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<tr>
<td>Chem -529</td>
<td>MODERN TECHNIQUES OF CHEMICAL ANALYSIS</td>
<td>2+2</td>
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### SEMESTER –III

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<tr>
<th>Course No</th>
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<th>Credits Hours</th>
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<tbody>
<tr>
<td>Chem I-531</td>
<td>INORGANIC CHEMISTRY-III Analytical &amp; Nuclear chemistry</td>
<td>3+1</td>
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<tr>
<td>Chem O-531</td>
<td>ORGANIC CHEMISTRY-III Spectroscopy and Photochemistry</td>
<td>3+1</td>
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<tr>
<td>Chem P-531</td>
<td>PHYSICAL CHEMISTRY-III Statistical &amp; Introductory Quantum</td>
<td>3+1</td>
</tr>
<tr>
<td>Chem I-539</td>
<td>INORGANIC CHEMISTRY – Inorganic Photochemistry &amp; Electronic Spectra of Coordination Compounds</td>
<td>4+0</td>
</tr>
<tr>
<td>Chem O-539</td>
<td>Bio - Organic Chemistry Special Theory - I</td>
<td>4+0</td>
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<tr>
<td>Chem P-539</td>
<td>PHYSICAL CHEMISTRY Adsorption &amp; Electrochemistry</td>
<td>4+0</td>
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<tr>
<td>Chem I-591</td>
<td>SEMINAR (Inorganic chemistry)</td>
<td>1+ 0</td>
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<tr>
<td>Chem O-591</td>
<td>SEMINAR (Organic chemistry)</td>
<td>1+ 0</td>
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<tr>
<td>Chem P-591</td>
<td>SEMINAR (Physical chemistry)</td>
<td>1+ 0</td>
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### SEMESTER –IV

#### A. INORGANIC CHEMISTRY SPECILIZATION

<table>
<thead>
<tr>
<th>Course No</th>
<th>Title</th>
<th>Credits Hours</th>
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</thead>
<tbody>
<tr>
<td>Chem I-541</td>
<td>ADVANCED ORGANOMETALLIC</td>
<td>3+0</td>
</tr>
<tr>
<td>Chem I-542</td>
<td>INORGANIC SPECTROSCOPY</td>
<td>3+0</td>
</tr>
<tr>
<td>Chem I-543</td>
<td>BIO-INORGANIC &amp; SUPRAMOLECULAR CHEMISTRY</td>
<td>3+0</td>
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#### B- ORGANIC CHEMISTRY SPECILIZATION

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<tr>
<th>Course No</th>
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<th>Credits Hours</th>
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<tbody>
<tr>
<td>Chem O-541</td>
<td>SYNTHETIC STRAGEY</td>
<td>3+0</td>
</tr>
<tr>
<td>Chem O-542</td>
<td>NATURAL PRODUCTS</td>
<td>3+0</td>
</tr>
<tr>
<td>Chem O-543</td>
<td>MEDICINAL CHEMISTRY</td>
<td>3+0</td>
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#### C- PHYSICAL CHEMISTRY SPECILIZATION

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<tr>
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<th>Title</th>
<th>Credits Hours</th>
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<tbody>
<tr>
<td>Chem P-541</td>
<td>ADVANCED QUANTUM CHEMISTRY</td>
<td>3+0</td>
</tr>
<tr>
<td>Chem P-542</td>
<td>SOLID STATE CHEMISTRY</td>
<td>3+0</td>
</tr>
<tr>
<td>Chem P-543</td>
<td>BIOPHYSICAL CHEMISTRY</td>
<td>3+0</td>
</tr>
<tr>
<td>Chem I-600</td>
<td>PROJECT WORK &amp; INDUSTRIAL VISIT</td>
<td>0+3</td>
</tr>
<tr>
<td>Chem O-600</td>
<td>PROJECT WORK &amp; INDUSTRIAL VISIT</td>
<td>0+3</td>
</tr>
<tr>
<td>Chem P-600</td>
<td>(PROJECT WORK &amp; INDUSTRIAL VISIT (Physical chemistry)</td>
<td>0+3</td>
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In chemistry each practical will at least of 3 hours and can further extended as per the requirement of the experiments.
Note: i. Ten questions will be set by the examiner selecting TWO from each unit. As far as possible every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

ii. Students can ask for Character Tables (except for C2V and C3V point groups) if required.

UNIT-I
Non-Aqueous Solvents: Factors justifying the need of Non Aqueous solution Chemistry and failure of water as a Solvent. Solution chemistry of Sulphuric acid: Physical properties, Ionic self dehydration in H2SO4, high electrical conductance in spite of high viscosity, Chemistry of H2SO4 as an acid, as an dehydrating agent, as an oxidizing agent, as an medium to carry out acid-base neutralization reaction. Liquid BrF3: Physical properties, solubilities in BrF3 , self ionization, acid base neutralization reactions, solvolytic reactions and formation of transition metal fluorides. Chemistry of Molten salts as Non-Aqueous Solvents: Solvent properties, solution of metals, complex formation, Unreactivity of molten salts, Low temperature molten salts.

UNIT-II
Inorganic Hydrides: Classification, preparation, bonding and their applications. Transition metal compounds with bonds to hydrogen, carbonyl hydrides and hydride anions. Classification, nomenclature, Wade’s Rules, preparation, structure and bonding in boron hydrides (boranes),carboranes, metalloboranes and metallocarboranes.

UNIT-III
Organic Reagents in Inorganic Chemistry: Chelation, factors determining the stability of chelates (effect of ring size, oxidation state of the metal, coordination number of the metal); Use of the following reagents in analysis:
(a) Dimethylglyoxime (in analytical chemistry)
(b) EDTA (in analytical chemistry and chemotherapy)
(c) 8-Hydroxyquinoline (in analytical chemistry and chemotherapy)
(d) 1,10-Phenanthroline & Dithiazone (in analytical chemistry)
(e) Thiosemicarbazones (in analytical chemistry and chemotherapy)

UNIT-IV

UNIT-V
Application of Group Theory in Vibrational Spectroscopy: A brief idea about Infrared and Raman scattering spectroscopy. Vibrational modes as basis of group representations w.r.t. SO2, POCl3, PtCl4 and Mutual exclusion principle, Classification of vibrational modes (i.e. stretching and angle deformation vibrations w.r.t. SO2, POCl3 and PtCl4
Books Recommended:

1. Chemical applications of Group Theory – F.A.Cotton
2. Inorganic Chemistry – Durrant and Durrant
3. Symmetry in Chemistry- Jaffe and Orchin
4. Non-aqueous solvents – H.Sisler
5. Non-aqueous solvents – T.C.Waddington
6. Non-aqueous solvents – Logowsky
8. Concise course in Inorganic Chemistry- J.D.Lee
10. Chemistry of Elements – Greenwood and Earnshaw
11. Inorganic Chemistry – T. Moeller
13. Topics in Current Chemistry (Inorganic/Bio-Chemistry)- Vol. 64
Note: Ten questions will be set by the examiner selecting **TWO** from each unit. As far as possible every question will be divided into **Two – Three Parts**. The students shall attempt **FIVE** questions selecting **ONE** from each unit.

UNIT-I
**Reaction Mechanism:** Structure and Reactivity: Thermodynamic and kinetic requirements, Kinetic and Thermodynamic control, Hammonds postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates.

**Effect of structure on reactivity:** resonance and field effects, steric effect. Quantitative treatment: Hammett equation and linear free energy relationship, Substituent and reaction constants, Methods of determining reaction mechanism.

UNIT-II
**Aliphatic Nucleophilic Substitution:** The SN2, SN1, mixed SN1 and SN2, SET mechanisms & SNi mechanism. The neighboring group mechanism, neighboring group participation by π and σ bonds, anchimeric assistance. Non-classical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements-Wagner-Meerwein, Pinacol-Pinacolone and Demjanov ring expansion and ring contraction. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Esterification of carboxylic acid, transesterification, transethification and preparation of inorganic esters. Phase-transfer catalysis, and ultrasound, ambident nucleophile,regioselectivity.

UNIT-III
**(A) Aliphatic Electrophilic Substitution:** Bimolecular mechanisms- SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts, halogenations of aldehydes, ketones, acids and acyl halides. Effect of substrates, leaving group and the solvent system on reactivity. Aliphatic diazonium coupling, Acylation at aliphatic carbon, alkylation of alkene, Stork-enamine reactions

**(B) Free radical reactions:** Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance, Reactivity in aliphatic and aromatic substrates at a bridgehead and attacking radicals. Effect of solvents on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Gomberg Bachmann reaction, Sandmeyer reaction, Hoffmann -Loffler- Freytag reaction, Hunsdiecker reaction.

UNIT-IV
**Nature of Bonding in Organic Molecules:** Delocalized Chemical Bonding: Kinds of molecules with delocalized bond, cross- conjugation, resonance, π-π bonding (ylides). aromaticity: other systems containing aromatic sextet, Aromatic systems with electron number other than six. Huckel rule, other aromatic compounds, hyperconjugation.

**Supramolecular chemistry:** Introduction, Bonding other than covalent bond. Addition compounds, Crown ether complexes and Cryptands, Inclusion compounds, Cyclodextrins, Catenanes and Rotaxenes and their applications.
UNIT-V

**Stereochemistry:** Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity in acyclic and cyclohexane systems. Steric strain due to unavoidable crowding. Elements of symmetry: chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, Optical activity due to chiral planes, Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape. Asymmetric Synthesis: Principle and categories with specific examples of asymmetric synthesis including newer methods involving enzymatic and catalytic reactions, enantio and diastereoselective synthesis.

**Books Recommended:**
SEMESTER-I
(COURSE No –Chem P-511)
(PHYSICAL CHEMISTRY)
SPECTROSCOPY & KINETICS

Credits Hours : 3 + 0

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT - I

UNIT – II

UNIT - III
Kinetics of complex reactions: Reversible / opposing reactions, consecutive / successive reactions, simultaneous side / parallel reactions, chain / free radical reactions viz. thermal (H2 – Br2) and photochemical H2 – Cl2) reactions. Rice – Herzfeld mechanism of dissociation of organic molecules viz. dissociation of ethane, decomposition of acetaldehyde as 3/2 or ½ order reactions. Kinetics of polymerization (molecular and free radical mechanisms). Reaction rates and chemical equilibrium, principle of microscopic reversibility, activation energy and activated complex.

UNIT - IV

UNIT - V
Books Recommended:
1. Chemical Kinetics: K.J. Laidler
3. Modern Chemical Kinetics: H. Eyring
4. Theories of Reaction Rates: K.J. Laidler, H. Eyring and S. Glasston
5. Fast Reactions: J.N. Bradly
6. Fast Reactions in Solutions: Caldin
7. Basic Principles of Spectroscopy: R. Chang
8. NMR and Chemistry: J.W. Akit
9. Introduction to Molecular Spectroscopy: G.M. Barrow
10. Physical Chemistry: P.W. Atkins
11. Fundamentals of Molecular Spectroscopy: C.N. Banwell
Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible every question will be subdivided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT - I
Cartesian coordinates: plane polar coordinates, spherical representation of functions, the complex plane, polar coordinates in trigonometric functions. Differential calculus: functions of single and several variables, partial derivatives, the total derivative, maxima and minima theorem, and simple examples related to chemistry. Concept of normalization, orthogonality and complete set of unit vectors.

UNIT – II

UNIT – III

UNIT – IV

UNIT – V
The Treatment of Experimental Data: Experimental Errors in Measured Quantities Statistical Treatment of Random Errors Data Reduction and the Propagation of Errors Graphical and Numerical Data Reduction Numerical Curve Fitting: The Method of Least Squares (Regression).

Books Recommended:
1. Mathematical Preparation for Physical Chemistry: F. Daniel
3. Applied Mathematics for Physical Chemistry: T.R. Barrant
SEMESTER-I  
(COURSE No –Chem Bio-511)  
CHEMISTRY OF LIFE  
Credit Hours : 3 + 0

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I  
Cell structure and function: Overview of metabolic processes (catabolic and anabolic), energy transfer processes, role and significance of ATP (the biological energy currency). Introductory idea of metabolism of proteins and lipids, biosynthesis of proteins and glycerides.

UNIT-II  
Nucleic acids: Chemical constitution of nucleic acids: chemical structure of nitrogenous bases in DNA & RNA, base pairing, Structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The Chemical basis for heredity, transcription, translation and genetic code. Chemical synthesis of mono and tri-nucleoside.

UNIT-III  
Introduction to photosynthesis: various plant pigments, Chemical structure of chlorophyll, Photosystem I & II, role of electron transport chain in photosynthesis,

UNIT-IV  
Enzymes: Definition, classification on the basis of chemical composition & functions, mode of action of enzymes (Lock and key hypothesis), Cofactors, vitamins and Hormones (brief introduction including definition, classification on the basis of chemical composition and functions).

UNIT-IV  

Books Recommended:

1. Principles of Biochemistry –A.L.Lehringer  
2. Introduction to Chemistry of Life-H.J.DeBay  
3. Outlines of Biochemistry-Conn and Stumpf.
1. Volumetric Analysis:
(a) Potassium iodate titrations: Determination of iodide, hydrazine, antimony(III) and arsenic (III)

(b) Potassium bromate titrations
i) Determination of antimony (III) and arsenic (III) Direct Method
ii) Determination of aluminium, cobalt and zinc (by oxine method)

(c) EDTA titrations
i) Determination of copper, nickel, magnesium
ii) Back titration
iii) Alkalimetric titration
iv) Titration of mixtures using masking and demasking agents
v) Determination of hardness of water
SEMESTER I
(ORGANIC CHEMISTRY PRACTICAL)

Credit Hours: 0 + 1

Qualitative Analysis: Separation, purification and identification of binary mixture of organic compounds by chemical tests, TLC, column chromatography and IR spectroscopy.


Books Recommended:
Chemical Kinetics
1. Determine the specific rate constant for the acid catalyzed hydrolysis of methyl acetate by the Initial Rate Method. Study the reaction at two different temperatures and calculate the thermodynamic parameters.
2. Compare the strengths of hydrochloric acid and sulphuric acid by studying the rate of hydrolysis of methyl acetate.
3. Study the saponification of ethyl acetate with sodium hydroxide volumetrically.
4. Determine the specific reaction rate of the potassium persulphate-iodide reaction by the Initial Rate Method.
5. Study the kinetics of the iodination of acetone in the presence of acid by the Initial Rate Method.
6. (a) Determine the specific rotation constant for sucrose.
   (b) Study the acid catalyzed inversion of cane sugar, and find out
      (i) the order with respect to sucrose;
      (ii) the rate constant;

Potentiometry
1. Prepare and test the Calomel Electrode.
2. Titrate hydrochloric acid and sodium hydroxide potentiometrically.

Conductometry
1. Determine the Cell Constant of the given conductivity cell at room temperature and study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (acetic acid).
SEMESTER-II
(COURSE No –Chem I -521)
(INORGANIC CHEMISTRY)
METAL LIGAND BONDING & MAGNATOCHEMISTRY
Credits Hours : 3 + 1

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I
Metal-Ligand Bonding-I: Recapitulation of Crystal Field Theory including splitting of d-orbitals in different environments, Factors affecting the magnitude of crystal field splitting, structural effects (ionic radii, Jahn-Teller effect), Thermodynamic effects of crystal field theory (ligation, hydration and lattice energy), Limitations of crystal field theory, Adjusted Crystal Field Theory (ACFT), Evidences for Metal-Ligand overlap in complexes, Molecular Orbital Theory for octahedral, tetrahedral and square planar complexes (excluding mathematical treatment)

UNIT-II
Atomic Spectroscopy: Energy levels in an atom, coupling of orbital angular momenta, coupling of spin angular momenta, spin orbit coupling, spin orbit coupling p2 case, Determining the Ground State Terms-Hund’s Rule, Hole formulation (derivation of the Term Symbol for a closed sub-shell, derivation of the terms for a d2 configuration), Calculation of the number of the microstates.

UNIT-III
Electronic Spectra-I: Splitting of spectroscopic terms (S,P,D,F and G,H,I), d1-d9 systems in weak fields (excluding mathematics), strong field configurations, transitions from weak to strong crystal fields.

UNIT-IV
Electronic Spectra-II: Correlation diagrams (d1-d9) in Oh and Td environments, spin-cross over in coordination compounds. Tanabe Sugano diagrams, Orgel diagrams, evaluation of B,C and β parameters.

UNIT-V
Magnetochemistry: Origin of Magnetic moment, factors determining paramagnetism, application of magnetochemistry in co-ordination chemistry (spin only moment, Russell Saunder’s coupling, quenching of orbital angular moment, orbital contribution to a magnetic moment) in spin free and spin paired octahedral and tetrahedral complexes. Magnetic susceptibility (diamagnetic, paramagnetic), magnetic moments from magnetic susceptibilities, Van Vlecks formula for magnetic susceptibility, temperature dependence of magnetic susceptibility.

Books Recommended:
1 Advanced Inorganic Chemistry – Cotton and Wilkinson
2 Coordination Chemistry- Experimental Methods – K.Burger
3 Theoretical Inorganic Chemistry – Day and Selbin
4 Magnetochemistry – R.L.Carlin
5 Comprehensive Coordination Chemistry – Wilkinson, Gillars and McCleverty.
6 Inorganic Electronic Spectroscopy – A.B.P.Lever
7 Concise Inorganic Chemistry – J.D.Lee
8 Introduction to Ligand Fields – B.N.Figgis
9 Physical Methods in Inorganic Chemistry-R.S.Drago
SEMESTER-II
(COURSE No –Chem O-521)
(ORGANIC CHEMISTRY)
ORGANIC REACTION MECHANISM –II & PERICYCLIC REACTIONS

Credits Hours : 3 + 1

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible every question will be subdivided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT – I
(A) Aromatic Electrophilic Substitution: Arenium ion mechanism, orientation and reactivity, energy profile diagrams, The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles, Diazonium coupling, Vilsmeir reaction, Scholl reaction, Amination reaction, Fries rearrangement, Reversal of Friedel Craft alkylation, Decarboxylation of aromatic acids.

(B) Aromatic Nucleophilic Substitution: SNAr, SN1, benzyne and SRN1 mechanism. Reactivity, effect of substrate structure, leaving group and attacking nucleophile, Von Richter, Sommelet- Hauser, and Smiles rearrangements, Ullman reaction, Ziegler alkylation, Schiemann reaction.

UNIT-II
Common Organic Reactions and Their Mechanisms: Perkin condensation, Michael reaction, Robinson annulation, Dieckmann reaction, Stobbe condensation, Mannich reaction, Knoevenagel condensation, Benzoin condensation, Witting reaction, Hydroboration, Hydrocarboxylation, Ester hydrolysis, Epoxidation.

UNIT- III

UNIT-IV

UNIT-V
Pericyclic Reaction: Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5 hexatrienes and allyl system. Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions: conrotatory and disrotatory motions, 4n and 4n+2 and allyl systems. Cycloadditions- antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions andchelotropic reactions. Sigmatropic rearrangements-Suprafacial and Antarafacial shifts of H, sigmatropic shifts involving carbon moieties, Claisen, Cope and aza-Cope rearrangements, Ene reaction.
Books recommended:
Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT – I
Brief resume of law of thermodynamics. Gibb’s and Helmholtz free energy functions and their significance. Partial molal quantities. Partial molal free energy and its variation with temperature and pressure. Determination of partial molar volume. Thermodynamic criteria for the fugacity of the process in terms of entropy change, internal energy change, enthalpy and free energy (Gibb’s and Helmholtz ) change. Gibb’s and Helmholtz equation and its utility in thermodynamics of cell reaction. Thermodynamics of ideal solutions. Fugacity and activity and their variation with temperature and pressure. Graphical method for the determination of fugacity.

UNIT – II

UNIT – III

UNIT – IV

UNIT – V

Books Recommended:
1. Thermodynamics for Chemists: S. Glasstone
2. Physical Chemistry: G.M. Barrow
3. Non – equilibrium Thermodynamics: C. Kalidas
4. Non – equilibrium Thermodynamics: I. Prigogene
5. Electrochemistry: S. Glasstone
6. Electrochemistry: P.H. Reiger
Note: Ten questions will be set by the examiner selecting **TWO** from each unit. As far as possible, every question will be subdivided into **Two – Three Parts**. The students shall attempt **FIVE** questions selecting **ONE** from each unit.

**UNIT-I**

**Spectrophotometry:** i) Introduction, fundamental laws of photometry, the electromagnetic spectrum and spectrochemical methods, UV/Visible instrumentation, absorption spectra, Beer-Lambert’s Law, deviation from Beer-Lambert’s Beer’s Law. ii) **Photometric Titrations:** titration curves and applications to quantitative analysis.

**UNIT-II**

**Atomic Spectroscopy:** Theory of flame photometer, intensities of spectral lines, selection of optimal working conditions, applications of flame photometry to quantitative analysis. The Theory of Atomic Absorption Spectroscopy (AAS), Origin of atomic spectra, line width effects in atomic absorption, instrumentation and its application, Atomic emission spectroscopy (AES) and the description of the techniques.

**UNIT-III**

**Electroanalytical Methods:**

A) **Electrogravimetric methods:** i) Current-voltage relationship during electrolysis, operation of a cell at a fixed applied potential, constant current electrolysis, physical properties of electrolytic precipitates, chemical factors of importance in electrodeposition, anodic deposition. ii) Spontaneous electrogravimetric analysis (internal electrolysis), apparatus and applications. iii) Electrolytic method with and without potential control, apparatus and applications.

B) **Coulometric Methods:** i) Controlled potential Coulometry, instrumentation and applications. ii) Coulometric titrations, cell for coulometric titrations, applications of coulometric titrations (neutralization, precipitation, and complex formation titrations), comparison of coulometric and volumetric titrations.

**UNIT-IV**

**Polarographic Methods:** General introduction: Theoretical measurements of classical polarography, polarographic measurements, polarograms, interpretation of polarographic waves, equation for polarographic waves, half-wave potential, effect of complex formation on polarographic waves, dropping mercury electrode (advantages and limitations), current variation with a dropping electrode, polarographic diffusion current, the ilkovic equation, effect of capillary characterization on diffusion current, diffusion coefficient temperature, kinetic and catalytic current, polarograms for mixtures of reactants, anodic waves and mixed anodic and cathodic waves, current maxima and its suppression, residual current, supporting electrolytes, oxygen waves, instrumentation and applications to inorganic and organic analysis.

**UNIT-V**

**Thermoanalytical methods:**

A) **Thermogravimetric analysis:** Introduction, Factors affecting thermogravimetric curves, instrumentation, applications to inorganic compounds (analysis of binary mixtures i.e. Ca and Mg, TG curves of calcium oxalate, determination of Ca, Sr & Ba ions in the mixture, drying of sodium carbonate, analysis of clays and soils, decomposition of potassium hydrogen phthalate,
oxidation of nickel sulphide, determination of titanium content of non-stoichiometric sample of titanium carbide).

**(b) Differential thermal analysis:** Introduction, Factors effecting DTA curves, instrumentation, applications, to inorganic compounds (thermal decomposition of mixtures of lanthanum-cerium and praseodymium oxalate, DTA curves for CuSO4.5H2O, sulphur, detection of organic contamination in ammonium nitrate, thermal decomposition for different magnesium carbonate samples, determination of uncalcined gypsum in plaster of paris.

**Books Recommended:**
1. Instrumental methods of analysis.-H.H.Willard, LL.Marritt and J.A.Dean
2. Fundamental of analytical Chemistry -D.A.Skoog & D.M.West
3. Basic concepts of analytical Chemistry-S.M.Khopkar
4. Instrumental Methods of Chemical Analysis-G.K.Ewring
5. Quantitative Inorganic Analysis-A.I.Vogel
6. Ion Exchange-AellFerish
7. Modern Polarographic Methods in Analytical Chemistry -A.M.Bond
SEMESTER II
(INORGANIC CHEMISTRY PRACTICAL)
Credit Hours 0 + 1

1. Commercial Analysis:
   i) Determination of available chlorine in bleaching powder
   iii) Determination of Phosphoric acid in commercial phosphoric acid.
   iv) Determination of Boric acid in borax.

2. Analysis of mixtures by gravimetric and volumetric methods from the mixture solutions:
   i Copper- Nickel
   ii. Copper -Magnesium
   iii. Copper-Zinc
   iv. Iron-Magnesium
   v. Silver-Zinc
   vi. Copper-Nickel-Zinc
   vii. Fe(II)-Fe(III)

3. Preparation of the following compounds
   i. Stannic iodide
   ii. Bis(acetylacetonate) oxovanadium (IV)
   iii. Tris (acetylacetonate) siliconchloride.
   iv. Mercuration of phenol.
   v. Hexa ammine nickel (II) chloride.
   vi. Pyridine perchromate.
1. Conductometric Titrations:
i) Differential behaviour of acetic acid to determine the relative acid strength of various acids and basic strength of various bases.
ii) Strong acid-strong base titration in acetic acid.

2. Potentiometric Titrations.
   a. Neutralisation reactions:
      i) Sodium hydroxide-hydrochloric acid.
      ii) Sodium hydroxide-Boric acid
      iii) Acetic acid and hydrochloric acid-sodium hydroxide.
   b. Oxidation-Reduction Reactions.
      i) Ferrous-dichromate
      ii) Ferrous-Ceric
      iii) Iodine-Thiosulphate
   c. Precipitation Reactions:
      i) Silver nitrate-sodium halides.
   d. Complexation Reactions
      i) Potassium cyanide-silver nitrate.

3. Colorimetric Analysis:
   i) Verification of Beer’s law for KMNO4, K2Cr2O7 solutions and determination of the conc. of KMNO4 K2Cr2O7 in the given solution.
   ii) Colorimetric determination of Iron (III) with potassium thiocyanate reagent or o-Phenanthroline method.
   iii) Determination of traces of manganese (in steel samples) colorometrically by oxidation to permanganic acid with potassium periodate.

4. pH metric –titrations
   i) Copper and cactechol
   ii) Copper and salicylic acid
   iii) Acid base titrations
   iv) Mixtures of acids with a base

5. Polarography:
   i) Determination of half wave potentials of cadmium ion in potassium chloride solution.
   ii) Determination of half wave potentials of zinc and manganous ions in potassium chloride solution.
   iii) Determination of cadmium in solution
   iv) Investigation of the influence of dissolved oxygen.

6. Flame Photometry:
   i) Determination of sodium
   ii) Determination of potassium
   iii) Determination of calcium

Books Recommended:
1. A Text Book of Quantitative Inorganic Analysis- A.I. Vogel
3. Inorganic Synthesis- R.A. Rowe and M.M. Jon


Books Recommended:
SEMESTER II
(PHYSICAL CHEMISTRY PRACTICAL)
Credits Hours : 0 + 1

Conductometry

1. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch’s law of independent migration of ions.
2. Determine the equivalent conductance, degree of dissociation and dissociation constant ($K_a$) of acetic acid.
3. Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in a commercial sample of soda ash.
4. Study the conductometric titration of
   (i) Acetic acid vs. sodium hydroxide,
   (ii) Acetic acid vs. ammonium hydroxide,
   (iii) Sodium acetate vs. HCl,
   Comment on the nature of the graphs.
5. Study the stepwise neutralization of a polybasic acid e.g. oxalic acid, citric acid, succinic acid by conductometric titration and explain the variation in the plots.
6. Study the conductometric titration of a mixture of a strong and weak acid.
7. Study the estimation of potassium sulphate solution by conductometric titration.

Potentiometry

1. Titrate hydrochloric acid and sodium hydroxide potentiometrically.
2. Determine the dissociation constant of acetic acid potentiometrically.
3. Titrate oxalic acid and sodium hydroxide potentiometrically.
4. Titrate a mixture of
   (i) strong and weak acids (Hydrochloric and acetic acids)
   (ii) weak acid (acetic acid) and dibasic acid (oxalic acid)
   (iii) strong acid (hydrochloric acid) and dibasic acid (oxalic acid)
   versus sodium hydroxide.
5. Titrate a solution of Mohr's salt against potassium permanganate potentiometrically.
6. Titrate a solution of Mohr’s Salt and potassium dichromate potentiometrically.

Books Recommended:
1. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
4. Practical in Physical Chemistry: P.S. Sindhu
SEMESTER-III  
(COURSE No – Chem I-531)  
(INORGANIC CHEMISTRY)  
ANALYTICAL & NUCLEAR CHEMISTRY  
Credits Hours : 3 + 1

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I
Metal π Complexes: Preparation, reactions, structures and bonding in carbonyl, nitrosyl, phosphine and related complexes, structural evidences from vibrational spectra, bonding and important reactions of metal carbonyls. Structure and bonding in metal cyanides, stabilization of unusual oxidation states of transition metals.

UNIT-II
Introductory Analytical Chemistry: Data Analysis – Types and sources of errors, propagation of errors, detection and minimization of various types of errors. Accuracy and precision, average and standard deviation, variance, its analysis and confidence interval, tests of significance ($F$-test, $t$-test and paired $t$-test), criteria for the rejection of analytical data (4d rule, 2.5d rule, $Q$-test, average deviation and standard deviation), least-square analysis.

UNIT-III
Photoelectron Spectroscopy: Basic principle, photoionization process, ionization energies, Koopman’s theorem, ESCA, photoelectron spectra of simple molecules, (N2, O2 and F2) Photoelectron spectra for the isoelectronic sequence Ne, HF, H2O, NH3 and CH4, chemical information from ESCA, Auger electron spectroscopy – basic idea.

UNIT-IV
Lanthanides and Actinides: Spectral and magnetic properties, comparison of Inner transition and transition metals, Transuranium elements (formation and colour of ions in aqueous solution), uses of lanthanide compounds as shift reagents, periodicity of translawrencium elements.

UNIT-V
Nuclear Chemistry: Nuclear binding energy and stability, nuclear models (nuclear shell model and collective model). Nuclear reactions: types of reactions, nuclear cross-sections, Q-value. Natural and artificial radioactivity, radioactive decay and equilibrium, Nuclear fission-fission product and fission yields, Nuclear fusion. 
Radioactive techniques: Tracer technique, (neutron activation analysis), Counting techniques such as G.M. Ionization and proportional counters.

Books Recommended:
1. Advanced Inorganic Chemistry – Cotton and Wilkinson
2. Fundamentals of Analytical Chemistry – Skoog and West
3. Quantitative Inorganic Analysis – Vogel
4. Chemistry of the Elements – Greenwood and Earnshaw
5. Nuclear Chemistry-U.C.Dash
6. Nuclear Chemistry – B.G.Harvey
7. Nuclear Chemistry – Arnikar
8. Techniques in Inorganic Chemistry Vol. II (Nuclear Chemistry-Johnson and Others).
11. Analytical Chemistry-G.D.Christian
12. Chemical Structure and Bonding- Dekock and Gray
14. Electronic absorption spectroscopy and related techniques: D.N. Sathyanarayan

SEMESTER-III
(COURSE No –Chem O-531)
(ORGANIC CHEMISTRY)
SPECTROSCOPY & PHOTOCHEMISTRY

Credits Hours : 3 + 1

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be subdivided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.
UNIT–I
Spectroscopy:

(B) Infrared Spectroscopy: Instrumentation and sample handling, Characteristic vibrational frequencies of common organic compounds. Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. Introduction to Raman spectroscopy. Applications of IR and Raman Spectroscopy in organic chemistry.

UNIT-II
Nuclear Magnetic Resonance (NMR) Spectroscopy: General introduction, chemical shift, spin-spin interaction, shielding mechanism, chemical shift values and correlation of protons present in different groups in organic compounds. chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei, virtual coupling. Stereochemistry, hindered rotation, Karplus- relationship of coupling constant with dihedral angle. Simplification of complex spectra-nuclear magnetic double resonance, spin tickling, INDO, contact shift reagents, solvent effects. Fourier transform technique, Nuclear Overhauser Effect (NOE). Introduction to resonance of other nuclei –F, P, Principle and introduction to C13 NMR, 2-D and 3-D NMR, Applications of NMR in organic chemistry.

UNIT-III
Mass Spectrometry: Introduction, ion production—EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, and ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, Molecular ion peak, Meta-stable peak, McLafferty rearrangement. Nitrogen Rule. High-resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination. Introduction to negative ion Mass spectrometry, TOF-MALDI. Problems based upon IR, UV, NMR and mass spectroscopy.

UNIT- IV

UNIT- V
Photochemistry – II: Photochemistry of Carbonyl compounds: Norrish Type I and II, Intermolecular and Intramolecular hydrogen abstraction, Paterno-Buchi reaction, α and β- cleavage reactions of cyclic and acyclic carbonyl compounds, Formation of oxetane and cyclobutane from α, β unsaturated ketones, Photo-reduction of carbonyl compounds, Photo-rearrangement of enones, dienones, epoxyketones, Photo Fries rearrangement.
**Books Recommended:**
6. Organic spectroscopy by Jagmohan
7. Organic spectroscopy by W. Kemp.

**SEMESTER-III**

**(COURSE No – Chem P-531)**

**(PHYSICAL CHEMISTRY)**

**STATISTICAL THERMODYNAMICS & INTRODUCTORY QUANTUM**

**Credits Hours : 3 + 1**

**Note:** Ten questions will be set by the examiner selecting **TWO** from each unit. As far as possible, every question will be subdivided into **Two – Three Parts.** The students shall attempt **FIVE** questions selecting **ONE** from each unit.

**Statistical Thermodynamics**

**UNIT – I**

Basic Terminology: probability, phase space, micro and macro states, thermodynamic probability, statistical weight, assembly, ensemble, probability considerations and chemistry. The most probable distribution: Maxwell-Boltzmann distribution. Thermodynamic properties from statistical Thermodynamics, The Partition Function for monoatomic gas, State functions in terms of partition function, separating partition function: the nuclear and electronic partition function, for molecules, electronic and vibrational partition function,

**UNIT – II**

Diatomic molecules: Rotations. Polyatomic molecules: Rotations, The partition function of a system, Thermodynamic properties of molecules from partition function: Total energy, entropy,
Helmholtz free energy, pressure, heat content, heat capacity and Gibb’s free energy, equilibrium constant and partition function, Heat capacity of crystals and statistical thermodynamics, quantum statistics: The Bose- Einstein statistics and Fermi- Dirac Statistics.

**Basic Quantum Chemistry**

**UNIT – III**


**UNIT – IV**

Quantum mechanical treatment of translational motion of a particle, particle in one and three dimensional boxes, harmonic – oscillator, rotational motion of a particle: particle on a ring, particle on a sphere, rigid rotator and hydrogen atom. Graphical presentation of orbitals (s, p and d), radial and angular probability distribution plots.

**UNIT – V**


**Books Recommended:**

1. Physical Chemistry: D.W. Ball
2. Theoretical Chemistry by S. Glasston
3. Statistical Chemistry by I. Prigogine
4. Quantum Chemistry An Introduction: H.L. Strauss
5. Introductory Quantum Chemistry: A.K. Chandra
6. Quantum Chemistry: A. Mcquarrie
7. Quantum Chemistry: I.N. Levine
Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be subdivided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I
Inorganic Photochemistry: Basic principles, Basic photochemical processes, Kashia’s rule, Thexi state, Photochemical behaviour of transition metal complexes, charge transfer spectra of crystalline and gaseous alkali halides, photochemical reactions of coordination compounds, oxidation-reduction reactions, Photo substitution reactions, Adamson’s rules and photosubstitution reactions of cobalt(III) complexes i.e. [Co(NH3)5X]2+, [Co(en)3]3+ and chromium(III) complexes i.e. [Cr(H2O)6]3+ and [Cr(NH3)6]3+ and ruthenium (II) polypyrpyridyl complexes.

UNIT-II

UNIT-III
Polymeric Inorganic Compounds: General chemical aspects (synthesis, properties and structure) of phosphazenes, borazines, silicones, sulphur- nitrogen cyclic compounds and condensed phosphates.

UNIT-IV
Stability of Coordination Compounds – Stability constants, stepwise formation constants, overall formation constants, relationship between stepwise and overall formation constants, difference between thermodynamic and kinetic stability. Determination of stability constants by:
(i) Spectrophotometric methods (Job’s method, Mole ratio and slope ratio method).
(ii) Bjerrum’s method
(iii) Leden’s method
(iv) Polarographic method
Factors affecting the stability constants (with special reference to metal and ligand ions).

UNIT-V
Books Recommended:
1. Instability Constants- Yttermiskii
2. Advanced Inorganic Chemistry- Cotton and Wilkinson
3. Inorganic Chemistry- T.Moeller
4. Concise Inorganic Chemistry- J.D.Lee
5. Introduction to Ligand Fields- B.N.Figgis
7. Inorganic chemistry: A Unified Approach W.W.Porterfield
8. Inorganic Reaction Mechanism – Edberg
9. Inorganic Reaction Mechanism – Basoloavd Pearsor
SEMESTER-III  
(COURSE No – Chem O-539)  
(BIO - ORGANIC CHEMISTRY SPECIAL THEORY - I)  

Credits Hours : 3 + 0

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I  
Carbohydrates: Types of naturally occurring sugars: Deoxy-sugars, amino sugars, branched chain sugars. General methods of structure and ring size determination with particular reference to maltose, lactose, sucrose, pectin, starch and cellulose, photosynthesis of carbohydrates, metabolism of glucose, Glycoside- (amygdalin).

UNIT-II  

UNIT-III  
Vitamins: A general study, detailed study of chemistry of thiamine (Vitamin B1), Ascorbic acid (Vitamin C), Pantothenic acid, biotin (Vitamin H), α-tocopherol (Vitamin E), Biological importance of vitamins.

UNIT-IV  
Enzymes: Nomenclature and classification, extraction and purification, Remarkable properties of enzymes like catalytic power, specificity and regulation, Proximity effects and molecular adaptation, Chemical and biological catalysis. Mechanism of enzyme action: Transition state theory, orientation and steric effect, acid base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms (chymotrypsin, ribo nuclease, lysozyme and carboxypeptidase A). Fischer’s lock and key and Koshland’s induced fit hypothesis, concept and identification of active site by the use of inhibitors affinity labeling and enzyme modification by site directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

UNIT-V  
(A) Kinds of reactions catalyzed by Enzymes: Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate addition and elimination reactions, enolic intermediates in isomerization reactions, β- cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation reactions.  
(B) Coenzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, and apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate

**Books recommended:**
2. Understanding Enzymes, Trevor Palmer, Prentice Hall.
10. Carbohydrates by N. Sharon.
11. Carbohydrates by Gutherie.
12. Carbohydrates by Pigman and Wolfom.
13. The Nucleic Acids (Vol I-III) by Chargoff and Davidson.
14. Protein Structures and Functions by A. Light.
17. The chemistry of Natural Products by P.S. Kalsi.
Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT –I

UNIT –II

UNIT –III
Solution and Interfacial Behaviour of Surfactants: Definition and classification of surfactants. Solution properties of surfactants: micelle and reverse micelle formation, critical micelle concentration (CMC), dependence of CMC on chain length of the surfactant, micelle shape and size. Thermodynamics of micelle formation, hydrophobic effect (a qualitative view only). Aggregation at high surfactant concentration (a qualitative aspect). to micelles. Surface tension and detergent., Practical application of surfactants.

UNIT –IV

UNIT –V
Chemistry of nano – materials: Definition and historical perspective. Effect of nanoscience and nanotechnology in various fields. Synthesis of nanoparticles by chemical routs and their caracerization techniques. Properties of nanostructured material: optical, magnetic and chemical properties. An overview of applied chemistry of nanometerials.

Books Recommended:
1. Physical Chemistry of Surfaces: A.W. Admson
2. Adsorption from Solutions: J.J. Kipling
5. Physical Chemistry: P.W. Atkins
7. Introduction to nanotechnology: Charles P.Poole, Jr. Frank, J. Owens: Wiley India
SEMESTER III
(INORGANIC CHEMISTRY PRACTICAL)

Credits Hours : 0 + 1

1. Analysis of the given sample (Ores)/Both Qualitative and Quantitative Dolomite, Pyrolusite, Galena.
2. Analysis of the given alloys: Coin, Gunmetal, Brass and Bronze.
3. To prepare a pure and dry sample of the following compounds:
   1. Potassium tris(oxalato)aluminate(III)
   2. Sodium hexa(nitro)cobaltate(III)
   3. Potassium tris(oxalato)cobaltate(III)
   4. Hexa(ammine)cobalt (III)chloride
   5. Tetrapyridine copper(II)persulphate
   6. Dinitrotetrapyridine nickel(II)
   7. Lead tetraacetate
8. Mercury (tetraisothiocyanato)cobaltate(II). and characterize them by the following techniques:
i) Elemental analysis
ii) Molar conductance values
iii) I.R. Spectral interpretation
iv) Thermal analysis
v) UV-Visible Spectra

Books Recommended:
1. A Text Book of Qualitative Inorganic Analysis – A.I. Vogel

SEMESTER III
(ORGANIC CHEMISTRY PRACTICAL)

Credits Hours: 0 + 1

(A) Extraction of Organic Compounds from Natural Sources: Isolation of Caffeine from tea leaves, casein from milk (the students are required to try some typical color reactions of proteins), lactose from milk (purity of sugar should be checked by TLC and PC and Rf value reported). Lycopene from tomatoes and β-carotene from carrots.

(B) Paper Chromatography: Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.

(C) Spectroscopy:
Identification of some organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR and MS)
Multistep Synthesis
Synthesis of Vacor
Synthesis of Indigo
Synthesis of p-nitro aniline

Books Recommended:

SEMESTER III
(PHYSICAL CHEMISTRY PRACTICAL)

Credits Hours: 0 + 1

CONDUCTOMETRY

1. Estimate the concentration of each component of a mixture of AgNO3 and HNO3 by conductometric titration against NaOH.
2. Titrate a moderately strong acid (salicylic/mandelic acid) by the
   (a) salt-line method
   (b) double alkali method.
3. Study the effect of dielectric constant (ε) on the nature of the conductometric titration between maleic acid and sodium methoxide using different mixtures of benzene and methanol as solvents.

SPECTROPHOTOMETRY

1. Determine the concentrations of KMnO4 and K2Cr2O7 in a mixture by the MLRA method.
2. Determine the dissociation constant of an indicator spectrophotometrically.
3. Record the U.V. spectrum of a given compound (acetone) in cyclohexane
   (a) Plot transmittance versus wavelength.
   (b) Plot absorbance versus wavelength.
   (c) Assign the transitions by recording spectra in solvents of different polarities (H2O, CH3OH, CHCl3, CH3CN and 1, 4-dioxane). Comment on the energy of hydrogen bonding.
(d) Calculate the energy involved in the electronic transition in different units, i.e. cm\(^{-1}\), Joules/mol, cal/mol, & eV.
(e) Calculate the oscillator strength/ transition probability.

**POTENTIOMETRY**

1. Set up the following electrodes and measure their potentials. Obtain values for their standard electric potentials:
   (a) Zn I ZnSO\(_4\) (0.1 M and 0.01 M);
   (b) Cu I CuSO\(_4\) (0.1 M and 0.01 M).
2. Determine the solubility and solubility product of an insoluble salt, AgX (X=Cl, Br or I) potentiometrically.

**SEMSTER-III**

**SEMINAR**
**(FOR ALL THREE SPECIALIZATIONS)**
Chem I/0/P-591

**Credits Hours : 0 + 1**

Every candidate will have to deliver a seminar of 30 minutes duration on a topic (not from the syllabus) which will be chosen by him / her in consultation with the teacher of the department. The seminar will be delivered before the students and teachers of the department. A three member committee (one coordinator and two teachers of the department of different branches) duly approved by the departmental council will be constituted to evaluate the seminar. The following factors will be taken into consideration while evaluating the candidate.
(i) Expression
(ii) Presentation
(iii) Depth of the subject matter and answers to the questions.
SEMESTER-IV  
(COURSE No –Chem 1-541 )  
(INORGANIC CHEMISTRY SPECIAL THEORY - II)  
(ADVANCED ORGANOMETALLICS)  
Credits Hours : 3 + 0

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be subdivided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I
Organometallic Compounds of transition elements: Types of ligands and their classifications in organometallic compounds, 16 and 18 electron rule and its limitations. Hapto-nomenclature, synthesis, structure and bonding aspects of following organometallic compounds with carbon-π donor ligands
a) Two electron donor (olefin and acetylenic complexes of transition metals)
b) Three electron donor (π-allyl complexes of transition metals)
c) Four electron donor (butadiene and cyclobutadiene complexes of transition metals)
d) Five electron donor (cyclopentadienyl complexes of transition metals – metallocenes with special emphasis to ferrocenes)
e) Six electron donor [Benzene (arene) complex]
Fluxional and dynamic equilibria in compounds such as η2-olefin, η3-allyl and dienyl complexes.

UNIT-II
Homogeneous Transition metal catalysis: General considerations, Reason for selecting transition metals in catalysis (bonding ability, ligand effects, variability of oxidation state and coordination number), basic concept of catalysis (molecular activation by coordination and addition), proximity interaction (insertion/inter-ligand migration and elimination, rearrangement). Phase transfer catalysis. Homogeneous hydrogenation of unsaturated compounds (alkenes, alkynes, aldehydes and ketones). Asymmetric hydrogenation.

UNIT-III
Some important homogeneous catalytic reactions:- Ziegler Natta polymerization of ethylene and propylene, oligomerisation of alkenes by aluminiumalkyl, Wackers acetaldehyde synthesis, hydroformylation of unsaturated compounds using cobalt and rhodium complexes, Monsanto acetic acid synthesis, carboxylation reactions of alkenes and alkynes using nickel carbonyl and palladium complexes. Carbonylation of alkynes (acetylene) using nickel carbonyls or Palladium complexes.

UNIT-IV
Metal-metal bonding in carbonyl and halide clusters:- Polyhedral model of metal clusters, effect of electronic configuration and coordination number, Structures of metal carbonyl clusters of three atoms M3(CO)12 (M=Fe, Ru & Os), Four metal atoms (tetrahedra) [M4(CO)12 {M= Co, Rh &Ir}] and octahedron of type M6(CO)16 [M= Co & Rh], and halide derivatives of Rhenium (III) triangles, metal carbonyls involving bridged-terminal exchange and scrambling of CO group.

UNIT-V
Transition Metal-Carbon multiple bonded compounds:-Metal carbenes and carbines (preparation, reactions, structure and bonding considerations). Biological applications and environmental aspects of organometallic compounds, Organometallic compounds in medicine, agriculture and industry.

Books Recommended:
1. Principles of organometallic compounds – Powell
2. Organometallic chemistry (an Introduction) – Perkin and Pollar
3. Organometallic chemistry – Parison
4. Advanced Inorganic Chemistry – Cotton and Wilkinson
5. Organometallic Chemistry-R.C.Mehrotra
6. Organometallic compounds of Transition Metal-Crabtree
7. Chemistry of the Elements – Greenwood and Earnshaw
8. Inorganic Chemistry – J.E.Huheey
9. Homogeneous transition metal catalysis – Christopher Masters
10. Homogeneous Catalysis – Parshall
11. Principles and Application of Homogeneous Catalysis – Nakamura and Tsutsui
14. Principles and applications of organotransition metal chemistry by Ccollmen and Hegden
INORGANIC CHEMISTRY SPECIAL THEORY - IV
INORGANIC SPECTROSCOPY

Credits Hours : 3 + 0

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I
Infrared Spectroscopy: Theory of IR absorption, Types of vibrations, Observed number of modes of vibrations, Intensity of absorption bands, Theoretical group frequencies, Factors affecting group frequencies and band shapes (Physical state, Vibrational Coupling, Electrical effects, Resonance, Inductive effects, Ring strain) Vibrational-rotational fine-structure. Experimental method. Application of IR to the following:

i) Distinction between
a) Ionic and coordinate anions such as NO3-, SO42- and SCN
b)Lattice and coordinated water.
ii) Mode of bonding of ligands such as urea, dimethylsulphoxide and hexamethylphosphoramidine.

UNIT-II
Nuclear Magnetic Resonance Spectroscopy:- Introduction to Nuclear Magnetic Resonance, Chemical shift, Mechanism of electron shielding and factors contributing to the magnitude of chemical shift, Nuclear overhauser effect, Double resonance, Chemical exchange, Lanthanide shift reagents and NMR spectra of paramagnetic complexes. Experimental technique(CW and FT).
Stereochemical non-rigidity and fluxionality: Introduction, use of NMR in its detection, its presence in trigonal bipyramidal molecules(PF5), Systems with coordination number six (Ti(acac)2Cl2, Ti(acac)2Br2, Ta2(OMe)10).

UNIT-III
Nuclear Quadrupole Resonance Spectroscopy: Basic concepts of NQR (Nuclear electric quadrupole moment, Electric field gradient, Energy levels and NQR frequencies), Effect of magnetic field on spectra, Factors affecting the resonance signal (Line shape, position of resonance signal) Relationship between electric field gradient and molecular structure. Interpretation of NQR data, Structural information of the following: PCl5, TeCl4, Na+GaCl4 -, BrCN, HIO3 and Hexahalometallates

UNIT-IV
Mössbauer Spectroscopy: Introduction, Principle, Conditions for Mössbauer Spectroscopy, parameters from Mössbauer Spectra, Isomer shift, Electric Quadrupole Interactions, Magnetic Interactions MB experiment, Application of MB spectroscopy in structural determination of the following: i) High spin Fe (II) and Fe (III) halides FeF2, FeCl2.2H2O, FeF3, FeCl3.6H2O. Low spin Fe(II) and Fe(III) Complexes-Ferrocyanides, Ferricyanides, Prussian Blue. ii) Iron carbonyls. Fe(CO)5, Fe2(CO)9 and Fe3 (CO)12 iii) Inorganic Sn(II) and Sn(IV) halides.

UNIT-V
Resonance Spectrometer, Presentation of the spectrum, Hyperfine coupling in Isotropic Systems (methyl, benzene and Naphthalene radicals). Factors affecting the magnitude of g-values. Zero field splitting and Kramer’s Degeneracy, Line width in solid state ESR, Double resonance technique in e.s.r. (ENDOR) Experimental method. Applications of ESR to the following:
1. Bis-Salicylaldimine - Copper –II
2. CuSiF6.6H2O & (NH3)5Co-O-Co(NH3)5

Books Recommended:
2. Modern Optical methods of Analysis - Eugens D.Olsen
3. Infrared spectra of Inorganic and coordination compounds - Kazuo Nakamoto
5. Fundamentals of Molecular Spectroscopy-C.N.Banwel
8. Quarterly reviews Vol 11 (1957)
9. Progress in Inorganic Chemistry Vol 8
10. Organic Spectroscopy-W. Kemp

SEMESTER-IV
(COURSE No –Chem I-543)
(INORGANIC CHEMISTRY SPECIAL THEORY - IV)
BIO-INORGANIC AND SUPRAMOLECULAR CHEMISTRY
Credits Hours : 3 + 0

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I
(a) **Metalloporphyrins**: (ref. Books No. 1,5,6): Porphyrins and their salient features, characteristic absorption spectrum of porphyrins, chlorophyll (structure and its role in photosynthesis). Transport of Iron in microorganisms (sidrophores), types of siderophores (catecholate and Hydroxamato siderophores).

(b) **Metalloenzymes**: (Ref. Book No. 1,2): Definitions: Apoenzyme, Coenzyme, Metalloenzyme, structure and functions of carbonic anhydrase A & B, carboxy peptidases.

**UNIT-II**

**Oxygen Carriers**: (Ref. Book No. 1,8):

a) **Natural oxygen carriers**: Structure of hemoglobin and myoglobin, Bohr effect, Models for cooperative interaction in hemoglobin, oxygen Transport in human body (-perutz machanism), Cyanide poisoning and its remedy. Non-heme protiens (Hemerythrin & Hemocyanin).

b) **Synthetic oxygen carriers**: Oxygen molecule and its reduction products, model compounds for oxygen carrier (Vaska’s Iridium complex, cobalt complexes with dimethyl glyoxime and schiff base ligands).

**UNIT-III**

Transport and storage of metals: (Ref. Books No. 1,2) The transport mechanism, transport of alkali and alkaline earth metals, ionophores, transport by neutral macrocycles and anionic carriers, sodium/potassium pump, transport and storage of Iron (Transferrin & Ferritin).

**UNIT-IV**

**Inorganic compounds as therapeutic Agents**: - Introduction chelation therapy, synthetic metal chelates as antimicrobial agents, antiarthritis drugs, antitumor, anticancer drugs (Platinum complexes), Lithium and mental health.

**UNIT-V**

**Supramolecular Chemistry** (Ref. Book 9): Introduction, Some important concepts, Introduction to Recognition, information and complementarity, Principles of molecular receptor designs, Spherical recognition (cryptates of metal cations) Tetrahedral recognition by macrotricyclic cryptands, Recognition of ammonium ions, Recognition of neutral molecules and anionic substrates (anionic coordination)

**Books Recommended:**
1. The Inorganic Chemistry of Biological processes - M.N.Hughes.
2. Bio Inorganic Chemistry - Robert Wittay
5. An Introduction to Biochemical Reaction Mechanism - James N.Lowe and Lloyalt Ingraham.
6. General Biochemistry - Fruton J.S. and Simmonds S.
SEMESTER-IV
(COURSE No –Chem O -541)
(ORGANIC CHEMISTRY SPECIAL THEORY - II)
SYNTHETIC STRATEGIES

Lectures: 60
Max. Marks: 80

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I
Organic Reagents: Reagents in organic synthesis: Willkinson catalyst, Lithium dialkyl cuprates (Gilman’s reagents), Lithium diisopropylamide (LDA), 1,3-Dithiane (Umpolung) Dicyclohexylcarbodiimide (DCC), and Trimethylsilyl iodide, DDQ, SeO2, Baker yeast, Tri-nbutyltin hydride, Nickel tetracarbonyl, Trimethylchlorosilane.

UNIT–II
Oxidations: Introduction, Different oxidative process. Aromatization of six membered ring, dehydrogenation yielding C-C double bond, Oxidation of alcohols, Oxidation involving C-C double bond, Oxidative cleavage of ketones, aldehydes and alcohols, double bonds and aromatic rings, Ozonolysis, Oxidative decarboxylation, Bis decarboxylation, Oxidation of methylene to carbonyl, Oxidation of olefines to aldehydes and ketones.

UNIT –III
**Reductions:** Introduction, Different reductive processes. Reduction of carbonyl to methylene in aldehydes and ketones, Reduction of nitro compounds and oximes, Reductive coupling, bimolecular reduction of aldehydes or ketones to alkenes, metal hydride reduction, acyloin ester condensation, Cannizzaro reaction, Tishchenko reaction, Willgerodt reaction.

**UNIT-IV**

**Rearrangements:** General mechanistic considerations-nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements: Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Backmann, Hofmann, Curtius, Schmidt, Benzidine, Baeyer- Villiger, Shapiro reaction, Witting rearrangement and Stevens rearrangement.

**UNIT-V**

**Disconnection Approach:** An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity cyclisation reactions, amine synthesis. Protecting Groups: Principle of protection of alcohol, amine, carbonyl and carboxyl groups. One Group C-C Disconnection: Alcohols and carbonyl compounds, regioselectivity. Alkene synthesis, use of acetylenes in organic synthesis.

**Books Recommended:**
2. Organic Synthesis- Concept, Methods and Starting Materials, J. Fuhrhop and G. Penzillin, Verlage VCH.
Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I
Terpenoids: Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, biosynthesis and synthesis of the following representative molecules: Monoterpenoids: Citral, geraniol (acyclic), α-terpeneol, menthol (monocyclic). Sesquiterpenoids: Farnesol (acyclic), zingiberene (monocyclic), santonin (bicyclic), Diterpenoids: Phytol and abietic acid.

UNIT- II

UNIT-III
Alkaloids: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, synthesis and biosynthesis of the following: Ephedrine, Coniine, Nicotine, Atropine, Quinine and Morphine.

UNIT-IV
Steroids: Occurrence, nomenclature, basic skeleton, Diel’s hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Androsterone, Testosterone, Estrone, Progestrone. Biosynthesis of steroids

UNIT-V
Plant Pigments: Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Anthocyanins (Cyanin and pelargonidin), polyphenols: Flavones
(chrysin), Flavonols (quercitin) and isoflavones (daidzein) coumarin, Quinones (lapachol), Hirsutidin. Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.

Books Recommended:
SEMESTER-IV  
(COURSE No – Chem O-543)  
(ORGANIC CHEMISTRY SPECIAL THEORY - IV)  
MEDICINAL CHEMISTRY  

Credits Hours : 0 + 1

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT-I  

UNIT-II  


UNIT-III  

UNIT-IV  
UNIT-V


Books Recommended:
1. An Introduction to Medicinal Chemistry, Graham L. Patrick.
4. Introduction to Medicinal Chemistry, Alex Gringuage.
SEMESTER-IV
(COURSE No –Chem P -541)
(physical chemistry special theory - II)
ADVANCED QUANTUM CHEMISTRY

Credits Hours: 0 + 1

Note: Ten questions will be set by the examiner selecting TWO from each unit. As far as possible, every question will be divided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

UNIT - I
Time – independent perturbation theory for non – degenerate states (first order correction to energy and wave function), and its application to particle in a one – dimensional box, ground state helium atom (without spin consideration) and perturbed harmonic – oscillator. Variational method: theory and application to ground state hydrogen and helium atoms and one – dimensional oscillator.

UNIT - II

UNIT - III

UNIT – VI

UNIT – V

Books Recommended:
1. Quantum Chemistry An Introduction: H.L. Strauss
2. Introductory Quantum Chemistry: A.K. Chandra
3. Quantum Chemistry: D.A. McQuarri
4. Quantum Chemistry: I.N. Levine
5. Molecular Quantum Mechanics: P.W. Atkins
7. Introductory Quantum Chemistry: S.R. LaPaglia
8. Fundamental Quantum Chemistry: T.E. Peacock
SEMESTER-IV  
(COURSE No –Chem P-542)  
(PHYSICAL CHEMISTRY SPECIAL THEORY - III)  
SOLID STATE CHEMISTRY  
Credits Hours : 0 + 1

*Note:* Ten questions will be set by the examiner selecting **TWO** from each unit. As far as possible, every question will be divided into **Two – Three Parts**. The students shall attempt **FIVE** questions selecting **ONE** from each unit.

**UNIT - I**

**UNIT - II**

**UNIT - III**

**UNIT – IV**

**UNIT - V**
Solid State Reactions: General principles: experimental procedures, kinetics of solid state reactions, vapour phase transport methods, interaction or ion exchange reaction, electrochemical
reduction methods, preparation of this films, growth of single crystal, high pressure and hypothetical method.

**Books Recommended:**
1. Introduction to Solids: Azaroff
2. Solid State Chemistry and its applications: West
3. Solid State Chemistry: Chakrabarty
5. Solid State Physics: Kiittal

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**SEMESTER-IV**

(COURSE No –Chem P-543)

(PHYSICAL CHEMISTRY SPECIAL THEORY - IV)

BIOPHYSICAL CHEMISTRY

**Credits Hours : 0 + 1**

**Note:** Ten questions will be set by the examiner selecting **TWO** from each unit. As far as possible, every question will be divided into **Two – Three Parts.** The students shall attempt **FIVE** questions selecting **ONE** from each unit.

**UNIT – I**


**UNIT – II**

Thermodynamics of Biopolymers Solutions: osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system. Statistical mechanics in biopolymers chain configuration of macromolecules, statistical distribution end – to – end dimensions, calculation of average dimensions for various chain structures. Polypeptide and protein structures and protein folding.
UNIT – III

UNIT – IV
Biomolecular Interactions: Interactions between biomolecules (proteins), Interaction of biomolecules with small ligands, independent ligand binding sites, the Scatchard plot, forces involved in the stability of proteins, hydrophobic interactions, hydrogen bonding, electrostatic interactions, electron delocalization, van der Waal’s forces Scope of Genomics, proteomics and bioinformatics, ribosomes: Site and Function of protein synthesis.

UNIT – V
Protein molecules: Protein sequence and structure (primary structure), secondary structure: α-Helix, β-Sheet, classification of proteins, torsion angles, tertiary structure, quaternary structure, Protein folding and refolding, computer simulation: thermodynamic-kinetic approach, statistical mechanics approach, Homolog Modelling, De Novo prediction, Protein misfolding, Biological factors (Chaperones) and chemical factors (Intra and intermolecular interactions) leading folding/refolding/misfolding. Brain diseases associated with it.

Books Recommended:
1. Physical Chemistry of Macromolecules: S.F.Sun
2. The Enzyme Molecules: W. Ferdinand
4. Biochemistry: Zubay
5. Principles of Biochemistry: A.I. Leninger
6. Physical Biochemistry: D. Friefelder
7. iophysics: Volkenstein

PROJECT WORK & INDUSTRIAL VISIT
Course No Chem. I/O/P-600 Credit Hours : 0 + 3