SYLLABI

FOR M.Sc. CHEMISTRY

(SEMESTER SYSTEM)
(SESSION 2013-14 AND ONWARDS)

HIMACHAL PRADESH UNIVERSITY
DEPARTMENT OF CHEMISTRY, SHIMLA-171005
INDIA
A meeting of the Board of Studies in PG in the subject of Chemistry was held on 04-04-2012 at 11.00AM in the Departmental Library of the Chemistry Department. The following were present:

1. Prof. D. K. Sharma Chairman & Convener
2. Prof. Pawan K. Sharma Member & External Expert
3. Prof. Neelam Sharma Member & External Expert
4. Prof. (Mrs.) Inderjeet Kaur Member
5. Prof. M.S. Chauhan Member
6. Prof. S.K. Lomesh Member
7. Dr. (Mrs.) S.B. Kalia Member
8. Dr. Baljit Singh Member

The following decisions were taken:

1. The scheme as well as the course contents of the syllabi of M. Sc. Chemistry, spread over four semesters (I-IV) applicable w. e. f. the Academic Session 2013-2014 i.e. July, 2013 onwards, was discussed and recommended for the consideration of the Faculty of Physical Sciences (as per annexure “A”).

2. The scheme as well as the course contents of the syllabi of M. Phil, Chemistry (Organic, Inorganic and Physical Chemistry specialization), applicable w. e. f. the Academic Session 2013-2014 i.e. July, 2013 onwards, was discussed and recommended for the consideration of the Faculty of Physical Sciences (as per annexure “B”).

3. BOS (PG) approved the syllabi for the Ph.D. course work for the students enrolled for Ph.D. without M. Phil degree as per H.P.U. rules and recommended the same for the consideration of the Faculty of Physical Sciences (as per annexure “C”). It was further resolved that the Ph.D. course work will run concurrently with the M. Phil Ist semester.

4. In order to maintain the academic standard in respect of research and teaching as well as to maintain the uniformity in PG Institutes of Chemistry affiliated to H.P. University, the BOS recommended that henceforth the concerned P. G. Institute will fix a suitable date for the P.G. practical examinations in consultation with the convener of BOS (PG) and the convener will draw a penal of examiners for final approval of the competent authorities.

5. It was resolved by the BOS (PG) that the pass percentage, as implemented from the Academic Session 2010-2011 i.e. 40% for the Undergraduate classes, shall also be applicable for M. Sc (Chemistry) from July 2013 in the light of the minutes of the meeting held on 24th August, 2011 in the office of the Controller of Examinations (as per annexure “D”) to be incorporated in the relevant provisions of 1st Ordinances of H. P. University.

The detail of pass percentage effective from July, 2013 onwards will be as under:

A. In Theory - 40% (32/80)
B. In I.A. - 40% (08/20)
C. In Practical - 40% (20/50)

However in case of M. Phil, the pass percentage will remain same as 50% as existing earlier (as per annexure “D”). The same will also be applicable for Ph.D. course work.

The meeting ended with a vote of thanks to the chair.

Sd/-
(Pawan K. Sharma)
(Ext. Expert)

Sd/-
(Neelam Sharma)
(Ext. Expert)

Sd/-
(Mrs. Inderjeet Kaur)

Sd/-
(M.S. Chauhan)

Sd/-
(S.K. Lomesh)

Sd/-
(Mrs. S.B. Kalia)

Sd/-
(Baljit Singh)

Sd/-
### Annexure-“A”

A Detailed Scheme and Course Contents of the Syllabi for M.Sc. Chemistry Spread Over Four Semesters (I-IV) For Session 2013-14 and Onwards

#### SEMESTER-I

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title</th>
<th>Max. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course-I</td>
<td>Inorganic Chemistry</td>
<td>80</td>
</tr>
<tr>
<td>Course-II</td>
<td>Organic Chemistry</td>
<td>80</td>
</tr>
<tr>
<td>Course-III</td>
<td>Physical Chemistry</td>
<td>80</td>
</tr>
<tr>
<td>Course-IV</td>
<td>Mathematics for Chemists and Applications of computer in Chemistry</td>
<td>80</td>
</tr>
</tbody>
</table>

#### SEMESTER-II

| Course-V   | Inorganic Chemistry                                        | 80         |
| Course-VI  | Organic Chemistry                                          | 80         |
| Course-VII | Physical Chemistry                                         | 80         |
| Course-VIII| Chemistry of Life and Environmental Chemistry              | 80         |
| Course-IX (Practical I and II Semesters Common to all) | Inorganic Chemistry-A | 50         |
| Course-IX (Practical I and II Semesters Common to all) | Organic Chemistry-B | 50         |
| Course-IX (Practical I and II Semesters Common to all) | Physical Chemistry-C | 50         |

#### SEMESTER-III

| Course-X   | Inorganic Chemistry                                        | 80         |
| Course-XI  | Organic Chemistry                                          | 80         |
| Course-XII | Physical Chemistry                                         | 80         |
| Course-XIII (Special Paper-I) | Any one of the following: Inorganic Chemistry-A | 80         |
| Course-XIII (Special Paper-I) | Organic Chemistry-B | 80         |
| Course-XIII (Special Paper-I) | Physical Chemistry-C | 80         |
| Course-XIV (Practical Common to all) | Inorganic Chemistry-A | 50         |
| Course-XIV (Practical Common to all) | Organic Chemistry-B | 50         |
| Course-XIV (Practical Common to all) | Physical Chemistry-C | 50         |

#### SEMESTER-IV

(A - Inorganic Chemistry specialization)

| Course-XV A (Special Paper-II) | Advanced Organometallics | 80         |
| Course-XVI A (Special Paper-III) | Modern Techniques of Chemical Analysis | 80         |
| Course-XVII A (Special Paper-IV) | Inorganic Spectroscopy | 80         |
| Course-XVIII A (Special Paper-V) | Bio-Inorganic Chemistry | 80         |

(B - Organic Chemistry specialization)

| Course-XV B (Special Paper-II) | Synthetic Strategy | 80         |
| Course-XVI B (Special Paper-III) | Natural products | 80         |
| Course-XVII B (Special Paper-IV) | Medicinal Chemistry | 80         |
| Course-XVIII B (Special Paper-V) | Polymer Chemistry | 80         |
### SEMESTER-IV

(C - Physical Chemistry specialization)

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course-XV C</td>
<td>Advanced Quantum Chemistry</td>
<td>80</td>
</tr>
<tr>
<td>(Special Paper-II)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course-XVI C</td>
<td>Solid State Chemistry</td>
<td>80</td>
</tr>
<tr>
<td>(Special Paper-III)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course-XVII C</td>
<td>Biophysical Chemistry</td>
<td>80</td>
</tr>
<tr>
<td>(Special Paper-IV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course-XVIII C</td>
<td>Chemistry of Macromolecules</td>
<td>80</td>
</tr>
<tr>
<td>(Special Paper-V)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Practicals

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course-XIX A</td>
<td>Inorganic Chemistry Practicals</td>
<td>75</td>
</tr>
<tr>
<td>Course-XIX B</td>
<td>Organic Chemistry Practicals</td>
<td>75</td>
</tr>
<tr>
<td>Course-XIX C</td>
<td>Physical Chemistry Practicals</td>
<td>75</td>
</tr>
<tr>
<td>Course-XX</td>
<td>(SEMINARS For all three specializations)</td>
<td>25</td>
</tr>
</tbody>
</table>

Note: The following criteria will be implemented with regards to the award of internal assessment:

1. Internal Assessment (I.A.) of 20 Marks will be added to each theory paper.
2. These marks would, however, be split as following: (a) 5 Marks for attendance in theory as well as in practical classes. The Weightage to attendance will be as follows: up to 75% with condonation from competent authority as per provision under ordinance-ZERO. Without condonation up to 75% - ONE MARK, 76-80% - TWO MARKS, 81-85% - THREE MARKS, 86-90% - FOUR MARKS and above 91% - FIVE MARKS.
3. The award of 15 Marks would be based on the performance of one Class Test of 15 Marks and this Test will be of objective / very short answer type.
SEMESTER-I  
(COURSE – I)  
(INORGANIC CHEMISTRY)  
Lectures-60  
Max. Marks-80

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 $C_{2v}$ and $C_{3v}$ point groups) if required.

UNIT-I  
**Group theory:** The concept of group, Symmetry elements and symmetry operations, Assignment of point groups to Inorganic molecules, Some general rules for multiplications of symmetry operations, Multiplication tables for water and ammonia, Representations (matrices, matrix representations for $C_{2v}$ and $C_{3v}$ point groups irreducible representations), Character and character tables for $C_{2v}$ and $C_{3v}$ point groups. Applications of group theory to chemical bonding (hybrid orbitals for $\sigma$-bonding in different geometries and hybrid orbitals for $\pi$-bonding. Symmetries of molecular orbitals in BF$_3$, C$_2$H$_4$ and B$_3$H$_6$.

UNIT-II  
**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 H$_2$SO$_4$, high electrical conductance in spite of high viscosity, Chemistry of H$_2$SO$_4$ as an acid, as an dehydrating agent, as an oxidizing agent, as a medium to carry out acid-base neutralization reaction and as a differentiating solvent. Liquid BrF$_3$: Physical properties, solubilities in BrF$_3$, self ionization, acid base neutralization reactions, solvolytic reactions and formation of transition metal fluorides.

UNIT-III  
**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-IV  
**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 (in analytical chemistry and chemotherapy)  
(e) Thiosemicarbazones (in analytical chemistry and chemotherapy)  
(f) Dithiazone (in analytical chemistry and chemotherapy)

UNIT-V  
**Supramolecular Chemistry (Ref. Book 15):** 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. 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  
7. Concise course in Inorganic Chemistry- J.D.Lee  
8. Chemistry of Elements – Greenwood and Earnshaw  
11. Topics in Current Chemistry (Inorganic/Bio-Chemistry)–Vol. 64  
14. Introduction to ligand fields – B.N.Figgis
SEMESTER-I
(COURSE - II)
(ORGANIC CHEMISTRY)

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
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 II

Unit III
Effect of structure on reactivity: resonance and field effects, steric effect. Quantitative treatment: Hammet equation and linear free energy relationship, Substituent and reaction constants, Taft equation. Methods of determining Reaction mechanisms,

Unit IV
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 vinlylic carbon. Esterification of carboxylic acid, transesterification, Phase-transfer catalysis, and ultrasound, ambident nucleophile, regioselectivity.

Unit V
Aliphatic Electrophilic substitution: Bimolecular mechanisms- SE₂ and SEᵢ. The SE₁ mechanism, electrophilic substitution accompanied by double bond shifts, halogenation 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 alkanes, Stork-enamine reactions
Free radical reactions: Geometry of free radicals, 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), Hoffmann -Löffler- Freytag reaction, Hunsdiecker reaction.

Books Recommended:
SEMESTER-I  
(COURSE – III)  
(PHYSICAL CHEMISTRY)

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


UNIT - II


UNIT - III

Kinetics of complex reactions: Consecutive and competitive (parallel) first order reactions. Kinetic vs. thermodynamic control reaction. Chain / free radical reactions; 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. Reaction rates and chemical equilibrium, principle of microscopic reversibility, activation energy and activated complex.

UNIT - IV


UNIT - V

1) Catalytic activity at surfaces: adsorption and catalysis, the Langmuir – Hinshelwood mechanism, the Eley – Rideal mechanism. Examples of catalysis: hydrogenation, oxidation and cracking nadroprming (qualitative treatment only).
2) Study of fast reactions; Flash photolysis and Stopped flow method

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 Reaction:C. Kalidas
7. Fast Reactions in Solutions: Caldin
8. Basic Principles of Spectroscopy: R. Chang
9. NMR and Chemistry: J.W. Akit
10. Introduction to Molecular Spectroscopy: G.M. Barrow
11. Physical Chemistry: P.W. Atkins
12. Fundamentals of Molecular Spectroscopy: C.N. Banwell
13. Physical Chemistry: G.K. Vemulapalli
SEMESTER-I
(COURSE – IV)
(MATHEMATICS FOR CHEMISTS & APPLICATION OF COMPUTER IN CHEMISTRY)

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 subdivided into Two – Three Parts. The students shall attempt FIVE questions selecting ONE from each unit.

Mathematics for Chemists

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. Vectors: representation and simple properties of vectors (addition and subtraction) vector addition by method of triangles, resolution of vectors. Scalar product of vector. Concept of normalization, orthogonality and complete set of unit vectors.

UNIT – II

UNIT – III

Application of Computer in Chemistry

UNIT – IV
Chemistry and FORTRAN Programming: Introductory FORTRAN concepts, character set, constant variables, data types, subscripted variables, and FORTRAN functions. FORTRAN expressions and naming FORTRAN programme, assignment statements, FORTRAN commands. Data transfer and program execution control: Introduction, format specification for READ and WRITE statements, format commands, control commands and transfer commands.

UNIT – V
Arrays and repetitive computation; Introduction, arrays arrange storage, dimension statement, do contruel, Nested do – loop continue statement, implied do. Sub – programme (functions and sub –routines): Introduction, sub programme, functions in FORTRAN, function arguments, subroutines, save variable function vs. subroutine programme. Global variables and file manipulation:Introduction, common statement, equivalence declaration, data command, block data subprogramme, declaration external, character expression and assignment, the open and closed statement, internal file, file ‘input’ and ‘output’. Developing Linear Least – Squares fit programs in FORTRAN, as well as for involving simple formulae in organic, inorganic and physical chemistry.

Books Recommended:
1. Mathematical Preparation for Physical Chemistry: F. Daniel
3. Applied Mathematics for Physical Chemistry: T.R. Barrassne
4. Fortran 77 & 90: V. Rajaraman
5. Computer in Chemistry: K.V. Raman
SEMESTER-II
(COURSE –V)
(INORGANIC CHEMISTRY)

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
Metal-Ligand Bonding: 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 momentum, Coupling of Spin angular momentum, Spin orbit coupling, spin orbit coupling $p^2$ 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 $d^2$ 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), $d^1$-$d^9$ systems in weak fields (excluding mathematics), strong field configurations, transitions from weak to strong crystal fields.

UNIT-IV
Electronic Spectra-II: Correlation diagrams ($d^1$-$d^9$) in Oh and Td environments, spin-cross over in coordination compounds. Tanabe Sugano diagrams, Orgel diagrams, evaluation of $B,C$ and $\beta$ parameters.

UNIT-V
Magnetochemistry: Origin of Magnetic moment, Magnetic susceptibility (diamagnetic, paramagnetic), spin only moment, Russell Sauder’s coupling, quenching of orbital angular moment, orbital contribution to a magnetic moment, magnetic moments from magnetic susceptibilities, temperature dependence of magnetic susceptibility, Factors determining paramagnetism, application of magnetochemistry in co-ordination chemistry in spin free and spin paired octahedral and tetrahedral complexes, Van Vlecks formula for 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 Inorganic Electronic Spectroscopy – A.B.P.Lever
6 Concise Inorganic Chemistry – J.D.Lee
7 Introduction to Ligand Fields - B.N.Figgis
SEMESTER-II
(COURSE - VI)
(ORGANIC CHEMISTRY)

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
(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, Dikmann reaction, Stobbe condensation, Mannich reaction, Knoevenagel condensation, Benzoin condensation, Witting reaction, Hydroboration, Hydrocarboxylation, Ester hydrolysis, Epoxidation.

Unit -III

Unit -IV
Elimination Reactions: Discussion of E$_1$, E$_2$, E$_1$cB and E$_2$C Mechanisms and orientation, Reactivity: Effects of substrate structures, attacking base, leaving group and medium. Mechanism and Orientation in Pyrolytic eliminations, Cis elimination, elimination in cyclic systems, eclipsing effects, cleavage of quaternary ammonium hydroxides, Shapiro reaction, Conversion of Ketoxime to nitriles.

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 and chelotropic reactions. Sigmatropic rearrangements-Suprafacial and Antarafacial shifts of H, sigmatropic shifts involving carbon moieties, Claisen, Cope and aza-Cope rearrangements, Ene reaction.

Books recommended:
SEMESTER-II
(COURSE – VII)
(PHYSICAL CHEMISTRY)

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
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
Non-Equilibrium Thermodynamics: Basic principles of non – equilibrium thermodynamics: rate laws, second law of thermodynamics for open system, law of conservation of mass, charge and energy flow. Electrokinetic phenomena and expressions for streaming potential, electro- osmotic pressure difference, streaming potential using the linear phenomenological equation.

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
SEMESTER-II
(COURSE –VIII)
(Chemistry of Life & Environmental Chemistry)

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
Cell structure and function: Basic concepts, 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: Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding. 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, an overview of replication of DNA, transcription, translation and genetic code. Chemical synthesis of mono and trinucleoside.

UNIT-III
Environmental Chemistry: Atmosphere, environmental segments, composition of the atmosphere, earth’s radiation balance, particulates, ions and radicals and their formation, chemical and photochemical reactions in the atmosphere, air pollution, oxides of C,N,S and their effects, acid-rain, smog formation, Green house effects (global warming and ozone depletion, air pollution controls and introduction to analytical methods for monitoring air pollution.

UNIT-IV
Hydrosphere: Chemical composition of water bodies-lakes, streams, rivers, sea etc, hydrological cycle, complexation in natural and waste water and microbially mediated redox reactions. Water pollution-inorganic, organic, pesticides, industrial and radioactive materials, oil spills and oil pollutants, eutrophication, acid-mine drainage, waste water treatment, domestic waste water (aerobic and anaerobic treatment), and industrial waste water treatment.

UNIT-V
Water quality parameters and standards: Analytical methods for measuring DO, BOD, COD, fluoride, oils and grease and metals (As, Cd, Hg, Pb, Zn,Cu,Cr), Biochemical effects of As, Cd, Hg, Pb, Cr, CN and pesticides. Lithosphere: Soil composition, micro and macro nutrients, soil pollution-fertilizers, pesticides.

Books Recommend:
1. Principles of Biochemistry –A.L.Lehringer
2. Introduction to Chemistry of Life–H.J.DeBay
3. Outlines of Biochemistry–Conn and Stumpf
5. Environmental Chemistry–Manaham
6. Environmental Pollution Analysis–Khopkar
SEMESTER I AND II
(COURSE – IX A)
(INORGANIC CHEMISTRY PRACTICAL)

Time - 6 hr/week
Max. Marks - 50

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 damasking agents
      v) Determination of hardness of water

2. 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.
   iv) Analysis of Ores (Dolomite, Pyrolusite) and alloys (Coin, Brass, Bronze).

3. Analysis of mixtures by gravimetric and volumetric methods from the mixture solutions:
   1. Copper- Nickel
   2. Copper -Magnesium
   3. Copper-Zinc
   4. Iron-Magnesium
   5. Silver-Zinc
   6. Copper-Nickel-Zinc
   7. Fe(II)-Fe(III)

4. Green methods of Preparation of the following:
   (i) Bis(acetylacetonato)copper(II)
   (ii) Tris(acetylacetonato)iron(III)
   (iii) Tris(acetylacetonato)manganese(III)

Books Recommended:
3. Commercial Methods of Analysis: Shell & Biffen
SEMESTER I AND II
(COURSE – IX B)
(ORGANIC CHEMISTRY PRACTICAL)

Time - 6 hr/week
Max. Marks - 50

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


**Books Recommended:**
4. Handbook of Organic Analysis-Qualitative and Quantitative, H.Clark, Edward Arnold.
1. **Refractive Index (RI) Measurements:** Refractive index measurements of pure solvents and analysis of solvent mixtures in terms of composition from the calibration plot.

2. **Conductometric Measurements:** Determination of cell constant, limiting molar conductance of simple electrolytes in water, verification of Ostwald, dilution law for week acetic acid.

3. **Surface Tension Measurements:** Surface tension of pure solvents, analysis of mixtures of two miscible solvents, verification of Gibb’s Thomson Rule of surface tension.

4. **Partition – Coefficient:** Determination of partition – coefficient for I₂ and benzoic acid between two immiscible solvents.

5. **Adsorption Measurements:** Verification of Freundlich adsorption isotherm for I₂, and acetic acid on charcoal.

6. **Colloidal Solution:** Preparation of sol solution of arsenic sulphide and estimation of flocculation value for NaCl, KCl, BaCl₂, AlCl₃.

7. **Thermochemistry:** Determination of water equivalent of thermos flask, and estimation of heat of neutralization for strong acid strong base, weak acid strong base or vice versa, heat of hydration and solution of salts.

**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 –X)
(INORGANIC CHEMISTRY)

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
Metal π Complexes: Preparation, reactions, structures and bonding in carbonyl, nitrosyl and phosphine complexes, structural evidences from vibrational spectra. 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.
Food and Drug Analysis- General methods for the analysis in food (moisture, ash, crude fiber and nitrogen (proteins). Discussion of official (pharmacopoeia) methods for the determination of following drugs as such: (i) Analgin (ii) oxyphenbutazone, (iii) phenyl butazone, (iv) sulphonamides.

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
3. Chemistry of the Elements – Greenwood and Earnshaw
4. Nuclear Chemistry-U.C.Dash
5. Nuclear Chemistry – B.G.Harvey
6. Nuclear Chemistry – Arnikar
10. Chemical Structure and Bonding- Dekock and Gray
12. Electronic absorption spectroscopy and related techniques: D.N. Sathyanarayan
13. Pharmacopoeia of India, Volume I and II.
SEMESTER-III
(COURSE - XI)
(ORGANIC CHEMISTRY)

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**

Ultra Violet and Visible Spectroscopy: Electronic transitions (185-800 nm), Beer- Lambert Law, Effect of solvent on electronic transitions, Ultra Violet bands of carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Steric effect in biphenyls, Fieser- Woodward rules for conjugated dienes and carbonyl compounds, ultra violet spectra of aromatic and heterocyclic compounds. Applications of UV- visible spectroscopy in organic chemistry.


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 deuterium, complex spin-spin interaction between two, three, four and five nuclei, virtual coupling. Stereochemistry, hindered rotation. Karplus- relationship of coupling constant with dihedral angle. First and second order spectra. Simplification of complex spectra-nuclear magnetic double resonance, spin tickling, INDOr, contact shift reagents, solvent effects. Fourier transform technique, nuclear Overhauser effect (NOE). Introduction to resonance of other nuclei $^{19}$F, $^{31}$P, $^{13}$C, NMR, 2-D and 3-D NMR, Applications of NMR in organic chemistry.

**Unit-II**

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. 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-III**


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, epoxymethones, Photo Fries rearrangement.

**Books Recommended:**
7. Organic spectroscopy by W. Kemp.
SEMESTER-III
(COURSE – XII)
(PHYSICAL CHEMISTRY)

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.

Statistical Thermodynamics
UNIT – I

UNIT – II
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, Third law of thermodynamics and entropy. Ortho- and para-hydrogen, statistical weights of ortho and para states, symmetry number. Calculation of equilibrium constants of gaseous solutions in terms of partition function, Einstein theory and Debye theory of heat capacities of monatomic solids.

Basic Quantum Chemistry
UNIT – III

UNIT – IV
Some analytically soluble problems (complete solutions) of particle in a one and three dimensional box, harmonic oscillator, the rigid rotor, the hydrogen atom and the quantum mechanical tunnelling.

UNIT – V

Suggested Reading:
1. Physical Chemistry: P.W. Atkins
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
SEMESTER-III  
(COURSE – XIII (A))  
(INORGANIC CHEMISTRY SPECIAL THEORY - I)  

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**
Basic principles, absorption, excitation, kasha rule, electronically excited state, its life-time and energy dissipation process. Thaxi state. Photochemical behaviour of transition metal complexes, charge transfer spectra of crystalline and gasous alkali halides. Photochemistry of chromium(III) octahedral complexes, \([\text{Cr(H}_2\text{O)}_6]^{3+}\) and \([\text{Cr(NH}_3)_6]^{3+}\). Photolysis/Adamson rules, photochemistry of cobalt(III) complexes, \([\text{Co(NH}_3)_5\text{X}]^{2+}\) and \([\text{Co(en)}_3]^{3+}\).

**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, factors affecting the stability constants (with special reference to metal and ligand ions), 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) Polarographic method

**UNIT-V**
*Electronic Spectra – III (Electronic spectra of complex ions):* Selection rules (Laporte, orbital and spin selection rules), band intensities, band widths, spectra in solids, spectra of aqueous solutions of d1-d9 ions in Oh and Td environments, Evaluation of 10 Dq, spectrochemical and nephelauxetic series, charge- transfer spectra.

**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
8. Inorganic Reaction Mechanism – Edberg
9. Inorganic Reaction Mechanism – Basolo and Pearson
10.Inorganic Photochemistry -- Adamson
SEMESTER-III

(COURSE – XIII (B))

(BIO-ORGANIC CHEMISTRY SPECIAL THEORY - I)

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
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: Remarkable properties of enzymes like catalytic power, specificity and regulation, Mechanism of enzyme action: Proximity effects and molecular adaptation, Chemical and biological catalysis, Transition state theory, orientation and steric effects, 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, Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

Unit-V

Books recommended:
2. Understanding Enzymes, Trevor Palmer, Prentice Hall.
10. Carbohydrates by N. Sharon.
11. Carbohydrates by Gutherie.
13. The Nucleic Acids (Vol I-II) by Chargoff and Davidson.
14. Protein Structures and Functions by A. Light.
17. The chemistry of Natural Products by P.S. Kalsi.
**SEMESTER-III**  
**(COURSE –XIII C)**  
*(Physical Chemistry Special Theory - I)*  

**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**  

**UNIT –II**  

**UNIT –III**  
Solution and Interfacial Behaviour of Surfactants: Definition and classification of surfactants. Solution properties of surfactants: 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 characterization techniques. Properties of nanostructured material: optical, magnetic and chemical properties. An overview of applied chemistry of nanomaterials.

**Books Recommended:**  
1. Physical Chemistry of Surfaces: A.W. Admson  
2. Adsorption from Solutions: J.J. Kipling  
5. Physical Chemistry: P.W. Atkins  
SEMESTER III
(COURSE – XIV A)
(INORGANIC CHEMISTRY PRACTICAL)

Preparation of following compounds:

1. Tetrapyridine copper(II)persulphate
2. Dinitritotetrapyridine nickel(II)
3. Mercury (tetraisothiocyanato)cobaltate(II).
4. Potassium tris(oxalato)aluminate(III)
5. Sodium hexa(nitro)cobaltate(III)
6. Potassium tris(oxalato)cobaltate(III)
7. Hexa(ammine)cobalt (III)chloride

Characterization of above compounds 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

B. **Multistep Synthesis:**
- Cannizzaro reaction: 4-chlorobenzaldehyde as substrate.
- Benzilic Acid Rearrangement: Benzaldehyde $\rightarrow$ Benzoin $\rightarrow$ Benzil $\rightarrow$ Benzilic acid.
- Hofmann bromamide Rearrangement: Phthalic anhydride $\rightarrow$ Phthalimide $\rightarrow$ Anthranilic acid
- Beckmann Rearrangement: Benzene $\rightarrow$ Benzophenone $\rightarrow$ Benzophenone oxime $\rightarrow$ Benzanilide.
- Skraup Synthesis: Preparation of quinoline from aniline.
- Synthesis using Phase Transfer Catalysis: Alkylation of diethyl malonate or ethyl acetoacetate and an alkyl halide.

**Books Recommended:**
4. Handbook of Organic Analysis-Qualitative and Quantitative, H.Clark, Edward Arnold.
1. **Solubility Measurements:** Heat of solution of electrolytes by solubility measurements.

2. **Heat of transfer Measurements:** Heat of transfer for benzoic acid and I\textsubscript{2} between two immiscible solvents.

3. **Conductometric Measurements:** Precipitation, and acid base titration. Determination of relative strength of acids in the given mixtures of acids. Solubility of sparingly soluble salt.

4. **Construction of Phase Diagram:** Phase diagram for liquids, (benzene and methanol) and phase diagram for solids, (benzoic acid and cinnamic acid, benzoic acid and naphthalene and acetamide and salicylic acid).

5. **Colorimetric Measurements:** Verification of Beer – Lambert’s law for aqueous solutions of KMnO\textsubscript{4}, K\textsubscript{2}Cr\textsubscript{2}O\textsubscript{7} and CuSO\textsubscript{4} and construction of calibration plot to estimate the unknown concentration.

6. **Kinetic Measurement:** Acid hydrolysis of ethylacetate and Saponification of ethylacetate.

**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-IV

(COURSE – XV A)
(INORGANIC CHEMISTRY SPECIAL THEORY - II)
(ADVANCED ORGANOMETALLICS)

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
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 Organometallic compounds (classification)

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 igration and elimination, rearrangement). Phase transfer catalysis. Homogeneous hydrogenation of unsaturated compounds (alkenes, alkynes, aldehydes and ketones). Asymmetric hydrogenation (Olefins).

UNIT-III
Some important homogeneous catalytic reactions:- Ziegler Natta polymerization of ethylene and propylene, oligomerisation of alkenes by aluminumalkyl, Wackers acetaldehyde synthesis, hydroformylation of unsaturated compounds using cobalt and rhodium complexes, Monsanto acetic acid synthesis, carbonylation of alkenes and alkynes using nickel carbonyl and 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 and industrial applications, and environmental aspects of organometallic compounds.

Books Recommended:
1. Principles of organometallic compounds – Powell
2. Organometallic chemistry (an Introduction) – Perkin and Pollar
3. Advanced Inorganic Chemistry – Cotton and Wilkinson
4. Organometallic Chemistry – R.C. Mehrotra
5. Organometallic compounds of Transition Metal – Crabtree
6. Chemistry of the Elements – Greenwood and Earnshaw
7. Homogeneous transition metal catalysis – Christopher Masters
8. Homogeneous Catalysis – Parshall
12. Principles and applications of organotransition metal chemistry by Collmen and Hegden

SEMESTER-IV
(COURSE – XVI A)
(INORGANIC CHEMISTRY SPECIAL THEORY - III)
(MODERN TECHNIQUES OF CHEMICAL ANALYSIS)

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

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 detailed description of the techniques of inductively coupled plasma AES (ICP-AES) and its instrumentation. Chemical and spectral interferences encountered in both techniques and how to overcome them.

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, polargrams, interpretation of polargraphic waves, equation for polargraphic waves, half-wave potential, effect of complex formation on polargraphic 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, polargrams 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 Ca and Mg in binary mixture, calcium oxalate, determination of Ca, Sr & Ba in the mixture, drying of sodium carbonate) and analysis of clays and soils, and determination of titanium content of non-stoichiometric sample of titanium carbide).

(b) Differential thermal analysis: Introduction, Factors affecting DTA curves, Instrumentation, Applications to inorganic compounds: Mixtures of lanthanum-cerium and praseodymium oxalate, CuSO4.5H2O, detection of organic contamination in ammonium nitrate, different magnesium carbonate samples and determination of uncalcined gypsum in plaster of paris.

Books Recommended:
1. Instrumental methods of analysis. - H.H. Willard, L.L. Marritt and J.A. Dean
3. Instrumental Methods of Chemical Analysis-G.K.Ewring

SEMESTER-IV
(COURSE - XVII A)
(INORGANIC CHEMISTRY SPECIAL THEORY - IV)
(INORGANIC SPECTROSCOPY)

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
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.
Applications 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) Modes of bonding of ligands such as urea and dimethylsulphoxide.

UNIT-II
Nuclear Magnetic Resonance Spectroscopy: Introduction, Chemical shift, Mechanism of electron shielding and factors contributing to the magnitude of chemical shift, Nuclear overhausser effect, Double resonance, Chemical exchange, Lanthanide shift reagents and NMR spectra of paramagnetic complexes. Experimental techniques (CW and FT).
Stereochemical non-rigidity and fluxionality: Introduction, use of NMR in its detection in PF5, 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. Structural information of the following: PCl5, TeCl4, Na’GaCl4’, BrCN, and Hexahalometallates

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

Electron Spin Resonance Spectroscopy:- Introduction, Similarities between ESR and NMR, Behaviour of a free electron in an external Magnetic Field, Basic Principle of an Electron Spin 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-Salicyldiimine - Copper(II)
2. CuSiF₆₂H₂O & (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 – XVIII A)
(INORGANIC CHEMISTRY SPECIAL THEORY - IV)
(BIO-INORGANIC CHEMISTRY)

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
(a) Metalloporphyrs: Porphyrins and their salient features, characteristic absorption spectrum of porphyrins, chlorophyll (structure and its role in photosynthesis), Transport of Iron in microorganisms (siderophores), types of siderophores (catecholate and Hydroxamato siderophores).
(b) Metalloenzymes: Definitions: Apoenzyme, Coenzyme, Metalloenzyme, structure and functions of Carboxy peptidases and Carbonic anhydrase.

UNIT-II
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: 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
Nitrogen fixation : A. Nitrogen molecule (MO picture) and its transition metal complexes, reactivity of coordinated dinitrogen, in-vivo and in-vitro nitrogen fixation, symbiotic and asymbiotic nitrogen fixation.
B. Nitrogen metabolism : Introduction, elementary idea about nitrogen nutrition in various forms (nitrate and ammonia nitrogen).

Books Recommended:
1. The Inorganic Chemistry of Biological processes - M.N.Hughes.
2. Bio Inorganic Chemistry - Robert Hay
5. General Biochemistry - Fruton J.S. and Simmonds S.
SEMMESTER-IV  
(COURSE – XV B)  
(ORGANIC CHEMISTRY SPECIAL THEORY - II)  
(SYNTHETIC STRATEGY)  

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: Wilkinson catalyst, Lithium dialkyl cuprates (Gilman’s reagents), Lithium diisopropylamide (LDA), 1,3-Dithiane (Umpolung) Dicyclohexylcarboxamide (DCC), and Trimethylsilylidide, DDQ, SeO2, Baker yeast, Tri-n-butylstannyldride, Nickel tetracarbonyl, Trimethylchlorosilane. Grubbs Catalysts.  

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, Bisdecarboxylation, 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. Penzlin, Verlage VCH.  
SEMESTER-IV  
(COURSE – XVI B)  
(ORGANIC CHEMISTRY SPECIAL THEORY - II)  
(NATURAL PRODUCTS)  

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

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:
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


Pharmacodynamics: Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, membrane active drugs, drug metabolism, xenobiotics, biotransformation, Significance of drug metabolism in medicinal chemistry.

Unit – III


Unit – IV


Anticonvulsants: Barbiturates, Oxazolidinediones, Succinimidenes, Phenacemide and Benzodiazepines. Psyctropic Drugs: The neuroleptics (Phenothiazines and butyrophenones), antidepressants (Monoamine oxidases inhibitors and Tricyclic antidepressants) and anti-anxiety agents (Benzodiazepines). Central Nervous System Stimulants: Strychnine, Purines, Phenylthylamine, analeptics, Indole ethylamine derivatives.

Unit – V


Antihistaminic agents: Ethylene diamine derivatives, amino alkyl ether analogues, amino alkyl ether analogues, cyclic basic chain analogues. Antifertility agents: General antifertility agents. HIV and anti AIDS drugs, Diuretics: Mercurial diuretic, Non mercurial diuretics (Thiazides, carbonic-anhydrase inhibitors, xanthine derivatives, pyrimidine diuretics and osmotic diuretics)

Books Recommended:
1. An Introduction to Medicinal Chemistry, Graham L. Patrick.
4. Introduction to Medicinal Chemistry, Alex Gringuage.
**SEMESTER-IV**

(COURSE – XVIII (B))

(ORGANIC CHEMISTRY SPECIAL THEORY - II)

(POLYMER CHEMISTRY)

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**

Chemistry of Polymerization: Macromolecular Concept, Chain polymerization – Radical, Cationic and Anionic polymerization, Step Growth polymerization, Electrochemical-initiated polymerization, Metathetical polymerization, Group transfer polymerization, Co-ordination polymerization, Kinetics of chain and step growth polymerization. Concept of chain transfer, Concept of copolymerization, Graft and Block copolymers, Copolymer equation, Monomer reactivity ratio, Alfrey-price scheme.

**UNIT- II**

Polymer synthesis: Bulk, solution, suspension, polycondensation, interfacial condensation and emulsion techniques of polymer synthesis


**Unit III**

Stereoisomerism in polymers: Types of stereoisomerism in polymers, Monosubstituted ethylenes (Site of steric isomerism, Tactility), Disubstituted ethylenes (1,1-disubstituted ethylenes, 1,2- disubstituted ethylenes). Stereoregular polymers: Significance of stereoregularity (isotactic, syndiotactic, and atactic polypropenes), Cis- and trans-1,4-poly-1,3- dienes, Cellulose and amylose.

Morphology and order in crystalline polymers: Configuration of polymer chains. Crystal structures of polymers, Strain-induced morphology, Crystallization and melting, Polymer structures and physical properties - crystalline melting point, Tm, Effect of chain flexibility and other steric factors, entropy and heat of fusion, Glass transition temperature, Tg, Relationship between Tm and Tg. Effect of molecular weight, diluents, chemical structure, chain topology, branching and crosslinking. Property requirement and polymer utilization.

**UNIT- IV**

Polymer Reactions: General introduction to the polymer reactions, Vulcanization, Chemical and radiation crosslinking, Derivatization of Cellulose: etherification and esterification, Graft co-polymerization, Methods of Graft Copolymerization. Polymer as carriers or supports, polymeric reagents, polymeric substrates, Merrifield resins, polymeric supports as catalysts and drug carrier.

**UNIT-V**


**Books Recommended:**

4. Introduction to Theoretical Organic Chemistry and Molecular Modeling, W.B. Smith, VCH.
SEMESTER-IV
(COURSE – XV C)
(PHYSICAL CHEMISTRY SPECIAL THEORY - II)
(ADVANCED QUANTUM CHEMISTRY)

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

UNIT - II

UNIT - III

UNIT – VI

UNIT – V
Quantum – mechanical treatment of conjugated \( \pi \)-electron systems: The \( \pi \)- electron approximation. The Huckel – Molecular Orbital Theory for conjugated hydrocarbon systems. Application to ethylene, butadiene, cyclobutadiene and benzene.

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 – XVI C)  
(PHYSICAL CHEMISTRY SPECIAL THEORY - III)  
(SOLID STATE CHEMISTRY)  

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  

UNIT - II  
Bonding in crystals: Ionic crystals, lattice energy of ionic crystals, metallic crystals. Band theory. Imperfections: Point defects (Schottky and Frankel defects). Thermodynamic derivation of these defects. Theories of Bonding: Free electro theory (a qualitative treatment) Zone theory; allowed energy zones, Brillouin zones, k–space, Fermi surfaces and density states.

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 thin films, growth of single crystal.

Books Recommended:  
1. Introduction to Solids: Azaroff  
2. Solid State Chemistry and its applications: West  
3. Solid State Chemistry: Charkrabarty  
5. Solid State Physics: Kiittal
SEMESTER-IV
(COURSE – XVII C)
(PHYSICAL CHEMISTRY SPECIAL THEORY - IV)
(BIOPHYSICAL CHEMISTRY)

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

UNIT – II
Statistical mechanics in biopolymers chain configuration of macromolecules, statistical distribution end – to - end dimensions, Polypeptide and protein structures and protein folding, calculation of average dimensions for various chain structures. Neurobiophysics: neurons, synapse, physics of membrane potential, neurotransmitters: Serotonin, GABA.

UNIT – III
Mechanism of Membrane Transport: Transport through cell membrane, active and passive transport (chemi-osmotic theory) systems, Irreversible thermodynamic treatment of membrane transport, Donnan effect in Osmosis, its dependence on pH difference across the membrane, Bio-mechanics: striated muscles, contractile proteins, mechanical properties of muscles and role of calcium.

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 weak interactions crucial to macromolecular structure and function, blood –the buffering system

UNIT – V
Protein molecules: Protein sequence and structure (primary structure), secondary structure: Ramachandran plot, (α-helix, β-strand, β-sheet, turns and loops), torsion angles,tertiary structure (ion-ion, ion-dipole and dipole-dipole interactions), quaternary structure, globular and fibrous proteins, structure of haemoglobin and myoglobin. Protein folding and refolding, Protein misfolding,Chaperones and chemical factors (Intra and intermolecular interactions) leading to folding/refolding/misfolding. Brain diseases associated with it, structure of virus.

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. Biophysics: Volkenstein
10. Biophysical Chemistry: Gurtu &Gurtu
UNIT – I

UNIT – II

UNIT – III
Chain conformation of macromolecules: statistical thermodynamics of interpenetrating random coiling polymers in solution with application to phase separations, swelling of networks, depression of melting point. The isolated chain molecule in dilute solutions analyzed for mass or size by static methods (osmometry, light scattering, neutron scattering) and by dynamic methods (intrinsic viscosity, size exclusion chromatography, sedimentation).

UNIT – VI
Rheology and Mechanical Properties of Polymers: Brief introduction to rheology and mechanical properties of polymers, phenomena of viscous flow, kinetic theory of rubber elasticity, amorphous polymers and practical importance of their aggregation states, viscoelasticity (experimental and dynamic method), The glassy state and glass transition temperature. Applications of polymers in Structural Polymers and Composites, Packaging Materials and Coatings, Transparent and Optical Materials, Biological and Medical Materials, Fluid Modifiers and Suspension Stabilizers

UNIT – V
1. Mechanical strength of polymers: Mechanical strength and life time of polymer mechanism of polymer fracture, effect of various factors on the mechanical properties of polymers (effect of size and shape, effect of fillers, effect of cross – linked density).
2. Polyelectrolytes: The water soluble charged polymers and their applications. Ionomers (ion containing polymers) conducting polymers solid polymer electrolytes, mechanism of conductivity. Polymers in combating environmental pollution and as chemical reagents.

Books Recommended:
1. Text Book of Physical Chemistry: G.M. Barrow
2. Text Book of Polymer Chemistry: Billmeyer
3. Polymer Chemistry: P.J. Flory
4. Physical Chemistry of Polymers: A Tagger
5. Physical Chemistry of Macromolecules: C. Tanford
6. Introduction to Polymer Science: V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar
7. Principles of Polymer Science: P. Bhadur and N.V. Sastry
Preparation of the following compounds and a study of the important properties viz. Molar conductance, magnetic susceptibility, electronic and infrared spectra.
1. Stannic iodide
2. Bis(acetylacetonato) oxovanadium (IV)
5. Lead tetraacetate
6. Cis- and trans- [Co(en)₂Cl₂]Cl

**INSTRUMENTAL ANALYSIS:**

**A) Conductometric Titrations:**

i) Differential behaviour of acetic acid to determine the relative acid strength of various acids.

ii) Strong acid-strong base titration in acetic acid.

iii) Potassium acetate-pyridine titration in acetic acid.

**B) Potentiometric Titrations:**

1. Neutralisation reactions:

i) Sodium hydroxide-hydrochloric acid.

ii) Sodium hydroxide-Boric acid.

iii) Acetic acid and hydrochloric acid-sodium hydroxide.

2. Oxidation-Reduction Reactions.

i) Ferrous-dichromate

ii) Ferrous-Ceric

iii) Iodine-Thiosulphate

3. Precipitation Reactions:

i) Silver nitrate-sodium halides.

ii) Chloride-Iodide mixture.

**C) Colorimetric Analysis:**

1) Verification of Beer’s law for KMnO₄, K₂Cr₂O₇ solutions and determination of the conc. of KMnO₄, K₂Cr₂O₇.

2) Colorimetric determination of Iron (II) with o-Phenanthroline method.

3) Determination of traces of manganese (in steel samples) colorimetrically by oxidation to permanganic acid with potassium periodate.

4) Spectrophotometric determination of pK value of an indicator (acid dissociation const. of methyl red)

5) Simultaneous determination of chromium (as Cr₂O₇²⁻) and manganese (as MnO₄⁻) in mixture.

6) Simultaneous determination of Fe(II) and Fe(III).

7) Photometric titration (simple illustrations)

8) Determination of stability constant of a complex by spectrophotometric method.

**D) pH metric –titrations**

1) Acid base titrations.

2) Mixtures of acids with a base.

**E) Polaroagrapy/Pulse polaroagrapy:**

1) Determination of half wave potentials of cadmium, zinc and manganous ions in potassium chloride solution.

2) Investigation of the influence of dissolved oxygen.

3) Differential pulse polaroagraphic determination of copper and zinc.

4) Determination of formation constant of a complex metal ion by polaroagrapy/pulse polaroagrapy.
(F) Cyclic voltammetry:
2. Study of electrode mechanism of cyclic voltammetry.

(G) Flame Photometry: Determination of sodium, potassium and calcium

Books Recommended:
1. A Text Book of Quantitative Inorganic Analysis - A.I. Vogel

SEMESTER - IV
COURSE - XIX (B)
(ORGANIC CHEMISTRY PRACTICAL - SPECIAL)

Time: 12 hrs/week
Max. Marks: 75

(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 $R_f$ value reported), lycopene from tomatoes and $\beta$-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 $R_f$ 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:
4. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Edward Arnold.
1. **Viscosity Measurements**: Verification of the Jones – Dole equation for simple electrolytes in water and in aqueous mixtures of organic solvents.

2. **Conductometric Measurements**: Determination of Walden’s product in case of simple electrolytes.

3. **Potentiometric Titration**: Titration of HCl with NaOH, determination of dissociation constant of acetic acid and phosphoric acid. Oxidation – reduction titration.

4. **Flamephotometric Measurements**: Estimation of concentration of Ca$^{2+}$, Na$^+$ and K$^+$ ions and in the given aqueous solution at ppm level.

5. **Determination of Molar Mass**: (i) Cryoscopic and Rast’s methods.

6. Determination of molar mass of polymer by viscosity measurement.

7. **Colometry Measurements**: Determination of composition and free energy of formation of ferric ions – salicylic acid complex using Job’s continuous method.

8. **Polarimetry Measurements**: Determination of specific and molecular rotation, percentage of tow optically active substances, kinetics of acid catalysed inversion of cane sugar and comparison of strengths of two acids.

Books Recommended:

1. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
4. Practical in Physical Chemistry: P.S. Sindhu
5. Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
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.