

॥ अंतरी पेटवू ज्ञानज्योत ॥



**NORTH MAHARASHTRA UNIVERSITY,  
JALGAON.**

**Syllabus for M.Sc.**

**CHEMISTRY (Part-I).**

**( W.e.f. Acd. Yr. 2002 - 2003)**

100  
100



SYLLABUS FOR M.Sc. CHEMISTRY (Part-I).

(W.e.f. Acad. Yr. 2002-2003)

COURSE STRUCTURE.

1. Each theory course should be covered in 5 periods, each of 60 minutes per week, four periods for lectures and one for tutorials, seminars etc.
2. Each practical course will require 6 hours of laboratory work per week and the course will be extended over two semesters and will be examined at the end of the year.
3. There should not be more than 10 students in a batch of M.Sc. practical course.
4. The students taking Physical Chemistry for M.Sc. Part-II must opt Section -III [Chemical mathematics] of general Chemistry course CH-290.
5. The distribution of course for two semesters will be as under :

Semester - I

- CH-110 : Physical Chemistry-I  
CH-130 : Inorganic Chemistry-I  
CH-150 : Organic Chemistry-I

Semester - II

- CH-210 : Physical Chemistry-II  
CH-230 : Inorganic Chemistry-II  
CH-250 : Organic Chemistry-II  
CH-290 : General Chemistry  
( Any two of the following sections )  
Section-I : Analytical Chemistry  
Section-II : Instrumental Methods of Analysis  
Section-III : Chemical Mathematics

Practical Courses

- CH-P-1 : Physical Chemistry Practical  
CH-I-1 : Inorganic Chemistry Practical  
CH-O-1 : Organic Chemistry Practical

## CH-110 PHYSICAL CHEMISTRY -I

### CONTENTS

1. Thermodynamic Properties of Simple Mixtures
2. Statistical Thermodynamics
3. Dynamic Electrochemistry
4. Radioactivity
5. Applications of Radioactivity
6. Elements of Radiation Chemistry

1) THERMODYNAMIC PROPERTIES OF SIMPLE MIXTURES :-

The chemical potential of a pure substance, The thermodynamic description of mixtures, partial molar quantities, Partial molar volume, partial molar Gibbs energies The wider significance of the chemical potential, The Gibbs-Duhem equation Determination of partial molar volume by method of intercepts, the thermodynamics of mixing, Gibbs free energy of mixing, other thermodynamic functions of mixing, Chemical potentials of liquids, Ideal solutions, Ideal dilute solutions, properties of solutions, Liquid mixtures, Colligative properties, Common features of colligative properties, Elevation of boiling point, Depression of freezing point, solubility, Osmosis and osmotic pressure.

Ref :- 1 Pages : 132,163 to 182.

[8]

2. STATISTICAL THERMODYNAMICS :-

Thermodynamic probability of a system of distinguishable and indistinguishable particles, Stirling's approximation, Boltzmann distribution law, Partition function, Energy and heat capacity in terms of partition function, Entropy and probability, Entropy in terms of partition function, Separation of partition functions, translational partition function, translational energy heat capacity and entropy for monoatomic gases, Sackur-Tetrode equation, Rotational partition function, Rotational energy, heat capacity and entropy, vibrational partition function, vibrational energy heat capacity and entropy, Electronic partition function, statistical calculation of equilibrium constant.

Ref:- 2 : Pages 751-771.

[8]

Ref:- 3 : Pages 183-185, 186-191, 193-196,  
100-105, 109-111 & 113-116.

3) DYNAMIC ELECTROCHEMISTRY :-

Introduction, processes at electrodes, Electrical double layer, rate of charge transfer, rate laws, activation Gibbs energy, Butler-Volmer equation, Overpotential, low and high overpotential limits, Polarization, Concentration polarization, Electrochemical processes, Electrolysis, Characteristics of working cells, Potentials of working cells, Power output of working cells, corrosion, Rate and inhibition of corrosion.

Ref:- 1 : Pages 877-887 & 890-895.

[8]

and probability, Entropy in terms of partition function, Separation of partition functions, translational partition function, translational energy heat capacity and entropy for monoatomic gases, Sackur-Tetrode equation, Rotational partition function, Rotational energy, heat capacity and entropy, vibrational partition function, vibrational energy, heat capacity and entropy, Electronic partition function, statistical calculation of equilibrium constant.

Ref:- 2 : Pages 751-771. [8]

Ref:- 3 : Pages 183-185, 186-191, 193-196,  
100-105, 109-111 & 113-116.

### 3] DYNAMIC ELECTROCHEMISTRY :-

Introduction, processes at electrodes, Electrical double layer, rate of charge transfer, rate laws, activation Gibbs energy, Butler-Volmer equation, Overpotential, low and high overpotential limits, Polarization, Concentration polarization, Electrochemical processes, Electrolysis, Characteristics of working cells, Potentials of working cells, Power output of working cells, corrosion, Rate and inhibition of corrosion.

Ref:- 1 : Pages 877-887 & 890-895. [8]

### 4] RADIOACTIVITY :-

Parent-daughter decay-growth relationships :- The daughter nucleus stable, General expression for the activity of daughter nuclide, Parent shorter lived than daughter, Parent and daughter of nearly the same half life, Parent longer lived than daughter, Secular and transient equilibrium, Branching decay, Alpha decay : Alpha active nuclides, Range, Ionizing power and energy spectrum of alpha particles, Geiger-Nuttals law. Theory of alpha decay, Beta decay : Three types of beta decays, Absorption and range of beta energetics of beta decay, Problems of beta decay, Nuclear deexcitation, Gamma transition, Isomeric transition, Internal conversion, Effects of vacancy filling : Radiation emission and electron emission.

Ref:-4 : Pages 126-158, 167, 174-179. [10]

### 5] APPLICATIONS OF RADIOACTIVITY

Probing by isotopes, Typical reactions involved in the preparation of radioisotopes, The Szilard-Chalmer's reaction, Radiochemical principles in the use of tracers, Application in Physico-chemical research : Solubility of sparingly soluble substance and surface area of powder or precipitate, Analytical application : Isotope dilution analysis, Neutron activation analysis.

Ref:-4 : Pages 358-359, 363-368, 371-373, 381-383, 391-399. [8]

Radiation chemistry, Interaction of radiation with matter: Primary effects

LET, Bremsstrahlung, Interaction of gamma radiation with matter: Photoelectric effect, Compton scattering, pair production, Units of measuring radiation absorption, Absorption in water, Radiation/dosimetry: Units of radiation energy, Chemical dosimetry, Conversion of measured dose values, Radiolysis of water: Ionic and free radical products, Hydrated electron, Molecular products, Chain reactions, Distribution of prp of water.

Ref:- 4: Pages : 427-457.

[6]

#### REFERENCES

1. Physical Chemistry  
By P.W. Atkins, Oxford University Press, 6th Edition.
2. Principles of Physical Chemistry.  
By S.H Maron and C.F. Prutton 4th Edition.
3. Thermodynamics for Chemists.  
By S. Glasstone D. Van Nostrand co-Inc.
4. Essentials of Nuclear Chemistry.  
New Age International Publisher Ltd. Willer-Eastern Ltd.  
4th Edition.  
By H.J. Arnikar.

## CH-130 INORGANIC CHEMISTRY-I.

### CONTENTS

1. Wave Mechanics
2. The Particle in one Dimensional box, the particle in three Dimensional box. Degeneracy.
3. The Hydrogen Atom
4. Quantum States
5. Molecular Orbital Theory
6. A) Valence Bond Theory  
B) Multiple Bonding in Polyatomic Molecules, Multicentre Bonding, Macro molecules and Metals.
7. The structure and energetics of inorganic solids
8. Complex formation
9. Physical properties of molecules

### CH-130 : INORGANIC CHEMISTRY-I

1. Wave Mechanics : Matter waves, Uncertainty principle, wave nature of electron. interpretation of wave function, normalized and orthogonal wave functions, wave equation and principle of superposition.  
Ref.: 1, Pages 26 to 38, Ref.:- 3, Pages 42 to 45 [4]
2. The particle in one dimensional box, the particle in three dimensional box, degeneracy.  
Ref.:- 1, Pages 38 to 45. Ref.:- 3, Pages 46 to 52 [3]
3. The hydrogen atom : Transformation of co-ordinates, separation of variables, the  $\phi$  equation, the  $\theta$  equation, the radial equation, spherical harmonics.  
( Mathematical solutions of equations are not expected ).  
Ref.:- 1, Pages 45 to 53, Ref.:- 3, Pages 52 to 58 [3]
4. Quantum states, electron spin, energy states of the hydrogen atom, the self consistent method, wave functions of the hydrogen atom, radial distribution curves, angular dependence of the wave function.  
Ref.:- 1, Pages 54 to 64, Ref.:- 3, Pages 54 to 59 [4]



5. Molecular orbital theory of polyatomic molecules like,  $\text{BeH}_2$ ,  $\text{CO}_2$ ,  $\text{NH}_3$ ,  $\text{CH}_4$ ,  $\text{BF}_3$ .  
Ref.: 2, Pages 95 to 147. [6]
6. A) Valence bond theory :- diatomic molecules, polyatomic molecules.  
E) Multiple bonding in polyatomic molecules, multicentre bonding, macromolecules and metals.  
Ref.: 3, Pages 100 to 113. [4]
7. The structure and energetics of inorganic solids :- Introduction, close packing of spheres, structure of ionic solids, ionic radii, radius ratio rules, Born Haber cycle, applications of lattice energies, metals.  
Ref.: 3, Pages 135 to 162, Ref.: 4, Pages 52 to 71. [8]
8. Inorganic Chemistry in aqueous media, complex formation formation constants of complexes, factors affecting the stability of complexes containing only monodentate ligands, redox processes, the stabilization of oxidation states, potential diagrams and oxidation state diagrams and factors determining the magnitude of redox potentials.  
Ref.: 4, Pages 114 to 137. [10]
9. Some physical properties of molecules, the shapes of molecules and ions of non-transition elements, symmetry, bond energies, force constants, bond lengths, bond polarities and electronegativity.  
Ref.: 3, Pages 115 to 133, Ref.: 4, Pages 90 to 101. [6]

#### REFERENCES

1. Theoretical inorganic chemistry (second edition), By Day and Selbin, Affiliated east-west press Pvt.Ltd. New Delhi.
2. Electrons and Chemical Bonding (1964), By H.B.Gray, W.A.Benjamin, New York.
3. Inorganic Chemistry, By A.G.Sharpe, ELBS and Longman group Ltd.
4. Modern Aspects of Inorganic Chemistry, By H.J.Emeleus and A.G.Sharpe, Universal book stall, New Delhi-2.
5. Concise Inorganic Chemistry (Fourth Edition), By J.D.Lee, ELBS with Chapman and Hall.
6. A New Concise Inorganic Chemistry (Third Edition), By J.D.Lee ELBS Van Nostrand Reinhold (UK).
7. Instrumental Methods of Chemical Analysis by Chatwal Anand (1st Edition), Pages 309-320.

CONTENTS

1. Aliphatic Nucleophilic Substitution.
2. A) Aromatic Electrophilic Substitution.  
B) Nucleophilic Aromatic Substitution.
3. Electrophilic Additions to Unsaturated Carbon.
4. Elimination Reactions.

CH-150 : ORGANIC CHEMISTRY-I

1. Aliphatic Nucleophilic Substitution [12]

Mechanism:- The  $S_N2$  mechanism, The  $S_N1$  mechanism, mixed  $S_N1$  and  $S_N2$  mechanism, the neighboring - group mechanism and the  $S_Ni$  mechanism. Nucleophilic substitution at an allylic carbon. Allylic rearrangements,

Reactivity :- The effect of substrate structure, the effect of the attacking nucleophile, the effect of the leaving group, the effect of the reaction medium.

Reference 1:- Pages 255 to 262; 265 to 272; 286 to 289 & 298-320.

Reference 2:- Relevant Pages.

Reference 11:- Relevant Pages.

2. A) Aromatic Electrophilic substitution [14]

a) Mechanisms:- The arenium mechanism, the  $SE_1$  mechanism, Orientation and reactivity, the ortho/para ratio, ipso attack. Orientation in benzene rings with more than one substituent. Orientation in other ring systems.

b) Nitration, halogenation, sulfonation, diazonium coupling, ipso substitution, Friedel-Craft alkylation, Friedel-Craft acylation. Other methods of aryl-carbon bond formation.

Reference 1:- Pages 447 to 462.

Reference 2:- Pages 616 to 631 and 638 to 660.

Reference 11:- Relevant Pages.

## 3] Nucleophilic Aromatic Substitutions

The addition - elimination mechanism, the elimination-addition mechanism. The aryl cation mechanism-diazonium salts.  
Reference 2:- Pages 662 to 671.

## Electrophilic Additions to Unsaturated Carbon :- [12]

The mechanism of electrophilic addition : The  $AdE_2$  mechanism, structural effects and reactivity. Direction and stereo-chemistry of addition. Addition to alkenes and alkynes : Halogenation, hydrohalogenation, hydration, hydroboration, epoxidation-hydroxylation, carbene addition, hydrogen -ation, ozonolysis, addition of alkenes and alkynes, alkenes and alkynes as petrochemical raw materials.

Reference 2:- Pages 517 to 537.

## 4. Elimination Reactions -

[10]

The reaction mechanism : The  $E_2$  mechanism, the  $E_1$  mechanism, the  $E1CB$  mechanism, mechanistic variables,  $E_1$  versus  $E_2$ . Elimination versus substitution. The direction of elimination. Stereochemistry : anti-elimination, stereo-electronic factors, syn elimination.

Formation of alkenes:- dehydrohalogenation, dehalogenation, dehydration, the Hofmann elimination, pyrolytic elimination, Catalytic dehydrogenation. Formation of alkynes.

Reference 2 :-Pages 466 to 501.

## REFERENCES :-

1. Advance Organic Chemistry. Third edition by Jerry March. John Wiley and Sons.
2. Organic Chemistry, Fifth edition by Stanley H.Pine.
3. Absorption Spectroscopy. by Y.R.Sharma.
4. Spectroscopy of Organic Compounds. Second edition. by P.S.Kalst. New Age International Publishers Ltd. Wiley Eastern Ltd.
5. Spectroscopic identification of organic compounds. Fifth edition. by R.M.Silverstein, G.C.Bassler, and T.C.Morrill. John Wiley & Sons.
6. Stereochemistry of carbon compounds. by E.L.Eliel. Tata McGraw - Hill Ltd.
7. Stereochemistry of organic compounds. Second edition. by D.Nasipuri. Wiley Eastern Ltd.
8. Modern synthetic reagents. by H.O.House
9. Principles of Organic Synthesis. by R.O.C.Norman and J.O.Coxon. Third edition. ELBS.
10. Molecular orbital symmetry and organic reaction mechanism. by I.Flemming.
11. Organic Chemistry. Sixth edition. by R.T.Morrison and R.N.Boyd. Printice-Hall of India Pvt. Ltd., New Delhi.

CONTENTS

1. Microwave Spectroscopy
2. Infrared Spectroscopy
3. Raman Spectroscopy
4. Electronic Spectroscopy of Molecules
5. The Rates of Reactions
6. The Kinetics of Complex Reactions.
7. Molecular Reaction Dynamics
8. Fast Reactions

CH-210 : PHYSICAL CHEMISTRY -II

1] MICROWAVE SPECTROSCOPY :-

The intensity of spectral lines, the rotation of molecules, the rigid diatomic molecules, intensities of spectral lines, effect of isotopic substitution, Non-rigid rotator, spectrum of non-rigid rotator, polyatomic molecules; linear molecules, symmetric top molecules. [6]

Ref:- 1 : Chapter 2 Pages 31-50.

2] INFRARED SPECTROSCOPY:-

Vibrating diatomic molecules, simple harmonic oscillator, anharmonic oscillator, Diatomic vibrating rotator, vibration rotation spectrum of  $\text{CO}_2$ , Breakdown of Bron-Oppen-heimer approximation, vibrations of polyatomic molecules, Fundamental vibrations and their symmetry, overtone and combination frequencies, the influence of rotation on spectra of polyatomic linear and symmetric top molecules, influence of nuclear spin.

Reference :- 1 Chapter 3 Pages : 55 to 82.

[7]

### 3] RAMAN SPECTROSCOPY :-

Quantum and classical theories of Raman effect, Pure rotational Raman Spectra : Linear molecules, Symmetric top molecules, spherical top molecules, vibrational Raman Spectra: Raman activity of vibrations, Rule of Mutual exclusion, vibrational Raman spectra, Rotational fine structure, structure determination from Raman and infrared spectroscopy.

Ref :- 1 Chapter -4 Pages : 100-116, 119-121. [5]

### 4] ELECTRONIC SPECTROSCOPY OF MOLECULES :-

Electronic spectra of diatomic molecules: Born-oppenheimer approximation, vibrational coarse structure, Intensity of vibrational-electronic spectra, Franck-Condon principle, Dissociation energy and dissociation products, Rotational fine structure of electronic-vibration transitions, the Fortrat diagram, predissociation.

Ref :- 1 Chapter 6 Pages 162-175 [6]

### 5] THE RATE OF REACTIONS :-

Rate laws and rate constants, reactions approaching equilibrium, consecutive elementary reactions, the variation of concentrations with time, the rate determining step, the steady state approximation, Pre-equilibria, the Michaelis-Menten mechanism, Unimolecular reactions. The Lindemann Hinshelwood mechanism, The activation energy of a composite reaction.

Reference :- 2:- 763-765, 771-773, 778-785.

Reference :- 3:- 21-28, 31-47, 325-329, 415 to 419. [6]

### 6] THE KINETICS OF COMPLEX REACTIONS :-

Chain reactions, the structure of chain reactions, the classification of reactions, Explosions, Photochemical reactions, quantum yield, photochemical rate laws, photosensitization, quenching polymerisation, chain and stepwise polymerisation, rate laws of stepwise polymerisation.

Reference :- 2 793-806. [6]

### 7] MOLECULAR REACTION DYNAMICS :-

Reactive encounters, collision theory, Diffusion controlled reactions. The material balanced equation, Activated complex theory. The reaction co-ordinate and transition state, Eyring equation, thermodynamic aspects. The dynamics of molecular collision, reactive collisions.

Reactions between ions, Influence of solvent and pressure on rates in solution, single phase activated complex, linear free energy relationships, Hammett equation, Taft equation.

Reference :- 2 Pages 819-833, 834-837. [8]

Reference :- 3 Pages 210-214, 217-222, 231-234 & 246-251.

## 8] FAST REACTIONS

Flash photolysis, Flow techniques, relaxation methods.

Reference :- 2 Pages 763, 773-775. [4]

Reference :- 3 Pages 21-28.

## REFERENCES

1. Fundamentals of Molecular Spectroscopy.  
By G.N.Banwell and E.M.McCash.  
Tata Mac-Graw Hill Publishing Co.Ltd.,[4<sup>th</sup> Edition]
2. Physical Chemistry  
By P.W.Atkins.  
Oxford University Press,[6<sup>th</sup> Edition]
3. Chemical Kinetics,  
By K J Laidler  
TMH [2<sup>nd</sup> Edition]

## CH-230: INORGANIC CHEMISTRY-II

### CONTENTS

1. Features of Solids
2. Electronic Spectra
3. Physical Methods of Inorganic Chemistry.
4. Reactions in Non-Aqueous Solvents.
5. Thermodynamic aspects of Transition Metal Chemistry.
6. d-Block Transition Elements.

### INORGANIC CHEMISTRY-II, CH-230

1. Features of solids :- Band theory of solids, defects inherent in the thermodynamics of the solid state, specific defect structures, stoichiometric defects, non-stoichiometric defects, semiconductors and transistors, rectifiers, photovoltaic cells, microminaturized semiconductor devices, integrated circuits.

Ref.:- 4, Pages 75 to 89, Ref.:- 5, Pages 58 to 68.

[8]

2. Electronic Spectra :-

Vector model of atom and spectroscopic terms, energy levels in an atom, coupling of orbital angular momenta, spin-orbit coupling, determination of ground state terms for closed sub-shell.

Derivation of terms for P<sup>2</sup> and d<sup>2</sup> configuration, hole formulation, calculation of number of microstates.

Ref.:- 2, Pages 22 to 27, Ref.:- 5, Pages 938 to 950.

[4]

3. Physical method of inorganic chemistry X ray diffraction methods. Laue photographic method, Bragg X ray spectrometer method, Rotating crystal method powder crystal method, polymer characterisation, particle size determination, applications of diffraction method to complexes.

Ref.:- 7, Pages 309 to 320.

[4]

4. Reactions in non-aqueous solvents :

Anhydrous sulphuric acid, other protonic solvents, aprotic solvent systems, the halogens, interhalogen compounds, other covalent hydrides, oxy-halides, dinitrogen tetroxide, sulphur dioxide.

Ref.:- 4, Pages 150 to 168.

[8]

5. Thermodynamic aspects of transition metal chemistry: Crystal field stabilization energies of the octahedral and tetrahedral complexes, oxidation states in aqueous media, ionization energies.

Ref.: - 3, Pages 490 to 502, Ref.: - 4, Pages 505 to 529. [8]

6. d-block transition elements :

General properties, scandium group, titanium group vanadium group, chromium group, manganese group, iron cobalt and nickel group, horizontal comparison in the iron, cobalt, nickel group, copper group, zinc group.

Ref.: - 5, Pages 294 to 393. [16]

#### REFERENCES:-

1. Theoretical inorganic chemistry (second edition), By Day and Selbin, Affiliated east-west press Pvt.Ltd.New Delhi.
2. Electrons and Chemical Bonding (1964), By H.B.Gray, W.A.Benjamin, New York.
3. Inorganic Chemistry , By A.G.Sharpe, ELBS and Longman group Ltd.
4. Modern Aspects of Inorganic Chemistry, By H.J.Emeleus and A.G.Sharpe, Universal book stall, New Delhi-2.
5. Concise Inorganic Chemistry (Fourth Edition), By J.D.Lee, ELBS with Chapman and Hall.
6. A New Concise Inorganic Chemistry (Third Edition), By J.D.Lee ELBS Van Nostrand Reinhold (UK).
7. Instrumental Methods of Chemical Analysis by Chatwal Anand ( 1st Edition), Pages 309-320.

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CONTENTS

1. Rearrangements
2. Reagents used in Organic Synthesis
3. Stereochemistry
4. Spectroscopic Methods.
5. Introduction to Pericyclic Reactions.

CH-250 : ORGANIC CHEMISTRY-II

1. Rearrangements :- [10]

Wagner-Meerwein, Pinacol, Wolff, Arndt-Eistert, Hofmann, Curtius, Schmidt, Lossen, Beckmann Baeyer-villiger, Favorskii, Benzilic acid, Stevens, Wittig, Claisen, Meisenheimer and Sigmatropic rearrangements.

Reference 2 :- Pages 973 to 994 and 997 to 1005.

2. Reagents used in organic synthesis : [10]

$\text{CrO}_3$ ,  $\text{Na}_2\text{Cr}_2\text{O}_7$ ,  $\text{Pb}(\text{OAc})_4$ , per acids periodic acid,  $\text{SeO}_2$ , NBS,  $\text{OsO}_4$ ,  $\text{O}_3$ , active  $\text{MnO}_2$ , Oppenauer oxidation,  $\text{NaBH}_4$ ,  $\text{LiAlH}_4$ ,  $\text{B}_2\text{H}_6$ ,  $\text{NH}_2\text{-NH}_2/\text{KOH}$ , Na-liq  $\text{NH}_3$ ,  $\text{Zn-Hg}/\text{H}_2\text{O}/\text{HCl}$ , DDC, DDQ, Pyridium chlorochromate, LAD, Lithium dimethyl cuprate, phase transfer catalyst.

Reference 8 :- Relevant pages.

Reference 9 :- Relevant pages.

3. Stereochemistry :- [8]

The actual shape of six-membered rings and its reaction to properties and reactivity.

Reference 6 :- Pages 204 to 246.

Reference 7 :- Relevant pages.

**Spectroscopic methods :-**

U.V. :- Conjugated dienes, conjugated enones, Aldehydes, Ketones, Woodward's rules and related problems.

I.R. :- Theory of molecular vibration. Principles of I.R. frequency and factors affecting I.R. frequency.

N.M.R. :- Basic principles of NMR spectroscopy and problems.

Problems on U.V., I.R. and N.M.R.

Reference :- 2,3,4 and 5 relevant pages.

## 5. Introduction to pericyclic reactions :-

[5]

F.M.O. of ethylene, 1,3 butadiene, 1,3,5 hexatriene and study of their symmetry elements.

Reference 10 :- Relevant pages.

## References :-

1. Advance Organic Chemistry. Third edition by Jerry March. John Wiley and Sons.
2. Organic Chemistry. Fifth edition by Stanley H. Pine.
3. Absorption Spectroscopy. by Y.R. Sharma.
4. Spectroscopy of Organic Compounds. Second edition. by P.S. Kalsi. New Age International Publishers Ltd. Wiley Eastern Ltd.
5. Spectroscopic identification of organic compounds. Fifth edition. by R.M. Silverstein, G.C. Bassler, and T.C. Morrill. John Wiley & Sons.
6. Stereochemistry of carbon compounds. by H.I. Eliel. John Wiley & Sons. McGraw-Hill Ltd.
7. Stereochemistry of organic compounds. Second edition. by D. Nasipuri. Wiley Eastern Ltd.
8. Modern synthetic reagents. by H.O. House
9. Principles of Organic Synthesis. by R.O.C. Norman and J.O. Coxon. Third edition. ELBS.
10. Molecular orbital symmetry and organic reaction mechanism. by I. Fleming.
11. Organic Chemistry. Sixth edition. by R.T. Morrison and R.N. Boyd. Prentice-Hall of India Pvt. Ltd. New Delhi.

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CH-290 GENERAL CHEMISTRY (ANY TWO SECTIONS)

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SECTION-I

ANALYTICAL CHEMISTRY

- 1] Statistics
- 2] Chromatographic Methods
- 3] Pollution Analysis

SECTION-II

INSTRUMENTAL METHODS OF ANALYSIS

- 1] Polarography
- 2] Photoacoustic Spectroscopy
- 3] Radioactivity as Analytical Tools

SECTION-III

CHEMICAL MATHEMATICS

- 1] Differential Calculus
- 2] Integral Calculus
- 3] Differential Equations
- 4] Errors
- 5] Graphical Methods in Physical Chemistry
- 6] Problems in Physical Chemistry

SECTION-I

ANALYTICAL CHEMISTRY

1] Statistics : Introduction to Chemometrics  
Recapitulation : Classification of errors, Accuracy, Precision, how to reduce systematic errors, Significant figures.

Topics : Mean and standard deviation, distribution of random errors, Reliability of errors, confidence intervals, comparison of results, paired t-test the number of replicate determination, correlation and regression, linear regression, errors in slope and intercept, Errors in the estimate of concentration.

Chemometric and experimental design, factorial design.

Ref. - 2 Chapter 4 Pages 117 to 137 & 146 to 149. [12]

2. Chromatographic Methods :-

A] Gas Chromatography :- Principles, Gas Chromatographic column, Gas Chromatography detectors, column efficiency in Gas Chromatography, some practical aspects in Gas Chromatography.

Ref.- 1 Chap.16 Pages 461 to 468.

Ref.- 2.Chap.9 Pages 289 to 307.

B] High Performance Liquid Chromatography:-

Principles, equipment for HPLC. choice of column materials for HPLC .

Ref.- 1 Chap.17 Pages 537 to 547

Ref.- 2.Chap.8 Relavent Pages.

C] Electrophoresis :-

The theory of electrophoresis, Instrumentation for capillary electrophoresis, capillaries, applied field, detectors, applications.

Ref.- 2 Pages 246 to 249.

[9]

3. Pollution Analysis :-

A] Air Analysis:- Air sample collection and analysis of the air sample.

B] Water Analysis :- Sampling of water. Analysis of water sample.

Ref.1- Pages 629 to 636

[3]

## REFERENCES :-

1. Analytical Chemistry.  
By G.D.Christian, John.Wiley & Sons, Inc.  
(Fourth Edition)
2. Vogel's Text Book of Quantitative chemical analysis  
By J. Mendham, R C Denney, J D Barnes,  
M J K Thomas [ Pearson Education, Asia ]  
( Sixth Edition ) ELBS

## SECTION-II INSTRUMENTAL METHODS OF ANALYSIS

1] Polarography :- Basic principles, polarization of electrode, current-voltage relationship, dropping mercury electrode and its characteristics, direct current Polarography, residual, migration, diffusion of kinetic current, Ilkovic equation, Half Wave potential and its derivation, maximum suppressor, Oxygen interference, Manual non recording polarograph ancillary equipment for cells, application of polarographic analysis in quantitative estimation, chronopotentiometry.

Amperometric Titration :- Principle, equipment, techniques, applications, rotating Platinum electrode, Biamperometric titration.

Ref.1- Chap.13,      Ref.-2 Chap.13,      Ref.3.- Chap.15,  
Ref.4- Chap.23,  
Ref.5- Chap.19, (Relavent Pages)      [14]

2. Photoacoustic Spectroscopy (PAS)  
Introduction, PAS Spectrometer, applications.  
Ref.6- Pages 217 to 220.      [6]

3. Radioactivity as Analytical Tools :- Scintillation counter, pulse height analyzer, counting errors.

Ref.7- Chapter 8 Relavent Pages  
Ref.8- Chapter 9 Relavent Pages      [4]

## REFERENCES :-

1. Instrumental methods of analysis by Willard, Dean, Merrit, Settle CBS  
Publication Delhi.(6<sup>th</sup> Edition)
2. Vogel's Text Book of Quantitative chemical analysis  
By J. Mendham, R C Denney, J D Barnes,  
M J K Thomas [ Pearson Education, Asia ]  
( Sixth Edition ) ELBS

### 3. Instrumental method of Chemical Analysis

- By G.W.Ewing McGraw -Hill  
International Edition (5<sup>th</sup> Edition)
4. Introduction to Instrumental Analysis  
By Brawn, International Edition McGraw-Hill
5. Instrumental method of chemical Analysis  
By B.K.Sharma, Goel Publication, Meerut.
6. Principle of Chemical Analysis  
By D.A.Skoog, Saunders College Publishing.
7. Essentials of Nuclear Chemistry  
By H.J.Arnikaar (4<sup>th</sup> Edition) Wiley Eastern.
8. Instrumental method of Chemical Analysis  
By Willard, Dean, Merrit, Settle  
CBS Publication Delhi.(4<sup>th</sup> Edition )

### SECTION-III CHEMICAL MATHEMATICS

#### 1] Differential Calculus :

Derrivative and its Physical significance, basic rules of differentiation (without derivation), maxima and minima and their applications in Chemistry, differentiation of trigonometric functions, partial differentiation.

Ref.1:- Chapter :- VII,VIII,IX,X,XIII & XVII. [6]

#### 2] Integral Calculus :-

Basic rules of integration ( without derivation),integration between limits, integration of trigonometric functions, integration by algebraic simplification by substitution, by parts, by partial fractions, geometrical applications of integral calculus.

Ref.1:- Chapter :- XI,XIII,XIV,& XVI. [6]

#### 3. Differential Equations :-

Simple differential equations in physical chemistry, separable variables, homogeneous differential equations, exact and in exact differential equations, linear differential equations.

Ref.1:- Chapter:- XVIII. [4]

4. Errors :-  
Permutation and combinations, errors.

Ref.1:- Chapter:- XX. [2]

5. Graphical Methods in Physical Chemistry :-  
Method of averages and least squares.

Ref.1:- Chapter-XXI. [2]

6. Problems Preparation of Physical Chemistry.  
By F.Daniels, Mc-Graw Hill Book Co.Inc. [4]

## REFERENCES

1. Mathematical Preparation of Physical Chemistry  
By Daniels, Mc-Graw Hill Book Co.Inc.

## CH-P-1: PHYSICAL CHEMISTRY PRACTICALS

### 1. CONDUCTOMETRY

- Hydrolysis of aniline hydrochloride/sodium acetate.
- Kinetics of the saponification of ethyl acetate.
- Titration of mixture of HCl and acetic acid.
- Determination of solubility of barium sulphate/Silver benzoate, at different temperatures and determination of thermodynamic properties  $\Delta G$ ,  $\Delta H$  and  $\Delta S$ .

### 2. POTENTIOMETRY

- Estimation of halides in a binary mixture.
- Stability constant of a complex ion  $[\text{Ag}(\text{S}_2\text{O}_3)_2]^{3-}$
- pKa of a weak monobasic acid-monochloro acetic acid
- Determination of mean activity coefficient of HCl at different concentration using chemical cell,  $\text{Hg}/\text{HgCl}_2(\text{s}), \text{KCl}(\text{satd}) \parallel \text{AA HCl}, \text{H}_2\text{Q}, \text{Cl}_2 / \text{Pt}$
- Differential titration.

### 3. pHmetry

- Titration of Phosphoric acid solution against alkali and to determine three ionization constants of the acid.
- Determination of Hammett constant of given substituted benzoic acid.
- Determination of amount of aspirin in the given tablet/ $\text{Na}_2\text{CO}_3$  in washing soda.

4. COLORIMETRY

- i] pKa value of an acid base indicator.
- ii] Copper ion II + Fe (III) EDTA titration.
- iii] Analysis of a mixture of  $Co^{2+}$  and  $Ni^{2+}/Cr^{2+}$ .
- iv] Bromination of acetone spectrophotometrically.

5. CHEMICAL KINETICS

- i] Kinetics of decomposition of diacetone alcohol by dilatometry.
- ii] Determination of order of reaction by fractional change method.
- iii] Verification of Bornsted primary salt effect.
- iv] Investigation of the auto catalytic reaction between potassium permanganate and oxalic acid.
- v] Kinetics of benzene diazonium chloride at two different temperature and determination of energy of activation.
- vi] Investigation of the kinetics of acetal using dilatometry.

6. NON INSTRUMENTAL

- i] Transport number of  $H^+$  and  $Cl$  ions by moving boundary method.
- ii] Determination of phase diagram of water-toluene-acetic acid system.

7. POLAROGRAPHY

- i] Determination of half wave potential and unknown concentration of  $Cd^{2+}/Zn^{2+}$  ions.

8. RADIOACTIVITY

- i] Determination of  $E_{max}$  of beta radiation and absorption coefficient in aluminium.

NOTE:- Each student should complete minimum of 18 experiment with atleast 3 experiment from each technique.

REFERENCES :-

1. Instrumental methods of analysis by Willard, Dean, Merrit, Settle CBS Publication Delhi.(6<sup>th</sup> Edition)
2. Vogel's Text Book of Quantitative chemical analysis  
By J. Mendham, R C Denney, J D Barnes,  
M J K Thomas { Pearson Education,Asia }  
( Sixth Edition ) ELBS
3. Instrumental method of chemical Analysis  
By G.W.Ewing McGraw -Hill  
International Edition (5<sup>th</sup> Edition)
4. Introduction to Instrumental Analysis  
By Brown, International Edition McGraw Hill.



5. Instrumental method of chemical Analysis  
By B.K.Sharma, Goel Publication, Meerut.
6. Principle of Chemical Analysis  
By D.A.Skoog, Saunders College Publishing.
7. Essentials of Nuclear Chemistry  
By H.J.Arnikaar (4<sup>th</sup> Edition) Wiley Eastern.
8. Instrumental method of Chemical Analysis  
By Willard, Dean, Merrit, Settle  
CBS Publication Delhi (4<sup>th</sup> Edition )

CH-I-1: INORGANIC CHEMISTRY PRACTICALS

1. Ore analysis :- Pyrohusite ore (Mn and Si), Haematite ore ( Fe and silica)
2. Alloy analysis :- Solder alloy ( Sn and Pb), Brass ( Cu and Zn), Steel ( Fe and Ni )
3. Synthesis and estimation of
  - i] Chromium in cis - trans potassium diaquo dioxalate chromate (III)
  - ii] Cobalt in chloropentammino cobalt (III) Chloride.
  - iii] Aluminium in potassium trioxalate aluminate.
  - iv] nickel in tris ethylene diammine Ni(II) thiosulphate.
4. Determination of phosphorous from the fertiliser.
5. Estimation of calcium from a drug sample.
6. Estimation of each of the constituents of binary mixture ( Co<sup>++</sup> and Ni<sup>++</sup> )
7. Simultaneous determination of Cr<sup>++</sup> and Mn<sup>++</sup> spectrophotometrically.
8. Effect of impurity ions addition on the Beer's law system such as Ni<sup>++</sup> on Co-R-nitroso salt.
9. Determination of lattice energy of binary salts by heat of dissolution system such as CaCl<sub>2</sub>, NiCl<sub>2</sub>, CuCl<sub>2</sub>, MnCl<sub>2</sub>, CoCl<sub>2</sub>.

Ref.:- Vogel's Text Book of Quantitative Chemical Analysis.

CH-O-1: ORGANIC CHEMISTRY PRACTICALS

1. Techniques.
  - i] Distillation.
  - ii] Steam distillation.
  - iii] Column Chromatography.
  - iv] TLC
2. Derivatives of functional groups.
 

Functional group	Derivative
i] -COOH	Amide, Anilide
ii] -C=O	Oxime, Semicarbazone
iii] Ar-OH	Aryloxyacetic acid, Benzoyl.

3. Single stage preparation ( any eight)

- i] Anthranalic acid to O-iodo benzoic acid.
- ii] Acetone to iodoform
- iii] Anisol to 2,4 dinitroanisol.
- iv] Benzophenone to Benzhydraol.
- v] Anthracene to Anthraquinone.
- vi] P-Toluidine to P-chlorotoluene.
- vii] Acetoacetic ester to 1. phenyl 3- methyl. 5- pyrazolone.
- viii] P-nitro toluene to P-nitro benzoic acid.
- ix] Chlorobenzene to 2,4 dinitro chlorobenzene.

4. Two stage preparation ( any 2 )

- i] Acetophenone to Benzal acetophenone to Epoxide.
- ii] Benzophenone to Oxime to Benzanilide.
- iii] Nitrobenzene to m-dinitrobenzene to m-nitroaniline
- iv] Hydroquinone to quinone to 1,2,4 triacetoxybenzene.

Reference :- Vogel's Text Book of Organic Chemistry.

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