

சென்னைப் பல்கலைக்கழகம்
தொலைதரரக் கல்வீ நிறுவனம்



Master of Science (M.Sc.) in

CHEMISTRY

வேதியியல்

Syllabus for Core Subjects

Non-Semester

(Effective from the Academic Year 2005 - 2006)

UNIVERSITY OF MADRAS

INSTITUTE OF DISTANCE EDUCATION

CHENNAI - 600 005

M.Sc. CHEMISTRY
SCHEME OF EXAMINATION
FIRST YEAR

Paper	Subjects	Hours	Marks
1	Organic Chemistry – I	3	100
2	Inorganic Chemistry – I	3	100
3	Physical Chemistry – I	3	100
4	Organic Chemistry – II	3	100
5	Inorganic Chemistry – II	3	100
6	Physical Chemistry – II	3	100
7	Inorganic Chemistry Practical – I (Practical-75, Record-10, Viva-15)	4	100
8	Organic Chemistry Practical – I (Practical-75, Record-10, Viva-15)	4	100
9	Physical Chemistry Practical – I (Practical-75, Record-10, Viva-15)	4	100
10	Comprehensive Viva - Voce		100
SECOND YEAR			
11	Organic Chemistry – III	3	100
12	Inorganic Chemistry – III	3	100
13	Physical Chemistry – III	3	100
14	Organic Chemistry – IV	3	100
15	Inorganic Chemistry – IV	3	100
16	Physical Chemistry – IV	3	100
17	Inorganic Chemistry Practical – II (Practical-75, Record-10, Viva-15)	4	100
18	Organic Chemistry Practical – II (Practical-75, Record-10, Viva-15)	4	100
19	Physical Chemistry Practical – II (Practical-75, Record-10, Viva-15)	4	100
20	Comprehensive Viva - Voce *Dissertation & Viva-Voce (Diss. 150 + Viva 50) has been changed as Comprehensive Viva - Voce from 2007 Onwards.		100

INSTITUTE OF DISTANCE EDUCATION

M.Sc. DEGREE COURSE IN CHEMISTRY

SYLLABUS

FIRST YEAR

ORGANIC CHEMISTRY – I (THEORY)

UNIT I - STEREOCHEMISTRY

Optical activity and chirality. Classification of chiral molecules as asymmetric and dissymmetric. A brief study of dissymmetry of allenes, biphenyls, spiro compounds, trans cyclooctene and cyclononene and molecules with helical structures. Absolute configuration – R,S notation of biphenyls and allenes. Fischer projection. Inter conversion of Sawhorse, Newman and Fischer projections. Molecules with more than one asymmetric center (restricted to five carbons) Eg. Erythro and threo compounds. Asymmetric synthesis, Cram's rule.

Geometrical isomerism. E,Z nomenclature of olefins, Geometrical and optical isomerism (if shown) of disubstituted cyclopropane, cyclobutane and cyclopentanes. Identification of enantiotopic, homotopic, diastereotopic hydrogens and

prochiral carbons in compounds containing up to ten carbons only, Stereo specific and stereo selective reactions.

Unit - II - CONFORMATIONAL ANALYSIS

Conformation of some simple, 1,2-disubstituted ethane derivatives. Conformational analysis of disubstituted cyclohexanes and their stereo chemical features [geometric and optical isomerism (if shown) by these derivatives]. Conformation and reactivity of substituted cyclohexanols (oxidation and acylation), cyclohexanones (reduction) and cyclohexane carboxylic acid derivatives (esterification and hydrolysis). Conformation and stereochemistry of cis and trans decalin and 9-methyl decalin.

Unit - III - ALIPHATIC NUCLEOPHILIC SUBSTITUTION REACTIONS

Kinetic and Non-Kinetic methods of determining mechanisms.

Taft equation and Hammett equation. Simple problems.

S_N1 , S_N2 and S_Ni mechanism – Neighbouring group participation – reactivity, structural and solvent effects – substitution in norbornyl and bridgehead systems – substitution at allylic and vinylic carbons - substitution by ambident nucleophiles such as CN , NO_2 , phenoxide and ambident dianions – substitution at carbon doubly bonded to oxygen and nitrogen – alkylation and acylation of amines, halogen exchange, Von-Braun reaction, alkylation and acylation of active methylene carbon compounds, hydrolysis of esters, Claisen and Dieckmann condensations.

Unit - IV - AROMATIC ELECTROPHILIC SUBSTITUTION REACTIONS

Electrophilic Substitutions

The arenium ion mechanism. Orientation and reactivity (ortho, meta and para directing groups). Hammett equations. Typical reactions to be studied – nitration, halogenation, alkylation, acylation and diazonium coupling. Formylation reactions – Gatterman, Gatterman-Koch, Vilsmeier-Hack & Reimer – Tieman Reaction. Synthesis of di & tri substituted benzenes (symmetrical tribromobenzene, 2-Amino 5-Methylphenol, 3-Nitro, 4-bromobenzoic acid, 3,4-dibromonitrobenzene, 1,2,3 – trimethylbenzene) starting from benzene or any mono substituted benzene. Electrophilic substitution of furan, pyrrole, thiophene and pyridine-N-oxide.

Nucleophilic Substitution Reactions

Methods for the generation of benzyne intermediate and reactions of arynes intermediate – Nucleophilic substitution involving diazonium ions. Aromatic Nucleophilic substitution of activated halides. Ziegler alkylation. Chichibabin reaction.

Books for study and Reference

1. Organic Synthesis by R.O.C. Norman, Chapman and Hall, NY, (1980)
2. Physical Organic Chemistry by Niel Isaacs, ELBS Publications (1987)
3. Organic Reaction Mechanism by S.M. Mukherji and S.P. Sing, MacMillan India Ltd., Madras (1990)
4. Organic Chemistry IV Edition by Stanely Pines.

5. Structure and Mechanism by E.S. Gould.
6. Advanced Organic Chemistry, Part A and B, by Francis A. Cray and Richard J. Sundberg, 3rd Edition (1990), Plenum Press.
7. Aromatic Nucleophilic Substitution by J. Miller.
8. Advanced Organic Chemistry III Edition by J. Miller.
9. Reactive Molecules, C. Wenstrup, John Wiley & Sons. New York, (1984).
10. Carbenes, Nitrenes and Arynes by T.L. Gilchrist and C.W. Rees, Thomas Nelson and Sons Ltd., London.
11. Stereochemistry, Conformation analysis and Mechanism by P.S. Kalsi, 2nd Edition (1993), Wiley Eastern Limited, Chennai.
12. Stereochemistry of Carbon compounds by Ernest Eliel.
13. Stereochemistry and Mechanism Through solved problems by P.S. Kalsi, Wiley Eastern Ltd., (1994)

INORGANIC CHEMISTRY – I

Unit - I

- 1.1 Poly acids: Isopolyacids and heteropolyacids of vanadium, chromium, molybdenum and tungsten.
- 1.2 Inorganic Polymers: Silicates, structure – properties – correlation and applications - molecular sieves polysulphur – nitrogen compounds and poly – organophosphazenes.
- 1.3 Boron hydrides: Polyhedral boranes, hydroborate ions, carboranes and metallo carboranes

- 1.4 Metal Clusters: Chemistry of low molecularity metal clusters (upto) trinuclear metal clusters; multiple metal-metal bonds.

Books for study and Reference

1. J.E. Huheey, Inorganic Chemistry – Principles, Structure and Reactivity; Harper Collins, NY., IV Edition (1993).
2. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry – A Comprehensive Text, John Wiley & Sons, V. Edition (1988)
3. K.F. Purcell and J.C. Kotz, Inorganic Chemistry – WB Saunders Co., USA (1977)
4. M.C. Day and J. Selbin, Theoretical Inorganic Chemistry, Van Nostrand Co., NY (1974)

Books for study and Reference

1. D.F. Shriver, P.W. Atkins and C.H. Langford, Inorganic Chemistry, CH Langford, OUP. (1990).
2. N.N. Greenwood and Earnshaw, Chemistry of the Elements, Pergamon Press, NY (1984).
3. E.L. Muttarties, Polyhedral Borneds, Academic Press, NY. (1975).
4. NH Ray, Inorganic Polymers, Academic Press, (1978).

Unit - II

2. Coordination Chemistry
 - 2.1 Stability of complexes; thermodynamic aspects of complex formation; factors affecting stability; HSAB approach.

Determination of stability constants by spectrophotometric, polarographic and potentiometric methods.

- 2.2 Stereochemical aspects; Stereoisomerism in inorganic complexes; isomerism arising out of ligand and ligand conformation; chirality and nomenclature of chiral complexes; optical rotatory dispersion and circular dichroism.
- 2.3 Macrocyclic ligands; types; porphyrins; corrins, schiff bases; crown ethers; crypts;

Books for study and Reference

1. J.E. Huheey, Inorganic Chemistry, Harper Collins NY IV Edition (1993).
2. K.F. Purcell and J.C. Kotz, Inorganic Chemistry – WB Saunders Co., USA (1977).
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry – A Comprehensive Text, John Wiley & Sons, V. Edition (1988).
4. G.S. Manku, Inorganic Chemistry, TMG Co., (1984).

Books for study and Reference

1. N.N. Greenwood and Earnshaw, Chemistry of the Elements, Pergamon Press, New York (1984).
2. S.F.A. Kettle, Coordination Chemistry, ELBS (1973)
3. K. Burger, Coordination Chemistry, Burtterworthy (1973).
4. F. Basolo and R.G. Pearson, Mechanism of Inorganic Reactions, Wiley New York (1967).

Unit - III

3.1 Analytical Chemistry

3.1.1 Polarography – theory, apparatus, DME, Diffusion, Kinetic and catalytic currents, current voltage curves for reversible and irreversible system, qualitative and quantitative applications to inorganic systems

3.1.2 Amperometric titrations – theory, apparatus, types of titration curves, successive titrations and indicator electrodes – Applications. Cyclic voltammetry - - theory, application to inorganic systems.

3.2 Complexometric Titrations

Chelating agents; types of EDTA titrations; direct and back titrations; replacement titrations; masking and demasking reagents.

3.3 Computers in Chemistry

3.3.1 Introduction to Computers: Hardware, Software and Programming Languages.

(Blowup) C-Programming: Variables, Constants, operators, input and output functions, control statements, loop, go to statement. Functions, arrays and pointers.

Unit - IV – COMPUTER APPLICATIONS IN CHEMISTRY

4.1 Calculation of pH, solubility product, calculation of bond energy using Born-Landé equation.

Standard deviation and correlation coefficient.

4.2 Internet: Introduction – internet service providers, Terms used in E-mail – search engines – chemistry data bases – table of contents – source for list of journals.

(Blowup) Internet: Introduction – Internet Service providers in India, Terms used in Internet – www, http, html, url, TCP/IP band-width, dial-up service, ISDN.

- 4.3 E-mail; Free E-mail providers, search engines, use of internet for chemistry, database – STN International, Chemical Abstracts Services, by the publishers – ACS, RSC, Elsevier, VCH etc. Source for list of Chemistry Journals – Chemweb.Co.

Books for study and Reference

1. Principles of Instrumental methods of Analysis – D.A. Skoog, Saunders College Publication, III Edition, 1985.
2. Instrumental methods of Analysis, Willard Merrit, Dean and Settle, CBS Publication, VI Edition, 1986.
3. Text Book of Qualitative Inorganic Analysis – A.I. Vogel, ELBS III Edition, 1976 and IV Edition 1985.
4. Fundamental of Analytical Chemistry, D.A. Skoog D.M. West., Holt Reinheart & Winston Publication. IV Edition 1982.
5. Basic Programming for Chemists – P.C. Jurns, T.L. Isehowr and C.C. Wilkinsons, JW & Sons, 1987.
6. Computer in Chemistry – K.V. Raman, Tata McGraw Hill, New Delhi, 1993.
7. Computer Applications in Chemistry:K. Ebert, H. Ederes and T.L. Isenhowr, VCH.

Books for study and Reference

1. Instrumental Analysis, G.D. Christian & J.E.O. Reily, Allegn Becon II Edition, 1986.
2. Chemical Instrumentation, H.A. Strobel, Addison – Wesley Publ. Co., 1976.

3. Treatise on Analytical Chemistry, Kolthoff and Elwing (all series).
4. Comprehensive Analytical Chemistry, Wilson and Wilson series.
5. Principles of Polarography, R.C. Kapoor and B.S. Aggarwal, Wiley Eastern Limited, Ms. 1991.

PHYSICAL CHEMISTRY - I

Unit - I - THERMODYNAMICS

Partial molar properties – Partial molar free energy (Chemical potential) – Partial molar volume and partial molar heat content – their significance and determination of these quantities. Variation of chemical potential with temperature and pressure.

Thermodynamics of real gases – gas mixture – fugacity definition – determination of fugacity – variation of fugacity with temperature and pressure – thermodynamics of ideal and non - ideal binary solutions-dilute solutions-excess functions for non-ideal solutions and their determination-the concepts of activity and activity coefficients-determination of standard free energies.

Choice of standard states – determination of activity and activity coefficients for non-electrolytes.

Books for study and Reference

1. S. Glasstone, Thermodynamics for chemists, Affiliated East West Press, New Delhi, 1960.
2. J. Rajaram and J.C. Kuriacose, Thermodynamics for students of chemistry, Lal Nagin Chand, New Delhi, 1986.

Books for study and Reference

1. W.J. Moore, Chemistry, Orient Longman, London, 1972.
2. K.G. Denbeigh, Thermodynamics of Steady State, Methien and Co. Ltd., London, 1951.
3. L.K. Nash, Elements of Chemical Thermodynamics, Addison Wesley, 1962.
4. G.M. Barrow, Physical Chemistry, McGraw Hill, 1988.

Unit - II - CHEMICAL KINETICS – I

Effect of temperature on reaction rates-collision theory of reaction rates-molecular beams-collision cross sections-effectiveness of collisions-probability factors-potential energy surfaces-partition functions and activated complex. Eyring equation-estimation of free energy, enthalpy and entropy of activation and their significance.

Unit - III – CHEMICAL KINETICS – II

Reactions in solutions-effect of pressure, dielectric constant and ionic strength on reactions in solutions-kinetic isotope effects-linear free energy relationships-Hammett and Taft equations-Acid base catalysis-mechanism of acid base catalysed reactions-Bronsted catalysis law.

Text Books

1. J. Rajaram and J.C. Kuriacose, Kinetics and mechanism of chemical transformations. MacMillan India Ltd., 1993
2. K.J. Laidler, Chemical Kinetics, Harper and Row, New York, 1987.
3. K. L. Kapoor, A Text book of Physical Chemistry, Macmillan India Ltd., 2001.

Books for study and Reference

1. R.G. Frost and Pearson, Kinetics and Mechanism, Wiley, New York, 1961.
2. W.J. Moore and R.G. Pearson, Kinetics and Mechanism, 1981.
3. C. Capellos and B.H.J. Bielski, Kinetics Systems, Wiley Interscience, New York, 1972.
4. I. Amdur and G.G. Hammes, Chemical Kinetics, Principles and selected topics, McGraw Hill, New York, 1968.
5. G.M. Harrus, Chemical Kinetics, D.C. Health and Co., 1966.

Unit - IV - GROUP THEORY

Symmetry elements and symmetry operations-point groups-identification and determination-reducible and irreducible representations-Direct product representation-orthogonality theorem and its consequences-character table-hybrid orbital in non linear molecules (CH_4 , XeF_4 , BF_3 , SF_6 and NH_3). Determination of representations of vibrational modes in non-linear molecules (H_2O , CH_4 , XeF_4 , BF_3 , SF_6 and NH_3)

Symmetry selection rules for infrared and Raman Spectra-Electronic Spectra of Ethylene and formaldehyde-application of group theory.

Text Books

1. V. Ramakrishnan and M.S. Gopinathan, Group Theory in Chemistry, Vishal Publications, 1988.
2. K.V. Raman, Group theory and its applications to Chemistry, Tata McGraw Hill Publishing Co., 1990.

Suggested References:

1. F.A. Cotton, Chemical Application of Group Theory, John Wiley and Sons Inc., New York, 1971.
2. N. Thinkham, Group Theory and Quantum Mechanics, McGraw Hill Book Company, New York, 1964.
3. A. Streitweiser, Molecular Orbital Theory for Organic Chemists, John Wiley and Sons., New York, 1961.
4. D.S. Schonland, Molecular Symmetry, Van Nostrand, London, 1965.
5. Alan Vincent, Molecular symmetry and Group theory-programmed introduction to Chemical Applications, Wiley, New York, 1977.
6. Sandorry, Electronic Spectra and Quantum Chemistry, Prentice Hall, 1964.

ORGANIC CHEMISTRY – II

Unit - I - ADDITION TO CARBON-CARBON AND CARBON-HETERO MULTIPLE BONDS

Electrophilic, nucleophilic and neighbouring group participation mechanism- Addition of Halogen and nitrosyl chloride to olefins. Hydration of Olefins and acetylenes. Hydroboration, Hydroxylations, Michael addition, 1,3-dipolar additions. Carbenes and their addition to double bonds – Simmon Smith Reaction. Mannich, Stobbe, Darzen, Wittig, Wittig-Horner and benzoin reactions. Stereo chemical aspects to be studied wherever applicable.

Unit - II - ELIMINATION REACTIONS

E_1 , E_2 and $E1cB$ mechanism - $E1$, $E2$ and $E1cB$ spectrum – Orientation of the double bond – Hoffman and

Saytzeff rule – competition, elimination and substitution. Typical eliminations to be studied – dehydration, dehydrohalogenation and similar reactions. Stereo chemistry of E₂ eliminations in cyclohexane systems. Mechanism of pyrolytic eliminations. Examples: Chugaev and Cope Elimination.

Unit -III - MOLECULAR REARRANGEMENTS

A detailed study with suitable examples of the mechanism of the following rearrangements: Pinacol-Pinacolone (examples other than tetramethyl ethylene glycol) – Wagner-Meerwein, Demjanov, dienone-phenol, Favorski, Baeyer-Villiger, Wolf, Stevens (in cyclic systems) and Von Richter rearrangements. (A few examples in each rearrangement to be studied).

Nitrene: Methods for generating nitrenes and their reactions.

Unit - IV - OXIDATION AND REDUCTION

Mechanism – study of the following oxidation reactions – oxidation of alcohols – use of DMSO in combination with DCC or acetic anhydride in oxidizing alcohols – oxidation of methylene to carbonyl – oxidation of aryl methanes – allylic oxidation of olefins- Reductions: Selectivity in reduction of 4-t-butyl cyclohexanone using selectrides hydride reductions - Synthetic importance of Clemensen and Wolf-Kishner reductions- Modifications of Wolf-Kishner reduction-Birch reduction, MPV reduction.

Recommended Books

1. Principles of Organic Synthesis by R.O.C. Norman, Chapman and Hall, London, 1980.
2. Structure and Mechanism by E.S. Gould.

3. Advanced Organic Chemistry – Part B by Francis A. Carey and Richard J. Sundberg, 3rd Edition, 1990.
4. Organic Reaction Mechanism by S.M. Mukherji and S.P. Sing, MacMillan India Ltd., Madras, 1990.
5. Physical organic Chemistry by Niel Issacs, ELBS Publications, 1987.
6. Carbenes, Nitrenes and Arynes by T.L. Gilchrist and C.W. Rees, Thomas Nelson and Sons Ltd., London.
7. Molecular Rearrangements Vol-I and Vol-II by Paul de Mayo.
8. Advanced Organic Chemistry III Edition by J. March.
9. Stereochemistry and Mechanism Through Solved Problems by P.S. Kalsi, Wiley Eastern Ltd., 1994.
10. Some Modern Methods of Organic Synthesis by W. Carruthers, III Edition, Cambridge University Press, 1993.
11. Modern Synthetic Reactions by H.O. House, The Benjamin Cummings Publishing Company, London, 1972.
12. Advanced Organic Chemistry, Mc Murray, Thomson Pvt. Ltd.

INORGANIC CHEMISTRY – II

Unit - I - THEORIES OF COORDINATION

- 1.1 Crystal field theory and its limitations, d-orbital splittings, LFSE, spectro chemical series, evidences for metal ligand orbital overlap, molecular orbital theory and energy level diagrams, concept of weak and strong fields, Jahn-Teller distortion, charge-transfer spectra

- 1.2 Term states for d^n - ions, energy diagrams, d-d transitions, Orgel and Sugano - Tanabe diagrams, spin orbit coupling, nephelauxetic effect, spectral and magnetic characteristics of transition metal complexes.

Unit -II - BIOINORGANIC CHEMISTRY

Transport proteins: Oxygen carriers, enzymes, carboxy peptidase, carbonic anhydrase, redox process, iron-sulphur proteins, chlorophyll, salient features of the photo synthetic process, vitamin B₁₂, role of sodium, potassium, calcium, zinc and copper, fixation of nitrogen, nitrogen cycle.

Text Books

1. K.F. Purcell and J.C. Kotz, Inorganic Chemistry WB Saunders Co., U.S.A., 1977.
2. J.E. Huheey, Inorganic Chemistry, Harper and Collins, NY, IV Edition, 1993.
3. F.A. Cotton and G.W. Wilkinson, Advanced Inorganic Chemistry – A Comprehensive Text; John Wiley & Sons, 1988.
4. B.E. Dogulas DH MX Daniels and Alexander, Concepts and Models of Inorganic Chemistry, Oxford IBH, 1983.
5. W.U. Mallik, G.D. Tul, R.D. Madan, Selected topics in Inorganic Chemistry, S. Chand & Co., New Delhi, 1992.

Suggested References

1. S.F.A. Kettle, Coordination Chemistry, ELBS, 1973.
2. B.N. Figgis, Introduction to Ligand Fields, Interscience, 1966.

3. M.N. Hughes, The Inorganic Chemistry of Biological processes, Wiley London, 1982, II Edition.
4. D. Nicholas, Complexes of First Row Transition Elements, 1974.
5. M.C. Shrivvers, P.W. Atkins, CH Langford, Inorganic Chemistry, OUP, 1990.
6. M.C. Day and J. Selbin, Theoretical Inorganic Chemistry, Van Nostrand Co., NY, 1974.
7. G.S. Manku, Inorganic Chemistry, TMH, 1984.
8. U. Sathyanarayana, Essentials of Biochemistry, Books and Allied (P) Ltd.

Unit - III - THE CHEMISTRY OF SOLID STATE

- 3.1 Structure of Solids; Comparison of X-Ray, Neutron and Electron Diffraction; Structure of ZnS, Rutile, Pervoskite, Cadmium iodide and nickel arsenide; spinels and inverse spinels; defects in solids, non-stoichiometric compounds. Use of X-ray powder diffraction data in identifying inorganic crystalline solids, details for cubic systems.
- 3.2 Electrical, Magnetic optical properties of solids, band theory, Semiconductors, Superconductors, Solid State Electrolytes, Types of Magnetic Behaviour - Dia, Para, Ferro, Antiferro and Ferrimagnetism, Hysterisis, Solid State Lasers, Inorganic Phosphorus, Ferrites, Garnets.
- 3.3 Reactions in Solid State and Phase Transitions, Diffusion, Diffusion Coefficient, Diffusion Mechanisms, Vacancy and Interstitial Diffusion, Formation of Spinel.
- 3.4 Solid Solutions: Order-Disorder Transformations and Super Structure.

Text Books

1. A.R. West, Basic Solid State Chemistry, John Wiley, 1991.
2. W.E. Addison, Structural Principles in Inorganic Chemistry, Longman, 1961.
3. D.M. Adams, Inorganic Solids, John Wiley Sons, 1974.

Suggested References

1. A.F. Wells, Structural Inorganic Chemistry, Oxford, V. Edition, 1984.
2. A.R. West, Solid State Chemistry, John Wiley, 1990.

Unit - IV - ANALYTICAL TECHNIQUES

- 4.1 Chromatography: Gas-liquid Chromatography, Principles, Retention Volumes, Instrumentation, Carrier Gas, Columns, Stationary Phase, Detectors, Thermal Conductivity, Flame Ionization, Electron Capture, Application of G.L.C.
- 4.2 High Performance Liquid chromatography : Scope, Column efficiency, Instrumentation, Pumping Systems, Columns, Column packing, Detectors, Applications.
- 4.3 Atomic absorption spectroscopy : Theory, Atomizers, Flame and Electro thermal, Radiation sources, Instrumentation, spectral and chemical interferences, application, Thermal methods : DTA and TGA – application.
- 4.4 Radio analytical methods, Isotope dilution analysis, Radiometric Titrations, Radio immuno assay, Neutron activation analysis.

Text Books

1. Principles of Instrumental Methods of analysis- D.A.Skoog & Saunders College Publ. III Edition, 1985.
2. Instrumental methods of analysis, Willard Merrit, Dean and Settle, CBS Publ. VI Edition, 1986.
3. Textbook of Qualitative Inorganic Analysis-A.I. Vogel, ELBS III Edition, 1976.
4. Fundamentals of Analytical Chemistry, D.A.Skoog and D.M. West Hold Reinhold & Winston Publication, IV Edition, 1982.

Suggested References

1. Instrumental Analysis, G.D.Christian & J.E.O. Reily, Allegen Recon II Edition, 1986.
2. Chemical Instrumentation, H.A. Strobel, Addition- Wesely Publ. Co., 1976.
3. Treatise on Analytical Chemistry, Kolthoff and Elwing (All Series).
4. Comprehensive Analytical Chemistry, Willson Series.

PHYSICAL CHEMISTRY - II

Unit - I - MACROMOLECULES

Polymerization in homogenous and heterogeneous phases - Kinetics of polymerization (Ionic and Addition)- Kinetics of Copolymerization -Mechanism of polymerization- Chain initiation-propagation- Termination-Transfer - Inhibition and retardation-properties of polymers, Molecular weight of polymers-Mw, Mn determination- Osmometry, Light scattering, Viscosity, Ultra centrifuge-Gel permeation

chromatography-crystallinity of polymers-Glass transition temperature-polymer technology moulding, extrusion and calendering.

Text Books

1. F.W.Billmeyer, Text book of Polymer Science, Wiley Interscience, 1984.
2. A.Rudin, The Elements of Polymer Science and Engineering, An Introductory Text for Engineers and Chemists, Academic Press, New York, 1973.

Suggested References

1. C.E.H.Bawn, The Chemistry of High Polymers, Butterworth and Co., London, 1948.
2. E.A.Collins, J.Bares and E.W.Billmeyer, Experiments in Polymer Science, Wiley Interscience, New York, 1973.
3. G.S.Krishenbaum, Polymer Science Study Guide, Gordon Breach Science Publishing, New York, 1973.
4. G.Odian, Principles of Polymerization, Mc Graw Hill Book Company, New York, 1973.
5. P.J.Flory, Principles of Polymer Chemistry, Cornell Press, Ithaca, 1971.

Unit - II - CHEMICAL KINETICS - III

Catalysis by Enzymes-rate of enzyme catalyzed reactions, effect of substrate concentration, pH and temperature on enzyme catalyzed reactions-inhibition of enzyme catalyzed reactions.

Study of surfaces-Langmuir and BET adsorption isotherms-study of kinetics of surface reactions-catalysis by metals, semiconductor oxides-mechanism of heterogeneous

catalytic reactions- the absorption coefficient and its significance.

Unit - III – CHEMICAL KINETICS – IV

Kinetics of complex reactions, reversible reaction, consecutive reactions, parallel reactions, chain reactions, general treatment of chain reactions-chain length-Rice Herzfeld Mechanism-explosion limits.

Study of fast reactions-relaxation methods-temperature and pressure jump methods-stopped flow and flash photolysis methods.

Text Books

1. J.Rajaram and J.C.Kurikose, Kinetics and mechanism of chemical transformations, Mac Millan India Ltd., 1993.
2. K.J.Laidler, Chemical kinetics, Harper and Row, New York, 1987

Suggested Reference Books

1. R.G.Frost and Pearson, Kinetics and Mechanism, Wiley, New York, 1961.
2. W.J.Moore and R.G.Pearson, Kinetics and Mechanism, 1981.
3. C.Capellos and B.J.J.Bielski, Kinetics Systems, Wiley Inter science, New York, 1972.
4. *I.Ambur and G.G.Hammes, Chemical Kinetics, Principles and Selected Topics, Mc Graw Hill, New York, 1968.*
5. G. M. Harris, Chemical Kinetics, D.C.Heat and Co., 1966.

Unit - IV - QUANTUM CHEMISTRY - I

Inadequacy of classical theory - Bohrs Quantum theory and subsequent developments- the Compton effect-wave particle duality- uncertainty principle-waves-wave equation for electrons-quantum mechanical postulates-the Schrodinger equation-elementary applications of Schrodinger's equation-the particle in a box (one, two and three dimensional cases)-particle in a ring – the harmonic oscillator- the rigid rotor- the hydrogen atom- the Schrodinger equation for hydrogen atom (no derivation is required) -the solution- the origin of quantum number (angular momentum and spin) -their physical significance.

Text Books

1. D.A. Mc Quarrie, Quantum Chemistry, University Science Books, Mil Valley, California, 1983.
2. T.N. Levine, Quantum Chemistry, Allyn and Bacon, Boston, 1983.
3. R. Anantharaman, Fundamentals of quantum chemistry, Macmillan India Limited, 2001.

Suggested References

1. R.K.Prasad, Quantum Chemistry, Wiley Eastern, New Delhi, 1992.
2. J.Goodman, Contemporary Quantum Chemistry, An Introduction, Plenum Press, New York, 1997.
3. R.Mcweeny, Coulon's Valence, ELBS Oxford University Press, 1979.
4. F.J.Bockhoff, Elements of Quantum theory, Addison Wesley, Reading Mass, 1976.

5. P.W.Atkins, Physical Chemistry, Oxford University Press, 1990.
6. H.Eyring, J.Walter and G. Gimball, Quantum Chemistry, John Wiley and Sons, New York, 1944.
7. L.S.Pauling and F.B.Wilson Introduction to Quantum mechanics, Mc Graw Hill Book Company, New York, 1935.
8. P.W.Atkins, Molecular Quantum Mechanics, Oxford University Press, Oxford, 1983.

PRACTICAL SYLLABUS

FIRST YEAR

INORGANIC CHEMISTRY PRACTICAL - I

PART I

Semi micro qualitative analysis of mixtures containing two common and two rare cations. The following are the rare cation to be included: W, Mo, Ti, Te, Se, Ce, Th, Zr, V,U and Li.

PART II

- a. Complexometric titrations (EDTA) – Estimation of Ca, Mg and Zn.
- b. Preparation of the following:
 1. Potassium tris (oxalato) aluminate (III) trihydrate
 2. Tris (thiourea) copper (I) chloride
 3. Potassium tris (oxalato) chromate (III) trihydrate
 4. Sodium bis (thiosulphato) cuprate (I)

5. Tris (thiourea) copper (I) sulphate
 6. Sodium hexanitrocobaltate (III)
 7. Chloropentammine cobalt (III) chloride
 8. Bis (acetylacetonato) copper (II)
 9. Hexaminenickel (II) chloride
 10. Bis (thiocynato) pyridine manganese (II)
- c. Separation of a mixture of two metal ions by paper chromatography.
- (i) Separation of zinc and magnesium on an anion exchanger.

Total **100 Marks**

- | | | | |
|----|-----|---|------------|
| 1. | (a) | Qualitative analysis (Semimicro)
(Mix. of 4 radicals cations)
(2 rare + 2 common cations) | : 35 Marks |
| | (b) | General procedure (Systematic analysis Procedure of mixture) | : 10 Marks |
| 2. | (a) | Preparation | : 15 Marks |
| | (b) | EDTA (Complexometric titration) | : 15 Marks |
| 3. | (a) | Practical Record Note Book | : 10 Marks |
| | (b) | Practical Viva-Voce | : 15 Marks |

ORGANIC CHEMISTRY PRACTICAL - I

PART – I

1. Identification of components in a two component mixture and preparation of their derivatives. Determination of b.p./ m.p. for components and m.p. for the derivatives.

PART – II

2. Any six preparation from the following.
1. Preparation of o-benzylbenzoic acid
 2. p-Nitrobenzoic acid from p-Nitrotoluene
 3. Anthroquinone from anthracene
 4. Benzhydrol from benzophenone
 5. m-Nitroaniline from m-dinitrobenzene
 6. 1,2,3,4-Tetrahydrocarbozole from cyclohexanone
 7. p-chlorotoluene from p-toluidine
 8. 2,3-Dimethylindole from phenyl hydrazine and 2-butanone (boiling acetic acid)
 9. Methyl orange from sulphanilic acid
 10. Diphenyl methane from benzyl chloride

Total	:	100 Marks
Qualitative Organic analysis	:	40 Marks
Preparation	:	35 Marks
Record	:	10 Marks
Viva	:	15 Marks

PHYSICAL CHEMISTRY PRACTICALS - I

Experiment in Thermodynamics, colligative properties, phase rule, chemical equilibrium and chemical kinetics.

Typical examples are given and a list of experiments is also provided from which suitable experiments can be selected as convenient.

1. Determination of molecular weight
2. Phase diagram construction involving two/three component systems.
3. Adsorption isotherm
4. Reaction rate and evaluation of other kinetic parameters using polarimetry, analytical techniques
5. Verification of Beer Lambert Law

Detailed list of Experiments for Physical Chemistry Practical

Typical list of possible experiments are given. Experiments of similar nature and other experiments may also be given. The list given is only a guideline. A minimum of 10-12 experiments have to be performed in a Year.

1. Study the kinetics of the reaction between acetone and iodine in acidic medium by half life method and determine the order with respect to iodine and acetone.
2. Study the Saponification of ethyl acetate by sodium hydroxide conductometrically and determine the order of the reaction.
3. Study the inversion of cane sugar in presence of acid using Polarimeter.
4. Determine the rate constant and order of reaction for the reaction between potassium persulphate and potassium iodide and determine the temperature coefficient and energy of activation of the reaction.
5. Study the effect of ionic strength on the rate constant for the saponification of an ester.

6. Study the salt effect on the reaction between acetone and iodine.
7. Study the kinetics of the decomposition of sodium thiosulphate by mineral acid (0.5M HCl).
8. Study the primary salt effect on the kinetics of ionic reactions and test the Bronsted relationship (iodide ion is oxidized by persulphate ion).
9. Study the reduction of aqueous solution of ferric chloride by stannous chloride.
10. Determine the molecular weight of benzoic acid in benzene and find the degree of association.
11. To study the phase diagram for m-toluidine and glycerine system.
12. Construction of phase diagram for a simple binary system : naphthalene - phenanthrene and benzophenone- diphenyl amine.
13. Construction of the boiling point composition diagram for a mixture having maximum boiling point and minimum boiling point.
14. Determine the equilibrium constant of the reaction between iodine and potassium iodide by partition method.
15. Construction of the phase diagram of the three component of partially immiscible liquid system (DMSO-water-benzene; acetone -chloroform-water; chloroform-acetic acid-water).
16. Study the absorption of acetic acid by charcoal (Freundlich isotherm).

SECOND YEAR

ORGANIC CHEMISTRY –III (THEORY)

Unit - I - PHYSICAL METHODS OF STRUCTURE DETERMINATION

Principles and applications of ultraviolet and infra-red spectroscopy in Organic structure determination. Nuclear magnet resonance spectroscopy. Proton chemical shift, spin-spin coupling, coupling constants and applications to organic structures-¹³C resonance spectroscopy (elementary treatment). Mass spectrometry and its applications. Optical rotatory dispersion and its applications. Cotton effect, axial haloketone rule and octant rule. Problem solving approach. (for molecules with a maximum number of C₁₀) Woodward Fieser Rule (only application).

Unit - II - ORGANIC PHOTOCHEMISTRY AND AROMATICITY

Aromaticity of benzenoid, heterocyclic and non-benzenoid compounds, Huckel's rule-Aromatic systems with pi electron numbers other than six - non-aromatic (cyclooctatetraene etc) and anti-aromatic systems (cyclobutadiene etc)-systems with more than 10pi electrons-Annulenes up to C₁₈ (synthesis of all these compounds is not expected). Interconversion of hexatrienes to cyclohexadienes.

Unit - III

Photochemical excitation-fate of the excited molecules-Jablonski diagram—study of photochemistry of ketone-photo reduction-photo cyclo addition-Paterno-Buchi reaction-di-pi-methane rearrangement-Pericyclic reactions-classification-orbital symmetry-Woodward Hoffman rules-Analysis of

electrocyclic and sigmatropic reactions-correlation diagram for butadiene –cyclobutene system. Structure of bulvalene, a fluxional molecule- Cope and Claisen rearrangements.

Unit - IV - HETEROCYCLES, TERPENOIDS AND STEROIDS SYNTHESIS OF THE FOLLOWING

Imidazole, oxazole, thiazole, flavones, isoflavones, anthocyanins, pyrimidines (cytosine and uracil only) and purines (adenine, guanine only). Synthesis of parent and simple alkyl or aryl substituted derivatives are expected). Synthesis of Vitamin A1 (Reformatsky and Wittig reaction methods only). Conversion of Cholesterol to progesterone, estrone and testosterone.

Elucidation of structure of cholesterol (by chemical degradation).

Recommended books

1. Application of absorption spectroscopy of Organic compounds by J.Dyer, Prentice-Hall of India Pvt., New Delhi.
2. Spectrometric identification of Organic compounds by R.M.Silverstein, G.C.Bassler and Monsil. John Wiley and Sons, New York.
3. Introduction to the Spectroscopic methods for the identification Organic Compounds-2 volumes, Schiemann, Pergamon Press.
4. Organic chemistry, Vol.II, I.L.Finar, 5th edition, ELBS Publication.
5. Spectroscopy of Organic compounds by P.S.Kalsi, Wiley Eastern Ltd, Chennai.

6. Molecular reaction and Photochemistry by Charles H. Depuy and Orville, L.Chapman, Prentice Hall of India Pvt. Ltd., New Delhi
7. Introduction to Chemistry of heterocyclic compounds by R.M. Acheson, Interscience Publishers.
8. Principles of Modern heterocyclic chemistry by L.A. Pacquette, Benjamin Cummings Publishing Co., London,1978.
9. Advanced Organic Chemistry III Edition by J.March.
10. Advanced Organic Chemistry by Francis A.Carey and Richard J. Sundberg, 3rd Editionn (1990), Plenum Press, New York.
11. Physical Organic Chemistry by Neil S. Issacs, ELBS Publication, 1987.
12. P.S. Kalsi, Textbook of Organic Chemistry, Macmillan India Ltd., 1999.

INORGANIC CHEMISTRY III

Unit - I - ORGANO METALLIC CHEMISTRY

- 1.1. Carbon donors: Alkyls and aryls; metalation, bonding in carbonyls and nitrosyls, chain and cyclic donars, olefin, acetylene and allyl systems, synthesis, structure and bonding, metallocenes.
- 1.2. Reactions: Association,substitution,addition and elimination, ligand protonation, electrophilic and nucleophilic attack on ligands, carbonylation and decarboxylation, oxidative addition, fluxionality.
- 1.3. Catalysis: Hydrogeneration of olefins (Wilkinson's catalyst), hydroformylation of olefins using cobalt or

rhodium catalysts (oxoprocess), oxidation of olefins to aldehydes and ketones (Wacker process); polymerization (Zeigler-Natta Catalyst); cyclo oligomerization of acetylene using nickel catalyst (Reppe's catalyst); polymer bound catalysts.

Text Books

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley & Sons (1988), V Edition.
2. K.F. Purcell and J.C. Kotz, Inorganic Chemistry, We Saunders Co., 1977.

Suggested References

1. G. Coates, M.L. Green and K. Wade, Principles of Organo metallic chemistry, Methven Co., London, 1988.
2. R.B. Jordon, Reaction mechanisms of Inorganic and Organo metallic systems, OUP, 1991.
3. P. Powell, Principles of Organo metallic chemistry , Chapman and Hall, 1998.
4. R.C. Mehothra, A. Singh, Organo metallic Chemistry, Wiley Eastern Co., 1992.

Unit - II - INORGANIC SPECTROSCOPY I AND MAGNETIC PROPERTIES

- 2.1.1. Applications to inorganic systems of the following: ultra-violet, visible, infra-red and Raman spectra of metal complexes, organo metallics and simple inorganic compounds with special reference to coordination sites, isomerism.
- 2.1.2. Magnetic Susceptibility and measurements- Guoy method, Faraday method-applications.

Text Books

1. R. Drago, Physical methods in Inorganic Chemistry, Reinhold NY, 1968.
2. E.A.V. Ebesworth, D. WH. Rankin and S. Craddock, Structural Methods in Inorganic Chemistry, Blackwell Scientific Publ., 1987.

Suggested References

1. R.B. Heslp and K. Jones, Inorganic Chemistry, Elsevier Scientific Publ., 1976.
2. H.A.O. Hill and P. Day, Physical methods in Advanced Inorganic Chemistry, John Wiley, 1968.
3. K. Burger, Coordination Chemistry, Experimental methods, Butterworths, 1973.
4. C.N.R. Rao, J.R. Ferraro, Spectroscopy in Inorganic Chemistry, Vol. I and Vol. II, Academic Press, 1970.

Unit -III - INORGANIC SPECTROSCOPY-II

- 3.1. Applications to Inorganic systems of the following:

NMR, NQR and Mossbauer spectra – NMR of ^{31}P , ^{19}F , NMR shift reagents, NQR – Nitrosyl compounds, Mossbauer of Fe and Sn systems.

Unit - IV

ESR Introduction – Zeeman equation, g-value, nuclear hyperfine splitting, interpretations of the spectrum, simple carbon centered free radicals. Anisotropy-g.value and hyperfine splitting constant. Mc Connel's equation, Kramers theorem, esr of transition metal complexes of copper, manganese and vanadyl complexes.

Photoelectron spectroscopy (UV and X-Ray)-photo electron spectra-Koopman's theorem, fine structure in PES, chemical shift and correlation with electronic charges.

Text Books

1. R.Drago, Physical methods in Inorganic Chemistry, Reinhold Ny, 1968.
2. E.A.V. Elesworth, D.W.H.Rankin and S.Cradock, Structural methods in Inorganic Chemistry, Blackwell Scientific Publ., 1987.

Suggested Refernces

1. R.B.Heslop and K.Jones, Inorganic Chemistry, Elsevier Scientific Publ., 1976.
2. H.A.O.Hill and P.Day, Physical methods in Advanced Inorganic Chemistry, John Wiley, 1968.
3. K.Burger, Coordination Chemistry, Experimental methods, Butterworths, 1973.
4. C.N.R.Rao, J.R.Ferraro, Spectroscopy in Inorganic Chemistry, Vol.I and Vol.II, Academic Press, 1970.
5. G. Aruldas, Molecular Structure and Spectroscopy – Prentice Hall.

PHYSICAL CHEMISTRY - III

Unit - I - QUANTUM CHEMISTRY - II

Approximation methods-perturbation and variation method-application to hydrogen, helium atoms-R.S.Coupling and term symbols for atoms in the ground state.

Born-Oppenheimer approximation-valence bond theory for Hydrogen molecule-LCAO-MO theory for di and poly

atomic molecules-concept of hybridization-Huckel theory for conjugated molecules (ethylene, butadiene and benzene) – semi-empirical methods –Slater orbital and HF-SCF methods.

Text Books

1. R.K. Prasad, Quantum Chemistry, Wiley Eastern, New Delhi, 1992.
2. M.W. Hanna, Quantum Mechanics in Chemistry, W.A.Benjamin Inc. London, 1965.

Suggested References

1. R.L. De Koch and H.B. Gray, Chemical Structure and Bonding, Benjamin/Cumming, Menlo Park, California.
2. A.K. Chandra, Introductory Quantum Chemistry, Tata Mc Graw Hill.
3. J.M. Murrell, S.F.A. Kettle and J.M. Tedder, The Chemical Bond, Wiley, 1985.
4. D.A. Mc Quarrie, Quantum Chemistry, University Science Books, Mill Valley, California, 1983.
5. P.W. Atkins, Molecular Quantum Mechanics, Oxford University Press, Oxford, 1983.

Unit - II - ELECTRO CHEMISTRY - I

Mean ionic activity and mean ionic activity coefficient-concept of ionic strength, Debye-Huckel theory of strong electrolytes-activity coefficient of strong electrolytes-determination of activity coefficient by electrical method-Debye Huckel limiting law at appreciable concentration of electrolytes-Huckel equation-Debye Huckel Bronsted equation-qualitative and quantitative verification-Debye Huckel limiting law, Electrode-electrolyte interface-adsorption

at electrified interface-electrical double layer-electro capillary phenomenon-Lippmann equation-Structure of double layers-Helmholtz –Perrin,Guoy Chappmann and Stern model of electrical double layers.

Irreversible Thermodynamics-Forces and fluxes-linear force –flux relation –phenomenological equations-Onsager’s theorem-diffusion-electrokinetic phenomena-membrane potential.

Text Books

1. S. Glasstone, Introduction to Electrochemistry, Affiliated East West Press, New Delhi, 1960.
2. D.R. Crow, Principles and Applications of Electrochemistry, Chapman and Hall, 1991.

Suggested Reference Books

1. J.O.M. Bokris and A.K.N. Reddy, Electrochemistry, Vols1 and 2 Plenum, New York, 1977.
2. P. Delahay, Electrode Kinetics and Structure of Double layer, Inter science, New York, 1965.
3. J. Robbins, Ions in Solution-An Introduction in electrochemistry, Clarendon press, Oxford, 1993.
4. P.H. Rieger, Electrochemistry, Chapman and Hall, New York, 1994.

Unit - III – SPECTROSCOPY

Interaction of matter with radiation-Einstein’s theory of transition probability-rotational spectroscopy of a rigid rotor-non-rigid rotor-diatomic and polyatomic molecules. Vibrational spectroscopy-harmonic oscillator-anharmonicity-vibrational spectra of poly atomic molecules-vibrational frequencies-group frequencies-vibrational coupling-overtones-Fermi resonance. Raman Spectra.

Electronic spectra of polyatomic molecules-group symmetry of molecules and selection rules-types of transition-solvent effects.

Unit - IV

Resonance spectroscopy-Zeeman effect-equation of motion of spin in magnetic fields-chemical shift-spin-spin coupling-NMR of simple AX and AMX type molecules-calculation of coupling constants- ^{13}C , ^{19}F , ^{31}P NMR spectra-applications-a brief discussion of Fourier transformation resonance spectroscopy.

Text Books

1. Raymond Chang , Basic principles of Spectroscopy, McGraw Hill Ltd., New York, 1971.
2. A. Carington and A.D Mc Lachlan ,Introduction to Magnetic Resonance Harper and Row, New York, 1967.
3. P.W. Atkins, Advanced Physical Chemistry, Oxford Press, 1990.
4. G. Aruldas, Molecular structure and spectroscopy, Prentice Hall, 2002.

Suggested Reference Books

1. G.M.Barrow, Introduction to Molecular Spectroscopy, McGraw Hill, New York, 1962.
2. W.Kemp, NMR in Chemistry McMilan Ltd., 1986.
3. G.W.King, Spectroscopy and Molecular Structure, Holt, Rinehart and Winston, 1964.
4. E.B. Wilson, J.C.Decius and D.C.Cross, Molecular Vibrations, McGraw Hill Book CO., 1955.

5. K.D.Mclauchlan, Magnetic Resonance, Oxford chemistry Series, Oxford, 1970.
6. B.P.Staughan and S.Walker, Spectroscopy Vol.1,11 and 111, Chapman and Hall 1976.
7. B.W.Cook and K.Jones, A.Programmed Introduction to Infra red spectroscopy, Heydon and Son Ltd., 1972.
8. F.A.Rushworth and D.P Tunstal, Nuclear Magnetic Resonance Gordon and Breach Science Publishing, New York,1973.
9. J.K.Sanders and B.K.Hunther, Modern NMR Spectroscopy, A Guide for Chemists, Oxford University Press, Oxford,1987.
10. J.K.M. Sanders, E.C.Constable and B.K. Hunther, Modern NMR Spectroscopy - A World Book of chemical problems, Oxford,1989.
11. C.N.Banwell Fundamentals of Molecular Spectroscopy McGraw Hill,1966.

ORGANIC CHEMISTRY - IV

Unit - I - BIO-ORGANIC CHEMISTRY

Structure and role of (genetic code) of DNA and RNA (Nucleotides only) Biosynthesis of Cholesterol and bile acids only.

Unit - II - ALKALOIDS AND PROTEINS

Peptides and their synthesis (Synthesis of tripeptide using the Amino acids Glycine, Alanine, Lysine, Cystine, Glutamine acid, Arginine). Merrified synthesis, Determination of tertiary structure of proteins. Total synthesis of quinine, morphine, reserpine and cocaine.

Unit - III - MODERN SYNTHETIC METHODOLOGY AND FREE RADICALS

Synthesis of simple organic molecules using standard reaction like acetylation and alkylation of enamines and active methylene compounds, Grignard reactions, Phosphorus and sulphur Ye Robinson annulation, Diels-Alder reactions, protections and deprotection of functional groups (R-OH, R-CHO, R-CO-R, R-NH₂ and R-COOH). Uses of the following reagents: DCC, Trimethyl silyliodides, 1,3-dithiane (mpolung), diisobutylaluminumhydride (DIBAL), 9BBN, Trimethylsilylchloride.

Unit - IV

Synthesis of the following target molecules : longifolene, cubane, 5-hexenoic acid, trans-9-methyl-1-decalone, Bicyclo(4,1,0)heptane-2-one and onocerin.

Long lived and short lived free radicals, methods of generation of free radicals. Addition of free radicals to olefinic double bonds. The following aromatic radical substituents are to be studied: decomposition of diazocompounds, phenols-coupling - Sandmeyer reaction - Gomberg - Gauchmann reaction, Pschorr reaction, Ullmann reaction, mechanism of Hunsdicker reaction Detection of free radicals by ESR.

Recommended Books

1. Guide book to Organic synthesis by Raymond K. Mackle and David M. Sunith, ELBS Publication.
2. Chemistry of alkaloids by Pelletier.
3. Introduction to Alkaloids by G.A. Swan.

4. Organic Chemistry V Edition, 1986, Vol .II BY I. L. Finar, ELBS Publication.
5. Outlines of Biochemistry V Edition by Eric .E. Conn, Paul.R.Stumpf, George Bruening and Roy. H. Dole, John Wiley and Sons.
6. Principles of Biochemistry General aspects by L.Smith, Robert L. Hill .I. Robert Lehman, Robert J.Let Rowitz, Philp Handler and abraham white. McGraw Hill Int (7th Edition)
7. Biochemistry by Lubert Stryer, W.H.Freeman and Co., New York.
8. Chemistry of organic natural products by Agarwal, Goel Publishing House.
9. Organic synthesis by R.E. Ireland, Prentice-Hall of India Pvt .Ltd., New Delhi, 1975.
10. Principles of organic synthesis by R.O.C.Norman, Champan and Hall, NY, 1980.
11. Advanced Organic Chemistry by Francis.A.Carey Richard J.Sundbreg, 3rd Edition, Plenum Press, New York, 1990.
12. Advanced Organic Chemistry by Jerry March, Wiley Eastern Ltd ,. New Delhi.
13. Organic Chemistry, 6th Edition, 1992, R.T.Morrison, R.S.Boyd, Prentice-Hall of India Pvt. Ltd., New Delhi.
14. Struture and Mechanism by E.S.Gould.

INORGANIC CHEMISTRY - IV

UNIT 1 - COORDINATION CHEMISTRY – REACTION MECHANISMS :

- 1.1 Electron transfer reactions; outer and inner sphere processes; atoms transfer reaction, formation and rearrangement of precursor complexes, the binding ligand, successor complexes, Marcus theory.
- 1.2 Substitution Reactions: Substitution in square planar complexes, reactivity of platinum complexes, influences of entering, leaving and other groups, the trans-effect, substitution of octahedral complexes of cobalt and chromium, replacement of coordinated water, solvolytic (acids and bases) reactions applications in synthesis (platinum and cobalt complexes only).
- 1.3 Rearrangement in 4 and 6 coordinate complexes: reaction at coordinated ligands-template effect.

Text Books

1. K.F.Purcell and J.C.Kotz., Inorganic Chemistry, W.B.Saunders Co., 1977.
2. J.Huheey, Inorganic Chemistry, Harper and Collins, NY IV Edition, 1993.

Suggested References

1. F. Basolo and R.G.Pearson, Mechanism of Inorganic Reactions Wiley, 1967.
2. D.Benson, Mechanism of Inorganic Reactions in Solution, McGraw Hill Co., 1968.
3. S.F.A.Kettle, Coordination Chemistry, ELBS, 1973.

Unit - II - NUCLEAR CHEMISTRY

- 2.1 Nuclear properties: Nuclear spin and moments, origin of nuclear forces, salient features of the liquid drop and the shell models of the nucleus.
- 2.2 Modes of radioactive decay: Orbital electron capture: nuclear isomerism, internal conversion, detection and determination of activity by cloud chamber, nuclear emulsion, bubble chamber, G.M., Scintillation and Cherenkov counters.
- 2.3 Nuclear reactions: Types, reactions, cross section, Q-value, energy, compound nucleus theory: high energy nuclear reactions, nuclear fission and fusion reactions as energy sources, direct reactions, photonuclear and thermo nuclear reactions.
- 2.4 Stellar energy: Synthesis of elements, hydrogen burning, carbon burning: The e,s,r,p and x processes.

Text Books

1. H.J. Arnikaar, Nuclear Chemistry, Wiley Eastern Co., II Edition, 1987.

Suggested References

1. S. Glasstone, Source Book on Atomic Energy, Van Nostrand Co., 1969.
2. G. Fliender, J.W. Kennady and J.M. Miller, Nuclear and Radiochemistry, John Wiley & Sons, 1964.

Unit - III

- 3.1 Nuclear Reactors : fast breeder reactors, particle accelerators, linear accelerators, cyclotron and synchrotron.

- 3.2 Inorganic Photochemistry: Photosubstitution, Photoredox and isomerisation processes, application of metal complexes in solar energy conversion.
- 3.3 The Chemistry of lanthanides and actinides: Oxidation states, spectral magnetic characteristics, Coordination numbers, Stereochemistry, nuclear and non-nuclear applications.

Unit - IV - ENVIRONMENTAL CHEMISTRY

- 4.2 Water Quality Standards, BOD, COD (1 Hour)
- 4.3 Ambient air quality standards: Photochemical smog, oxides of nitrogen.
- 4.4 Toxic Chemicals in environmental: LD₅₀, Toxicity of Hg, Pb, Cr. Analytical Methods in Environmental toxins.

Text Books

1. H.J. Arnika, Nuclear Chemistry, Wiley Eastern Co., II Edition, 1987.
2. R.B. Jordan, Reaction Mechanism of inorganic and Organometallic Systems, OUP, 1991.
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley & Sons, 1988, V. Edition.
4. F.A. Cotton, F.A. Hart, The Heavy Transition Elements McMillan Co., 1975.

Suggested References

1. A.W. Glasstone, Source Book on Atomic Energy, Van Nostrand Co., 1969.
2. A.W. Adamson and P. Fleischauer Concepts of Inorganic Photochemistry, Wiley, 1975.
3. F. Basolo and R.G. Ferason, Mechanisms of Inorganic Reactions, Wiley, New York, 1967.

4. N.N. Greenwood and A. Earnshaw, Chemistry of Elements Pergamon, New York, 1984.
5. G.T. Seaborg, J.J. Katz, The Chemistry of Actinide Elements, Methuen, 1957.
6. G.T. Seaborg, Transurenum elements, Dowden Hitchinson & Ross, 1978.
7. R.B. Heslop and K. Jones, Inorganic Chemistry, Elsevier Co., 1976.
9. B.E. Douglas, D.H. McDaniels & Alexander, Oxford I Bh, II Edition, 1983.

PHYSICAL CHEMISTRY – IV

Unit - I - ELECTROCHEMISTRY – II

Mechanism of electrode reaction - polarization and overpotential – the Butler Volmer equation for one step and multistep electron transfer reactions- significance of electron exchange current density and symmetry factor-transfer coefficient and its significance-mechanism of the hydrogen and oxygen evolution reactions.

Corrosion and passivation of metals- Pourbaix diagram- Evan's diagram-fuel cells-electrodeposition - principle and applications. Electro chemical inorganic reactions of technological interest.

Text Books

1. S. Glasstone, Introduction to Electrochemistry, Affiliated East West Press, New Delhi, 1960.
2. D.R. Crow, Principles and Applications of Electrochemistry, Chapman and Hall, 1991.
3. P.H. Rieger, Electrochemistry, chapman and hall, New York, 1994.

Suggested Reference Books

1. J.O.M. Bockris and A.K.N. Reddy, *Electrochemistry*, Vols. 1 and 2 plenum, New York, 1977.
2. P. Delahay, *Electrode kinetics and structure of Double layer*, Interscience, 1965.
3. J. Rabbits, *Ions in Solution- A Introduction to Electrochemistry*, Clarendon Press, Oxford, 1972.
4. C.M.A. Brett and A.S. Ms. O. Brett, *Electrochemistry Principles, Methods and Applications*, OUP, Oxford, 1993.

Unit - II - THERMODYNAMICS – II

Objectives of statistical thermodynamics-concept of thermodynamics and mathematical probabilities-distribution of distinguishable and non-distinguishable particles.

Maxwell-Boltzmann, Fermi-Dirac and Bose Einstein statistics – comparison and applications-modes of contribution to energy-ortho and para hydrogen – radiation law-electron in metals. Partition function-evaluation of translational, vibrational and rotational partition functions for mono, diatomic and polyatomic ideal gases-thermodynamic functions in terms of partition functions, isotope exchange and dissociation of diatomic molecules-application of partition functions to heat capacities of ideal gases-heat capacity of solids (Einstein and Debye Models)

Text Books

1. M.C. Gupta, *Statistical Thermodynamics*, Wiley Easter, New Delhi, 1990.
2. R. Hasee, *Thermodynamics of irreversible process*, Addition Wesley, Reading, mass, 1969.

Suggested Reference Books

1. Dole, Statistical Thermodynamics, Prentice Hall, New York, 1954.
2. B.J. Mc Clelland, Statistical Thermodynamics, Chapman and hall, London, 1973.
3. I. Prigogine, Introduction to Thermodynamics of irreversible process, Interscience, New York, 1961.
4. N.O. Smith, Elementary Statistical Thermodynamics, A problem approach, Pleunum Press New York, 1961.
5. Clyde, Physical Chemistry, Schaum Series, McGraw Hill, 1976.

Unit - III – PHOTOCHEMISTRY – I

Adsorption and emission of radiation-Franck-Condon Principle-decay of electronically excited states-radiative and non radiative processes-fluorescence and phosphorescence-spin forbidden radiative transition-internal conversion and intersystem crossing-energy transfer process-excimers and exciplexes-static and dynamic quenching-Stern Volmer analysis.

Unit - IV – PHOTOCHEMISTRY – II

Experimental methods-quantum yield and life measurements-steady state principle-quantum yield and chemical actinometry. Photo physical process and kinetics of photochemical reactions, photoredox reactions, photo substitution, photosensitized reaction, photoisomerization - photovoltaic and photogalvanic cells, photoelectrochemical cells, photo assisted electrolysis of water, aspects of solar energy conversion.

Text Books

1. N.J. Turro, Modern Molecular Photochemistry, Benjamin, Cummings, Menlo Park, California, 1978.
2. K.K. Rohatgi Mukherjee, Fundamentals of Photochemistry, Wiley Eastern Ltd., 1978.

Suggested Books for Reference

1. J.G. Calvert and J.N. Pitts, Photochemistry, Wiley, London, 1966.
2. R.P. Wayne, Photochemistry, Butterworths, London, 1970.
3. R.P. Cundell and A. Gilbert, Photochemistry, Thomas Nelson, London, 1970.

PRACTICAL SYLLABUS

INORGANIC CHEMISTRY PRACTICAL – II

QUANTITATIVE ANALYSIS OF COMPLEX MATERIALS

- a. Analysis of Ores and Alloys
 1. Determination of percentage of calcium and magnesium in dolomite.
 2. Determination of percentage of MnO_2 in pyrolusite.
 3. Determination of tin and lead in solder.
 4. Determination of copper and zinc in brass.
 5. Determination of chromium and nickel in stainless steel.

- b. Analysis of Inorganic Complex Compounds:
1. Preparation of cis and trans potassium bis(oxalato) diaquochromate and analysis of each of these for chromium.
 2. Preparation of potassium tris (oxalato) ferrate (III) and analysis for iron and oxalate.
- d. Quantitative analysis:
- Quantitative analysis of mixtures of iron and magnesium; iron and nickel; copper and nickel and copper and zinc.
- e. Colorimetric analysis:
- (Using) Photoelectric method: Estimation of iron, nickel, manganese, copper.

List of spectra to be given for interpretation.

1. ^{31}P NMR Spectra of methylphosphate
2. ^{31}P NMR Spectra of HPF_2
3. ^{19}F NMR Spectra of ClF_3
4. ^1H NMR Spectra of of Tris (ethylthioacetato) cobalt (III)
5. Expanded high resolution ^1H NMR spectra of (N-propylisonitrosoacetylacetoniminato) (acetylacetoniminato) Nickel (II)
6. ESR Spectra of the aqueous $\text{ON}(\text{SO}_3)_2^{2-}$ ion.
7. ESR Spectra of the H atoms in CaF_2
8. ESR Spectra of the $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ ion
9. ESR Spectra of the bis (salicyladiminato) copper (II)

10. IR Spectra of the sulphato ligand
11. IR Spectra of the nitro and nitritopentaminocobalt (III) chloride
12. IR Spectra of the dimethylglyoxime ligand and its Nickel (II) complex.
13. IR Spectra of carbonyls
14. Mossbauer spectra of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
15. Mossbauer spectra of FeCl_3
16. Mossbauer spectra $[\text{Fe}(\text{CN})_6]^{3-}$
17. Mossbauer spectra $[\text{Fe}(\text{CN})_6]^{4-}$

INORGANIC CHEMISTRY - II PRACTICAL – II

Maximum marks : 100

Duration : 6 Hours

I. Estimation of mixture containing two metal ions

Volumetric	:	15 marks
Gravimetric	:	15 marks
Procedure	:	10 marks

II. Colorimetric Estimation

(Estimation : 15 marks and Procedure : 5 marks) : 20 marks

- | | |
|---------------------------------------|------------|
| III. Interpretation of Spectra | : 15 marks |
| IV. Practical Record Note Book | : 10 marks |
| Practical Viva-Voce | : 15 marks |

Text Books

1. Text book of Inorganic quantitative analysis: by Vogel.
2. Principles of Instrumental Analysis: Douglas A. Skoog, 3rd Edition.

ORGANIC CHEMISTRY – PRACTICAL – II

a. ANY SIX PREPARATIONS FROM THE FOLLOWING INVOLVING TWO STAGES

1. Sym-Tribromobenzene from aniline.
2. p-nitroaniline from acetanilide
3. m-Nitrobenzoic acid from methylbenzoate.
4. 2,4-Dinitrobenzoic acid from p-nitrotoluene.
5. m-Nitrobenzoic acid from benzaldehyde
6. p-bromoaniline from acetanilide
7. Anthraquinone from phthalic anhydride.
8. Phthalide from phthalic anhydride
9. 2-phenyl indole from phenylhydrazine
10. 2-4, Dinitrophenyl hydrazine from p-nitrochlorobenzene.

b. ANY FIVE ESTIMATIONS

1. Estimation of aniline
2. Estimation of phenol
3. Estimation of glucose (Bertrands Methods)
4. Saponification of fat or an oil.
5. Iodine value of an oil.
6. Estimation of Ketone.

c. SPECIAL INTERPRETATION OF ORGANIC COMPOUNDS. UV, IR, PMR AND MASS SPECTRA OF 15 COMPOUNDS.

1. 1,3,5-Trimethylbenzene
2. Pinacolone

3. n-propyl amine
4. p-Methoxybenzyl alcohol.
5. Benzyl bromide
6. Phenylacetone
7. 2-Methoxyethyl acetate
8. Acetone
9. Isopropyl alcohol
10. Acetaldehyde diacetate
11. 2-N, N-Dimethylamino ethanol
12. Pyridine
13. 4-Picoline
14. 1, 3 -dibromo -1,1-dichloropropene
15. Cinnamaldehyde

Total	:	100 Marks
Preparation	:	25 marks
Estimation	:	30 marks
Interpretation of Spectra	:	20 marks
Record	:	10 marks
Viva	:	15 marks

Recommended Books

1. A Text Book of Practical Organic Chemistry by Arthur I. Vogel.
2. Laboratory Manual of Organic Chemistry Raj K. Bansal, Wiley Eastern Limited.
3. Laboratory manual of Organic Chemistry by Mann and Saunders.

PHYSICAL CHEMISTRY – PRACTICAL - II

Experiments in electrochemistry, conductometry, potentiometry, pHmetry and spectroscopy.

a. CONDUCTIVITY MEASUREMENTS

1. Determination of equivalent conductance of a strong electrolyte and verification of Debye Huckel law.
2. Verification of Debye Huckel law.
3. Verification of Ostwald's dilution law for a weak electrolyte.
4. Conductometric titrations between acid and (simple and mixture of strong and weak acids) base, precipitation titrations involving a single halide, Salt-Acid titration, Salt-Base titration.

b. EMF MEASUREMENTS:

1. Determination of standard potentials(Cu and Zn)
2. Determination of thermodynamic quantities from EMF measurements and potentiometric titrations.
3. Determination of pH and calculation of pKa.
4. Determination of stability constant of a complex.
5. Determination of solubility product of a sparingly soluble salt.
6. Redox titrations.
7. Precipitation titration of mixture of halides by emf measurements.

c. SPECTROSCOPY :

Experiments given is to familiarise only the interpretation of spectra provided. Interpretation of simple UV-Vis spectra of simple molecular for the calculation of molecules data -

identification of functional groups. (5 typical spectra will be provided).

IR and NMR spectra - calculation of force constant - identification and interpretation of spectra (5 each in IR and NMR will be provided).

d. LIST OF EXPERIMENTS SUGGESTED FOR PHYSICAL CHEMISTRY PRACTICAL -II

Typical list of possible experiments are given. Experiments of similar nature and other experiments may also be given. The list given is only a guideline. A minimum of 10-12 experiments have to be performed in a year.

1. Determine the equivalent conductance of weak acid at different concentrations and verify Ostwald's dilution law and calculate the dissociation constant of the acid.
2. Determine the equivalent conductivity of a strong electrolyte at different concentrations and examine the validity of the Onsager's theory as limiting law at high dilutions.
3. Determine the activity coefficient of zinc ions in the solution of 0.002 M Zinc sulphate using Debye Huckel limiting law.
4. Determine the solubility product of silver bromate and calculate its solubility in water and in 0.01 M KBrO_3 , using Debye Huckel limiting law.
5. Conductometric titrations of a mixture of HCl , CH_3COOH and CuSO_4 and sodium hydroxide.
6. Determine the dissociation constant of an acid at different dilution.

- Determine the solubility of lead iodide in water, 0.04M KI and 0.04M $\text{Pb}(\text{NO}_3)_2$ at 298 K.
- Determine the solubility product of lead iodide at 298K and 308 K
- Compare the relative strength of acetic acid and monochloroacetic acid by conductance method.
- Determine the electrode potentials of Zn and Ag electrodes in 0.1M and 0.001M solutions at 298 K and find the standard potentials for these electrodes and test the validity of Nernst equation.
- Determine the dissociation constant of acetic acid titrating it with sodium hydroxide using quinhydrone as an indicator electrode and calomel as a reference electrode.
- Determine the strength of a given solution of KCl using differential potentiometric titration technique.
- Determine the pH of the given solution with the help of indicators using buffer solutions and by colorimetric method.
- Perform acid base titration in a non aqueous medium.
- Determine the pH of a given solution by emf method using glass and calomel electrode and evaluate pK value of an acid.
- Determine the pH of a given solution by emf methods using hydrogen electrode and quinhydrone electrode.
- Determine the equivalent conductivity of a Ca electrolyte at infinite dilution and dissociation constant of the electrolyte.