



SHIVAJI UNIVERSITY, KOLHAPUR

M.Sc. (T & D) Chemistry Syllabus

Annual System

M.Sc. (Theory and Dissertation)

Subject: Chemistry

The M.Sc. (T&D) course in chemistry is offered to those who are in services. The eligibility for admission to this course is degree of Bachelor of Science in chemistry, Shivaji University or degree of any other University recognized as equivalent there to. **The desired candidate should be employed for a minimum period of three years as prerequisite within the Shivaji university area.** The students shall be admitted, this course in June/July or November/December every year. The medium of interaction and examination is English. Course is of Annual pattern.

Semester	No of Paper		Total Marks
Part-I	4		400
Part-II	4		400
			<hr/> 800
	Internal	External	
Dissertation	100	100	200
(To be submitted to the end of second year)			
Oral on dissertation			100
	I	II	
Seminar	50	50	100
(One seminar of 50 marks in each semester)			
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	Total marks		1200

Each question paper carries 100 marks

Nature of question paper :

Q 1. Short answer type 4 Sub questions	4x5	20 marks
Q. 2, 3, 4 and 5 are of 20 marks each with internal options	4x20	80 marks
		<hr/>
		100 marks

[A] Ordinance and Regulations:-

O. M.Sc.

1.1) Any person who has taken the degree of B.Sc. of this University or the degree of any other statutory University recognized as equivalent, be admitted to the examination for the degree of M.Sc. in Chemistry.

1.2) A student shall be held eligible for admission to the M.Sc. course provided he/she has passed the B.Sc. examination with chemistry principal subject.

B] Revised Syllabus for Master of Science (T&D)

- 1. TITLE :** Chemistry
- 2. Specializations Offered at M.Sc. Part-II:** Inorganic , Organic, Physical and Analytical Chemistry

3. YEAR OF IMPLIMENTATION :

Revised Syllabus will be implemented from June 2010 on wards.

3. GENERAL OBJECTIVES OF THE COURSE:

4. Duration:

- The Course shall be a part time course
- The duration of course shall be two years

FEE STRUCTURE:

Course Fee: As per prescribed by Shivaji University, Kolhapur.

IMPLEMENTATION OF FEE STRUCTURE: June 2010

5. ELGIBILITY FOR ADMISSION:

6. MEDIUM OF INSTRUCTION: English

7. STRUCTURE OF COURSE:

M.Sc. Part-I

1)	CH-Paper-I	:	Inorganic Chemistry
2)	CH-Paper-II	:	Organic Chemistry
3)	CH-Paper-III	:	Physical Chemistry
4)	CH-Paper-IV	:	Analytical Chemistry

M.Sc.Part-II

(General outline for each Specilization)

Inorganic chemistry (ICH)

Paper No. ICH-V	:	Inorganic Chemical Spectroscopy
Paper No. ICH-VI	:	Coordination Chemistry
Paper No. ICH-VII	:	Nuclear Chemistry
Paper No. ICH-VIII	:	Environmental Pollution

Organic chemistry (OCH)

Paper No. OCH-V	:	Reaction mechanism and Theoretical Organic Chemistry
Paper No. OCH-VI	:	Spectroscopic and Stereochemistry
Paper No. OCH-VII	:	Advanced Synthetic methods and Natural Products
Paper No. OCH-VIII	:	Drug, Agerochemicals & Heterocyclic

Physical Chemistry (PCH)

Paper No. PCH-V	:	Quantum Chemistry and Statistical Thermodynamics
Paper No. PCH-VI	:	Electrochemistry and Chemical Kinetics

Paper No. PCH-VII : Molecular Structure
Paper No. PCH-VIII : Solid State and Surface Chemistry

Analytical Chemistry

**Paper No. ACH – V : General Analytical Techniques and
Applied Analytical Chemistry**

Paper No. ACH-VI : Organic analytical Chemistry

Paper No. ACH – VII : Elective Methods in Chemical Analysis

Paper No ACH –VIII : Environmental Chemical Analysis and Control

Paper CH – I: Inorganic Chemistry

Paper-I INORGANIC CHEMISTRY **90 h**

Unit-I Wave Mechanics **15 h**

Origin of quantum theory, black body radiation, atomic spectra, photoelectric effect, matter waves, wave nature of the electron, the wave equation, the theory of hydrogen atom, particle in one dimensional box, transformation of coordinates, Separation of variables and their significance.

Unit –II Stereochemistry and Bonding in Main Group Compounds **15 h**

VSEPR theory & drawbacks, $P\tilde{\pi}$ - $P\pi$, $P\tilde{\pi}$ - $d\pi$ and $d\pi$ - $d\pi$ bonds, Bent rule, Hybridization involving f-orbital energies of hybridization, some simple reactions of covalently bonded molecules.

Unit-III **15 h**

a) Chemistry of Transition Elements **10h**

General characteristic properties of transition elements, co-ordination chemistry of transition metal ions, stereochemistry of coordination compounds, ligand field theory, splitting of d orbitals in low symmetry environments, Jahn- Teller effect, Interpretation of electronic spectra including charge transfer spectra, spectrochemical series, nephelauxetic series, metal clusters, sandwich compounds, metal carbonyls

b) Bioinorganic Chemistry **05h**

Role of metal ions in biological processes, structure and properties of metalloproteins in electron transport processes, cytochromes, ferredoxins and iron sulphur proteins, ion transport across membranes, Biological nitrogen fixation, PS-I, PS – II, Oxygen uptake proteins.

Unit-IV

Electronic, Electric and Optical Behavior of Inorganic Materials **15 h**

Metals, Insulators and Semiconductors, Electronic structure of solid, band theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, the band gap, temperature dependence of conductivity, carrier density and carrier mobility in semiconductors, synthesis and purification of semiconducting materials, single crystal growth, zone refining, fractional crystallization, semiconductor devices, rectifier transistors, optical devices, photoconductors, photovoltaic cells, solar batteries.

Unit-V Chemistry of Non – Transition Elements **15 h**

General discussion on the properties of the non – transition elements, special features of individual elements, synthesis, properties and structure of halides and oxides of the non – transition elements, Polymorphism in carbon, phosphorous and sulphur, Synthesis, properties and structure of boranes, carboranes, silicates, carbides, phosphazenes, sulphur – nitrogen compounds, peroxo compounds of boron, carbon, sulphur, structure and bonding in oxyacids of nitrogen, phosphorous, sulphur and halogens, interhalogens, pseudohalides.

Unit-VI **15 h**

a) Organometallic Chemistry of Transition Elements **08 h**

Ligand hapticity, electron count for different types of organometallic compounds, 18 and 16 electron rule exceptions, synthesis, structure and bonding, organometallic reagents in organic synthesis and in homogeneous catalytic reactions (Hydrogenation, hydroformylation, isomerisation and polymerisation), pi metal complexes, activation of small molecules by coordination

b) Metal – Ligand Equilibria in Solution **07 h**

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of formation constants by pH – metry, spectrophotometry methods.

Recommended Books:

- 1) A. F. Wells, Structural Inorganic Chemistry – 5th edition (1984)
- 2) J H Huheey, Inorganic Chemistry - Principles, structure and reactivity, Harper and Row
Publisher, Inc. New York (1972)
- 3) J. D. Lee, Concise Inorganic Chemistry, Elbs with Chapman and Hall, London
- 4) A. R. West, Plenum, Solid State Chemistry and its applications
- 5) N. B. Hanney, Solid State Physics
- 6) H. V. Keer, Principles of Solid State
- 7) S. O. Pillai, Solid State Physics
- 8) W. D. Callister, Wiley, Material Science and Engineering: An Introduction
- 9) R. Raghwan, First Course in Material Science
- 10) R. W. Cahan, The coming of Material Science
- 11) A. R. West, Basic Solid State Chemistry, 2nd edition
- 12) U. Schubert and N. Husing, Synthesis of Inorganic Materials, Wiley VCH (2000)
- 13) M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP

- 14) A. H. Hanney, Solid State Chemistry, A. H. Publications
- 15) O. A. Phiops, Metals and Metabolism
- 16) Cullen Dolphin and James, Biological aspects of Inorganic Chemistry
- 17) Williams, An Introduction to Bioinorganic Chemistry
- 18) M. N. Hughes, Inorganic Chemistry of Biological Processes
- 19) Ochi, Bioinorganic Chemistry
- 20) John Wulff, The structure an properties of materials
- 21) L. V. Azoroff, J. J. Brophy, Electronic processes in materials, Mc Craw Hill
- 22) F. A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry
- 23) Willam L. Jooly, Modern Inorganic Chemistry
- 24) Manas Chanda, Atomic Structure and Chemical bonding
- 25) N. N. Greenwood and A. Earnshaw, Chemistry of elements,. Pergamon
- 26) Chakraborty, Soild State Chemistry, New Age International
- 27) S. J. Lippard, J.M . Berg, Principles of bioinorganic Chemistry, University Science Books
- 28) G. L. Eichhron, Inorganic Biochemistry, Vol I and II, Elesevier
- 29) Progress in Inorganic chemistry , Vol 18 and 38, J. J. Loppard, Wiley
- 30) A. F. Wells, Structural Inorganic Chemistry – 5th edition (1984)
- 31) J H Huheey, Inorganic Chemistry - Principles, structure and reactivity, Harper and Row Publisher, Inc. New York (1972)
- 32) J. D. Lee, Concise inorganic Chemistry, Elbs with Chapman and Hall, London
- 33) M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
- 34) Jones , Elementary coordination Chemistry
- 35) Martell, Coordination Chemistry
- 36) T. S. Swain and D. S. T. Black, organometallic Chemistry
- 37) John Wulff, structure and properties of materials, vol – 4, electronic properties,
Wiley Eastern
- 38) L. V. Azoroff, J. J. Brophy, Electronic processes in materials, Mc Craw Hill
- 39) F. A. Cotton, R. G. Wilkinson. Advanced Inorganic chemistry
- 40) Willam L. Jooly, Modern Inorganic Chemistry
- 41) Manas Chanda, Atomic Structure and Chemical bonding
- 42) P. L. Pauson, Organometallic Chemistry
- 43) H. S. Sisler, Chemistry in non – aqueous solvents, Reinhold Publishing Corporation, USA, 4th edition (1965)
- 44) H. J. Arnikaar, Essentials of Nclear Chemistry
- 45) Friedlander, Kennedy and Miller, Nuclear and Radiochemistry

Paper CH-II: Organic Chemistry

UNIT-I

[15]

a) Aromatic Electrophilic Substitutions: (8)

Introduction, Concept of Aromaticity, the arenium ion mechanism, orientation and reactivity in Nitration, Sulphonation, Friedel-Crafts and Halogenation in aromatic systems, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in their ring systems. Diazo-coupling, Vilsmeier reaction, Gatterman-Koch reaction, Von Richter rearrangement. Nucleophilic aromatic substitution reactions SN1, SN2.

UNIT-II

[15]

a) Addition to Carbon–Carbon Multiple Bonds (7)

Mechanism and stereochemical aspects of the addition reactions involving electrophiles and free radicals, regio and chemo-selectivity, orientation and reactivity. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Michael reaction.

b) Elimination Reactions: (8)

The E1, E2 and E1cB mechanisms. Orientation in Elimination reactions. Reactivity: effects of substrate structures, attacking base the leaving group the nature of medium on elimination reactions. Pyrolytic elimination reactions.

UNIT-III

[15]

a) Study of following reactions: (7)

Beckmann, Fries, Benzilic acid, Hoffman, Schmidt, Curtius, Lossen & Benzilic acid, Wittig, Neber, and Prins.

b) Stereochemistry: (8)

Concept of Chirality and molecular dissymmetry, Recognition of symmetry elements and chiral centers, Prochiral relationship, homotopic, enantiotopic and diastereotopic groups and faces. Racemic modifications and their resolution, R and S nomenclature. Geometrical isomerism E and Z. Nomenclature. Conformational analysis cyclohexane derivatives, stability and reactivity, Conformational analysis of disubstituted cyclohexanes.

UNIT-IV

[15]

a) Alkylation and Acylation

Introduction, Types of alkylation and alkylating agents: C-Alkylation and Acylation of active methylene compounds and Applications. (8)

b) Hydroboration and Enamines : Mechanism and Synthetic Applications. (7)

UNIT-V

[15]

a) Reductions: (08)

Study of following reductions- Catalytic hydrogenation using homogeneous and

heterogeneous catalysts. Study of following reactions: Wolff-Kishner, Birch, Clemmensen, Sodium borohydride, Lithium Aluminium hydride (LAH) and Sodium in alcohol, Fe in HCl.

b) Oxidation : (07)

Application of following oxidizing agents: KMnO_4 , chromium trioxide, Manganese dioxide, Osmium tetroxide, DDQ, Chloranil .

UNIT-VI

[15]

a) Study of Organometallic compounds: (08)

Organo-magnesium, Organo-zinc and Organo-lithium, Hg and Sn reagents; Use of lithium dialkyl cuprate their addition to carbonyl and unsaturated carbonyl compounds.

b).Methodologies in organic synthesis -ideas of synthones and retrones. Functional group transformations and interconversions of simple functionalities. (07)

RECOMMENDED BOOKS

- 1.Modern synthetic reactions-(Benjamin) H. O. House.
- 2.Reagents in organic synthesis-(John Wiley) Fieser and Fieser
- 3.Principles of organic synthesis-(Methuen) R. O. C. Norman
- 4.Hydroboration- S. C. Brown.
- 5.Advances in Organometallic Chemistry- (A.P.)F. C. A. Stone and R. West.
- 6.Organic Chemistry (Longman)Vol. I & Vol. II- Finar
- 7.Oxidation by-(Marcel Dekker) Augustin
- 8.Advanced Organic chemistry 2nd Ed. R R. Carey and R. J. Sundburg.
- 9.Tetrahydron reports in organic chemistry- Vol.1, No. 8.
- 10.Organic Synthesis-(Prentice Hall)R. E. Ireland.
- 11.Homogeneous Hydrogenation-(J. K.) B. R. James.
- 12.Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis.
- 13.Organic reactions- various volumes- R. Adams.
- 14.Some modern methods of Organic synthesis-(Cambridge) W. Carruthares.
15. A guide book to mechanism in Organic chemistry (Orient-Longmens)- Peter Sykes.
16. Organic reaction mechanism (Benjamin) R. Breslow.
17. Mechanism and structure in Organic chemistry (Holt Reinh.)B. S. Gould.
18. Organic chemistry(McGraw-Hill)Hendrikson, Cram and Hammond.
19. Basic principles of Organic chemistry (Benjamin) J. D.Roberts and M. C. Caserio.
20. Reactive Intermediates in Organic chemistry (John Wiley)N. S. Issacs.
21. Organic Stereochemistry (McGraw-Hill) by Hallas.
22. Organic reaction mechanism (McGraw-Hill) R. K. Bansal.
23. Organic chemistry- R. T. Morrison and R. N. Boyd,(Prentice Hall.)

Paper –CH-III: PHYSICAL CHEMISTRY

UNIT-I

THERMODYNAMICS-I

[15]

1. Introduction, revision of basic concepts. 03
2. Second law of thermodynamics: Physical significance of entropy (Direction of spontaneous change and dispersal of energy), Carnot cycle, efficiency of heat engine, coefficient of performance of heat engine, refrigeration and problems. 06
3. Maxwell relations, thermodynamic equation of state, chemical potential, variation of chemical potential with temperature & pressure. Applications of chemical potential, phase rule, lowering of vapor pressure (Rault's law) and elevation in boiling point. 06

UNIT-II

THERMODYNAMICS-II

[15]

1. Ideal solutions, Rault's law, Duhem-Margules equation and its applications to vapor pressure curves(Binary liquid mixture), determination of activity coefficients from vapor pressure measurements, Henry's law. 08
2. Nonideal solutions : deviations from ideal behaviour of liquid mixtures, liquid-vapor compositions, conditions for maximum. 07

UNIT-III

[15]

KINETIC THEORY OF GASSES

1. Postulates of kinetic theory of gases, P-V-T relations for an ideal gas, non-ideal behavior of gases, equation of state, compressibility factor, virial equation, van der Waal's equation, excluded volume and molecular diameter, relations of van der Waal's constants with virial coefficients and Boyle temperature. [05]
2. Molecular statistics, distribution of molecular states, deviations of Boltzmann law for molecular distribution, translational partition function, Maxwell-Boltzmann law for distribution of molecular velocities, physical significance of the distribution law, deviation of expressions for average, root mean square and most probable velocities, experimental verification of the distribution law. [05]
3. Molecular collision in gases, mean free path, collision diameter and collision number in a gas and in a mixture of gases, kinetic theory of viscosity and diffusion. [05]

UNIT-IV

PHOTOCHEMISTRY

[15]

Absorption of light and nature of electronic spectra, electronic transition, Frank-Condon principle, selection rules, photodissociation, predissociation, photochemical reactions: photoreduction, photooxidation, photodimerization, photochemical substitution, Photo physical phenomena: Electronic structure of molecules, molecular orbital, electronically excited singlet states, designation based on multiplicity rule, life time of electronically excited state, construction of Jablonski diagram, electronic transitions and intensity of absorption bands,

photophysical pathways of excited molecular system(radiative and non-radiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photexcited donor and acceptor systems. Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and analytical significance, bimolecular collisional V quenching and Stern-Volmer equation.

UNIT-V.

[15]

ELECTROCHEMISTRY

1. Arrhenius theory of electrolytic dissociation (Evidences and limitations), revision of basic electrochemistry(Types of electrodes and cells). (03)
2. Electrochemical cells with and without transference, determination of activity coefficients of an electrolyte, degree of dissociation of monobasic weak acid (approximate and accurate), instability constant of silver ammonia complex. (10)
3. Acid and alkaline storage batteries. 02

UNIT-VI

[15]

CHEMICAL KINETICS

Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples. Order and methods of determination(Initial rate, Integration, graphical and half life methods), rate determining step, steady state approximation and study of reaction between NO₂ and F₂, decomposition of ozone, and nitrogen pentoxide. 08

2. Kinetics of complex reactions, Simultaneous (first order opposed by first order), Parallel and Consecutive reactions. Examples and numericals. 07

RECOMMENDED BOOKS

1. Physical Chemistry – P. W. Atkins, Oxford University press, VIIth edition, 2002.
2. Text book of Physical Chemistry – S. Glasstone
3. Principles of Physical Chemistry – Marron and Pruton
4. Physical Chemistry – G. M. Barrow, Tata-McGraw Hill, Vth edition, 2003.
5. Physical chemistry- G. K. Vemulapalli, Prentice-Hall of India, 1997.
5. Thermodynamics for Chemists – S. Glasstone, D. Van Nostrand , 1965.
6. Thermodynamics A Core Course- R. C. Srivastava, S. K. Saha and A. K. Jain, Prentice-Hall of India, IInd edition, 2004.
7. Physical Chemistry of macromolecules- D. D. Deshpande, Vishal Publications.
8. Polymer Chemistry- F. W. Billmeyer Jr, John-Wiley & Sons, 1971.
9. Photochemistry – J. G. Calverts and J. N. Pitts, John-Wiley & Sons
10. Fundamentals of Photochemistry- K. K. Rohatgi-Mukharjii, Wiley Eastern
11. Introduction to Photochemistry-Wells
12. Photochemistry of solutions-C. A. Parker, Elsevier
13. Chemical Kinetics-K. J. Laidler, pearson Education, 2004
14. Electrochemistry- S. Glasstone, D. Van Nostrand , 1965

15. Advanced Physical Chemistry- Gurdeep Raj, Goel Publishing House
16. Basic chemical Kinetics- G. L. Agarwal, Tata-McGraw Hill
17. Physical Chemistry – P. W. Atkins, Oxford University press, VIIth edition, 2002.
18. Physical Chemistry – G. M. Barrow, Tata-McGraw Hill, Vth edition, 2003.

Paper CH-IV Analytical Chemistry

UNIT-I

Errors and treatment of Analytical Chemistry [15]
 Errors, Determinant, constant and indeterminate. Accuracy and precision
 Distribution of random errors. Average derivation and standard derivation,
 variance and confidence limit. Significance figures and computation rules. Least
 square method. Methods of sampling: samples size. Techniques of sampling of
 gases, fluid, solids, and particulates.

UNIT-II

Chromatographic methods: [15]
 General principle, classification of chromatographic methods. Nature of partition
 forces. Chromatographic behavior of solutes. Column efficiency and resolution.
 Gas Chromatography: detector, optimization of experimental conditions. Ion
 exchanges chromatography. Thin layer chromatography: coating of materials,
 prepartive TLC. Solvents used and methods of detection Column chromatography:
 Adsorption and partition methods. Nature of column materials.
 Preparation of the column. Solvent systems and detection methods.

UNIT-III

Computer Science: [15]
 Introduction: History etc. Hardware: Central processor unit. Input devices. Storage
 devices. Peripherals, Software: Overview of the key elements of basic program
 structure, loops, arrays, mathematical function. User defined functions, conditional
 statements, string. Applications. Data representation, Computerized instruments
 system. Microcomputer interfacing

UNIT-IV [15]

a) Ultraviolet and visible spectrophotometry (UV-VIS) (08)
 Introduction, Beer Lambert's law, instrumentation, calculation of absorption
 maxima of dienes, dienones and polyenes, applications.

b) Infrared Spectroscopy (IR) (07)
 Introduction, instrumentation, sampling technique, selection rules, types of bonds,
 absorption of common functional groups. Factors affecting frequencies,
 applications.

UNIT-V

[15]

a) Nuclear Magnetic Resonance (NMR) 8

Magnetic and non magnetic nuclei, Larmor frequency, absorption of radio frequency. Instrumentation (FT-NMR). Sample preparation, chemical shift, anisotropic effect, spin-spin coupling, coupling constant, applications to simple structural problems

b) Mass spectroscopy (MS) 7

Principle, working of mass spectrometer (double beam). Formation of different types of ions, McLafferty rearrangements, fragmentation of alkanes, alkyl aromatics, alcohols and ketones, simple applications, simple structural problems based on IR, UV, NMR and MS

UNIT-VI

a) Atomic Absorption Spectroscopy (10)

Introduction, Principle, difference between AAS and FES, Advantages of AAS over FES, advantages and disadvantages of AAS. Instrumentation, Single and double beam AAS, detection limit and sensitivity, Interferences applications.

b) Inductively coupled Plasma Spectroscopy (5)

Introduction, Nebulisation Torch, Plasma, Instrumentation, Interferences, Applications

REFERENCE BOOKS

1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P.S. Kalsi
6. A Text book of Qualitative Inorganic Analysis- A. I. Vogel
7. Physical Methods in Inorganic Chemistry (DWAP)- R. Drago
8. Fundamentals of Analytical Chemistry – D.A. Skoog and D.M. West (Holt Rinehart and Winston Inc)
9. Analytical Chemistry: (J.W) G. D. Christain
10. Introduction to chromatography : Bobbit
11. Instrumental Methods of analysis (CBS)- H.H . Willard, L.L. Mirrit, J.A. Dean
12. Instrumental Methods of Analysis : Chatwal and Anand
13. Instrumental Methods of Inorganic Analysis(ELBS) : A.I. Vogel
14. Chemical Instrumentation: A Systematic approach- H.A. Strobel
15. The principals of ion-selective electrodes and membrane transport: W.E.Morf
16. Physical Chemistry – P.W. Atkins
17. Principal of Instrumental Analysis- D. Skoog and D. West
18. Treatise on Analytical Chemistry: Vol I to VII – I.M. Kolthoff

19. Computer, Fundamentals-P.K.Sinha
20. Programming in BASIC : E. Balaguruswamy
21. Computer programming made simples : J.Maynard.

M. Sc. -II (Theory and Dissertation)
INORGANIC CHEMISTRY (ICH)

Paper-V: INORGANIC CHEMICAL SPECTROSCOPY

Unit-I

Group Theory [15]

Molecular symmetry, elements of symmetry and symmetry operations, Products of operation, point group, classification of Molecules into point group, reducible and irreducible representation, the great Orthogonality theorem, character table, symmetry aspects of Molecular orbitals.

Unit-II

Electronic absorption Spectroscopy [15]

Term symbols, energies of atomic and Molecular transitions, Selection rule, Morse potential energy diagram, electronic transitions, polarized absorption spectra. Nature of absorption spectra, nature of absorption spectra of transition metal complexes, Orgel diagram, Tanabe Sugano diagram, charge transfer spectra.

Unit-III [15]

A] Infrared and Raman Spectroscopy [9]

Molecular vibrations, force constants, Molecular vibrations and absorption of Infrared radiations Raman Spectroscopy, polarized Raman lines, Use of symmetry considerations to determine the no. of lines in IR and Raman Spectra, Spectra of gases, applications of Raman and Infrared spectroscopy. Selection rule in Inorganic structure determinations, Hydrogen bonding and infrared spectra, metal ligand and related vibrations.

B] Microwave spectroscopy [6]

Basic concept, rotation spectra of simple inorganic compounds, Classification of molecules, rigid rotor model, effect of isotopic substitution on transition frequencies & intensities non rigid rotor, stark effect nuclear and electron spin interaction and effect of external field. Applications of Micro wave Spectroscopy.

Unit-IV [15]

A] Nuclear Magnetic Resonance Spectroscopy [8]

Principle Instrumentation of NMR, the chemical shift, mechanism of electron shielding and factors contributing to the magnitude of chemical shift. Local & remote effect, spin-spin splitting, applications of spin coupling to structural determination, double Resonance techniques. The contact and Pseudo contact shifts Factors affecting nuclear relaxation, an overview of NMR of metal nuclear with emphasis on ^{195}Pt & ^{119}Sn NMR.

B] Electron & Photo acoustic Spectroscopy [7]

Introduction, principle, Instrumentation and applications of following techniques photo

acoustic Spectroscopy (PAS) photo electron Spectroscopy (PES), auger electron Spectroscopy (AES)

UNIT-V [15]

Mossbauer Spectroscopy

Introduction to Mossbauer effect, recoilless emission & absorption of x-rays, Instrumentation, isomer shift, Quadrupole splitting and hyperfine interactions, application of Mossbauer effect to the investigations of compounds of iron and tin .

UNIT-VI [15]

A] Electron spin Resonance [ESR] [8]

Principles of ESR, hyperfine splitting in simple systems, Instrumentation, factors Affecting G values, applications to inorganic complexes.

B] Nuclear Quadrupole Resonance Spectroscopy [NQR] [7]

Introduction, effects of magnetic field on the spectra, relation between electric field gradient and structure, application of NQR.

Recommended books:

1. K. Burger, Coordination Chemistry-experimental methods, Butterworth's
2. R. Drago: Physical method in Inorganic Chemistry, DUSAP.
3. Hill & Day advanced methods in Inorganic Chemistry, J. Wiley
4. F.A. Cotton, chemical application of group theory, Wiley eastern
5. Figgis, Introduction to ligand field theory field
6. Schaefer & Gilman: Basic principles of ligand field Theory, J. Wiley
7. P.R. Backer: Molecular symmetry and Spectroscopy A.P.
8. Ferraro Ziomek, Introduction to Group theory, plenum
9. Soctland Molecular symmetry DVN
10. Dorian: symmetry in Chemistry EWAP
11. Hall: Group theory and symmetry in Chemistry MGLt
12. Nakamoto Infrared R Raman Spectra of Inorganic & Coordination compounds J. Wiley
13. Nakanisha: Spectroscopy and structure J. Wiley
14. Ferrero: Metal ligand and related vibrations
15. CNR Rao Spectroscopy in Inorganic Chemistry Vol I,II,III
16. Durie: vibrations spectra and structure Vol. I to IV, Elsevier
17. Dudd, chemical Spectroscopy Elsevier
18. Popel : H.N.M.R. Spectroscopy J. Wiley
19. R.J. Abraham, J. Fisher and P Loftus Wiley Introduction to NMR spectroscopy.
20. P.K. Bhattacharya: Group Theory & Its Chemical Applications
21. K.V. Reddy: Symmetry & spectroscopy of Molecules.
22. Elements of x-ray diffraction, B.D.Cullity, Addison Wisley, 1967.
23. Diffraction Method, Wormald, Oxford University, Press, 1973
24. Standard Method of Chemical Analysis IIIA6th end.
25. Neutron Scattering in Chemistry, Baun, G.E. Butleworth, London, 1971.
26. Mossbauer Spectroscopy, Greenwood N.N., Gibbs T.C., Chapman Hall, 1971.
27. Chemical Application of Mossbauer Spectroscopy, Goldanski V.I & Harber R.H., Academic Press 1968.
28. Basic Principles of Spectroscopy Cheney R. Mac Grows Hill, 1971.

29. Thermal Method, Wendlandt, W.W. John, Wiley, 1986.
30. Principles of Instrumental analysis, Skoog, III rd edn., Sounders, 1985

Paper-VI : Coordination Chemistry

UNIT-I

Theories of Metal-Ligand bonding [15]
Molecular Orbital treatment, Octahedral (with and without pi bonding) tetrahedral and square planer complexes in a qualitative manner, comparison of theories of bonding, VBT, CFT, LFT and MOT.

UNIT-II

Structural studies of coordination compounds [15]
Compounds of first transition series elements, with respect to their electronic spectra, magnetic & thermal properties (DTA, TGA)

UNIT-III

Magneto Chemistry [15]
Diamagnetic correction, single & multielectron system, types of the magnetic behaviour, Diamagnetism, Para magnetism, Ferro & Ferri, Antiferro and magnetic interaction, The origin of Para magnetism, Magnetic behavior of complexes, Simplification of Van Velck equation, magnitude of magnetic moments, Determination of magnetic susceptibility by Gouy and faraday method.

UNIT-IV [15]

A] Transition metal complexes & catalysis [8]
Introduction, General Principle, catalysis by transition metal complexes, Hydrocarbons Oxidation by Molecular oxygen, olefin Oxidation, olefin polymerization, olefin hydrogenation, Arene reactions catalyzed by metal complexes, catalysis of condensation polymerization reaction, Current and feature trend in catalysis.

B] Mixed Ligand complexes [7]
Stabilities of ternary complexes, Dynamics of formation of ternary complexes reaction of Coordination ligand in ternary complexes, Mimicking reactions in biological systems, enzyme models, Amino acids ester hydrolysis, peptide synthesis & hydrolysis, Detarbodylation of B keto acids

UNIT-V [15]

A] Stereo chemical aspects of substitution reaction of Octahedral Complexes, Stereochemical changes in dissociation (SN₂) and displacement (SN₂) mechanism through various geometries of coordination compounds. Isomerization and r-acemization reactions in octahedral complexes.

B] Substitution reaction of labile transition metal complexes
General discussion of some of the metal complexes, the effect of other bonded liquids on rate, reaction in nonaqueous solvents.

C] Mechanism of atom and electron transfer reactions
Key ideas concerning electron transfer, outer sphere electron transfer and

inner sphere electron transfer two electron transfer, $[\text{Co}(\text{CN})_5]_3$ A redox & catalytic reagent.

UNIT-VI

[15]

Photochemistry

Photochemistry of Coordination compounds, electronically excited states of metal complexes, types of photochemical reactions, substitution reactions, rearrangement reactions, redox reaction, and photochemistry of metallocene.

Recommended Books.

1. Jones: Elementary Coordination Chemistry. J. Wiley
2. Graddon: Introduction to Coordination Chemistry. J. Wiley
3. Drago: Physical methods of Inorganic Chemistry. J. Wiley.
4. Graddon: Introduction to coordination Chemistry, Parasmom
5. Lewis and Wilkins: Coordination Chemistry. J. Wiley
6. Msrtel: Coordination Chemistry Vol I, II VNR
7. Earnshaw: Introduction to Magneto Chemistry
8. Mabbs & Machin Magnetism & transition metal complexes Chamman hall
9. Calvin, Magnetic properties of transition metal complexes.
10. L.N. Maley: Magneto Chemistry
11. Datta & Shymal Elements of Magneto Chemistry
12. Martel & Taqui Khan: homogeneous catalysis with metal complexes Vol.I & II AP.
13. James E. Huheey: Inorganic Chemistry Principles of Structure and reactivity, Harber & Row, Publishers Inc. New York 1972.
14. K.P. Purcell & J.C. Kote: An Introduction to Inorganic Chemistry Holt Sounders, Japan 1980.
15. William L. Jolly: Modern Inorganic Chemistry, Mecgrow Hill USA, 1984
16. F.A. Cotton & R.G. Willkinson: Advanced Inorganic Chemistry.
17. Taube, electron transfer reactions of metal complex ions in solution. Academic Press, 1970.
18. E.S. Tould, Inorganic Chemistry
19. K.F. Purcell & J.C. Kotz, An Introduction to Inorganic Chemistry, Holt Sounder, Japan.
20. V. Balzani & V. Cavassiti, Photochemistry of Coordination compounds, AP, London, 1970.
20. K. Burger, Coordination Chemistry Experimental Methods, Butterworths's
21. K.K. Rastogi & Mukharjee, Fundamentals of photochemistry, Wiley eastern
22. J.G. Calverts & J.N. Pitts, Photochemicals of Photochemistry, John Wiley
23. Wells, Introduction to Photochemistry.

Paper-VII: NUCLEAR CHEMISTRY

UNIT-I

Systematic of alpha, beta and gamma decays

[15]

Alpha decay, energy curve, spectra of alpha particles, Giger-Nuttal law, theory of alpha decay, penetration of potential barrier, beta decay, range of energy relationship, beta spectrum, sergeants curve, Fermi theory of beta decay, matrix elements, allowed and

forbidden transitions, curie plots, gamma decay, Nuclear energy levels, selection rule, isomeric transitions, Internal conversion, Auger effect.

UNIT-II

Nuclear Structure and Stability [15]
Binding energy, empirical mass equation, The nuclear models, the liquid drop model, the shell model, the Fermi gas model & collective nuclear model, nuclear spin, parity & magnetic moments of odd mass numbers nuclei.

UNIT-III [15]

A] Nuclear reaction. [8]
Introduction, Production of projectiles, nuclear cross section, nuclear dynamics, threshold energy of nuclear reaction, Coulomb scattering, potential barrier, potential well, formation of a compound nucleus, Nuclear reactions, direct Nuclear reactions, heavy ion induced nuclear reactions, photonuclear reactions.

B] Nuclear fission [7]
Liquid drop model of fission, fission barrier and threshold, fission cross section, mass energy and charge distribution of fission products, symmetric and A symmetric fission, decay chains and delayed neutrons.

UNIT-IV [15]

A] Reactor Theory - [10]
Nuclear fission as a source of energy, Nuclear chain reacting systems, critical size of a reaction, research reactors, graphite moderated, heterogeneous, enriched uranium reactors, light water moderated, heterogeneous, enriched uranium reactors, water boilers enriched aq. Homogeneous reactors, Thermonuclear reactors, gamma interactions, shielding and health protection. Reactors in India.

B] Nuclear Resources in India [5]
Uranium and Thorium resources in India and their extractions, Heavy water manufacturing in India.

UNIT-V [15]

Principle of tracer chemistry
Application of tracers in physiochemical studies, diffusion studies, isotopic and exchange reactions, tracer in the study of the mechanism of the inorganic chemical reaction, atom transfer & electron transfer mechanisms. Heterogeneous catalysis and surface area measurements, radio carbon dating, tracer studies with tritium, application in metallurgy and preservation of food, geochemical application and hot atom chemistry.

UNIT-VI

Radiation detection and measurements. [15]
Ionization current measurements, multiplicative ion collector, methods not based on ion collection, auxillary Instrumentation and health physical instruments and counting statistics.

Reference Books.

1. Friedlander, Kennedy and Miller, Nuclear and Radio Chemistry: John Wiley
2. B.G. Harvey, Nuclear Chemistry
3. Hassinsky: Translated by D.G. Tuck, Nuclear Chemistry and its application: Addison Wiley
4. B.G. Harvey, Introduction to Nuclear Physics and Chemistry
5. Maeclefort: Nuclear Chemistry: D.Van Nostrand
6. An N.Nesmeyannoy: Radiochemistry: Mir
7. Jacobs et al: Basic Principles of nuclear Science and Reactors, V.Nost & EWAP
8. N.Jay: Nuclear Power Today Tomorrow: ELBS
9. Kenneth: Nuclear Power Today, Tomorrow: ELBS
10. Essentials of Nuclear Chemistry, W.J. Arnikaar, John Wiley
11. Nuclear and Radiation Chemistry: B.K. Sharma, Krishna Publication
12. A Introduction to Nuclear Physics: R. Babber. And Puri
13. Mark lefort, Nuclear Chemistry, D.V. Nostrand.
14. D.C. Dayal, nuclear physics.

Paper-VIII – Environmental Pollution

UNIT-I [15]

A] Air Pollution [8]

Sources and sinks of gases pollutants, classification & effects of air pollutants on living and nonliving things, Air pollution problems in India, pollution problems in industrial area, global air pollution problems, green house effect, acid rain, ozone depletion and their consequences on Environment. Major air pollution disasters.

B] Water pollution [7]

Types, sources and classification of water pollutants, Industrial water pollution, constituents of aquatic Environment, oxygen contents of water and aquatic life, oxygen electrode, and its use, mercury pollution and estimation of organomercurials, industrial water, Effects of water pollutants on life and Environment.

UNIT-II [15]

A] Method of control of air pollution [8]

Method of control of air pollution, electrostatic precipitation wet & dries scrubber, filters, gravity and cyclonic separation, Adsorption, absorption and condensation of gaseous effluent

B] Method of control of water pollution [7]

Water and waste water treatment, aerobic and anaerobic, aeration of water, principle of coagulation, flocculation, softening, disinfection, demineralization and fluoridation.

UNIT-III [15]

Sampling & analysis of air and water pollutants.

a) Methods of sampling gaseous, liquid and solid pollutants, analysis of CO, CO₂, NO_x, SO₂, H₂S, CO₂, analysis of toxic heavy metals, Cd, Cr, As, Pb, Cu, Separation of Co, Cu,

Mg, Mn, Fe, analysis of SO_4^{2-} , PO_4^{3-} , NO_3^- , NO_2^-
- analysis of total cationic and anionic burdens of water.

b) Pesticide, residue analysis soil pollution, Sources of pesticides residue in the Environment, pesticides degradation by natural forces, effect of pesticide residue on life, Analytical techniques for pesticides residue analysis.

UNIT-IV

[15]

A] Radiation pollution-classification & effects of radiation, effects of ionizing radiation on man, Effects of non ionizing radiation on life, radioactivity and Nuclear fall out, protection and control from radiation.

B] Environmental toxicology

Chemical solutions to environmental problems biodegradability, principles of decomposition better industrial processes, Bhopal gas tragedy, Chernobyl, three mile island, sewozo and minamata disasters.

Reference Books:

1. Environmental Pollution, A.K. De
2. Air Pollution, Wark & Werner
3. Environmental Pollution Control in Process Industries, S.P. Mahajan
4. Environmental Pollution, B.K. Sharma & H.Kaur
5. Introduction to Air Pollution, P.K. Trivedi
6. Environmental Pollution Analysis, S.M. Khopkar
7. A Text Book of Environmental Pollution: D.D. Tyagi, M. Mehre
8. Environmental Pollution Engineering and Control, C.S. Rao
9. Chemical in the Environment, Satake & M. Midu
10. Environmental Sciences, E.G. Engel
11. Environmental Chemistry, B.K. Sharma & H.Kaur

M.Sc – II (Theory and Dissertation) Organic chemistry (OCH)

Paper -V: Reaction mechanism and Theoretical Organic Chemistry

UNIT-I. Reactive Intermediates:

[15]

Carbenes, nitrenes, arynes reactions, Phosphorous, nitrogen and sulphur yields, methods of generation and reactivity and applications. Non-classical carbocations.

UNIT-II

Study of following reaction:

[15]

Mechanism, Stereochemistry, migratory aptitude, (application using complicated example): Favorskii, Baeyer-Villiger, Chichibabin, Dienone –Phenol , Pinacol- Pinacolone, Suzuki Coupling, Wolff, Smile's & Michael reactions

UNIT-III Photochemistry:

[15]

Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions, photodissociation gas phase photolysis, photochemistry of

alkynes, intramolecular reactions of the olefinic bonds, geometrical isomerism, cyclisation reactions, rearrangements of 1,4 and 1,5 dienes, photochemistry of carbonyl compounds, intramolecular reactions of carbonyl compounds saturated cyclic and acyclic α,β unsaturated compounds, cyclohexadiones, intermolecular cycloaddition reactions, dimerisation and oxitane formation, photochemistry of aromatic compounds, miscellaneous photochemical reactions, photo fries reactions of anilides, photo fries rearrangements. Singlet molecular oxygen reactions, photochemistry of vision.

UNIT-IV Molecular Orbital Theory:

[15]

Aromaticity in benzenoids, alternant and non-**alternant** hydrocarbon, Huckels rule, energy level of pi molecular orbital and concept of aromaticity, calculation of energies of orbitals in cyclic and acyclic systems. Determination energies and stabilities of different systems calculation of charge densities PMO theory and reactivity index.

UNIT-V Non benzenoid aromatic Compounds:

[15]

Aromaticity in Non- benzenoids compounds Annulenes and hetroannulenes, fullerenes C₆₀ , Tropone, tropolone azulene, fulvene, tropylium salts, ferrocene, Three and five membered systems. Crown ether complexes, cyclodextrins, cryptands, catenanes and rotaxanes, bonding in fullerenes.

UNIT-VI

[15]

a)Free radical reactions:

Types of free radical reactions, detection by ESR, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in attacking radicals. The effect of solvent on reactivity. Allylic hydrogenation (NBS) , oxidation of aldehydes to carboxylic acids, auto oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salt, Sandmeyer's reaction. Free radical rearrangement, Hunsdiecker reaction.

Recommended Books:

1. Lehar and Merchant: Orbital Symmetry.
2. R. B. Woodward and Hoffman: Conservation of orbital symmetry.
3. Kan: Organic Photochemistry
4. Cixon and Halton : Organic photochemistry
5. Arnold: Photochemistry
6. N. Turro : Modern molecular photochemistry
7. Rohatgi- Mukherji : Fundamentals of photochemistry.
8. Ginsburg: Nonbenzenoid aromatic compound
9. A. Streitwieser : Molecular orbital theory for organic chemistry.
10. E. Cler : The aromatic sextet.
11. Lloyd: Carbocyclic non- benzenoid aromatic compounds.
12. W. B. Smith; Molecular orbital methods in organic chemistry.
13. Grratt; Aromaticity.
14. A guide book to mechanism in organic chemistry

- (orient- Longmans)- Peter Sykes
15. Organic Reaction Mechanism (Benjamin)- R. Breslow
 16. Mechanism and structure in Organic Chemistry
(Holt Reinhartwinston)- B. S. Gould
 17. Organic chemistry (McGraaw Hill)- Hendrikson, cram and Hammond
 18. Basic principles of organic chemistry (Benjamin)
 19. J. D. Roberts and M. C. Caeserio.
 20. Reactive intermediates in organic chemistry, (J. Wiley) N. S. Issacs.
 21. Organic reaction mechanism (Mc Graw Hill) R. K. Bansal
 22. Fundamentals of photochemistry K. K. Rohtagi- Mukherji Wiley- Eastern

Paper -VI: Spectroscopic and Stereochemistry

UNIT-I

a) Ultraviolet Spectroscopy 6

Woodward- Fisher rules for conjugated dienes and carbonyl compounds; Calculation of λ max. Ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

b) IR Spectroscopy 9

Characteristic vibrational frequencies of alkanes; alkenes; alkynes; aromatic compounds; alcohols; ethers; phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds [ketones; aldehydes; esters; amides; acids; anhydrides; lactones; lactams and conjugated carbonyl compounds] Effect of hydrogen bonding and solvent effect on vibrational frequencies; overtones; combination bands and Fermi resonance. FT-IR of gaseous; solids and polymeric materials

UNIT-II NMR Spectroscopy 15

General introduction and definition; chemical shift; spin –spin interaction; shielding mechanism of measurement; chemical shift values and correlation for protons bonded to carbons [aliphatic; olefinic; aldehyde and aromatic] and other nuclei [alcohols; phenols; enols; acids; amines; amides and mercapto]; chemical exchange; effect of deuteration; complex spin-spin interaction between two; three; four; and five nuclei [first order spectra]; virtual coupling. Stereochemistry; hindered rotation; Karplus curve variation of coupling constant with dihedral angle. Simplification

Simplification of complex spectra; nuclear magnetic double resonance; shift reagent; solvent effect. Fourier transform technique; nuclear overhauser effect [NOE] Resonance of other nuclei – F; P.

UNIT-III Mass Spectrometry 15

Introduction, ion production- EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, nitrogen rule. High-resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

UNIT-IV Newer methods of stereo selective synthesis: [15]

Introduction and stereo selective and stereospecific reactions. Enantioselective synthesis (chiral approach) reactions with hydride donors, hydroboration, catalytic

hydrogenation via chiral hydrazones and oxazolines. Sharpless epoxidation. Diels Alder selective synthesis, use of calculations of optical purity and enantiomeric excess.

UNIT-V [15]

a) Conformation and reactivity in acyclic compounds and of cyclohexanes. [5]

Stability and reactivity of diastereoisomers. Curtin- Hammett principle,

b) Some aspects of the stereochemistry of ring systems: [5]

Stereoisomerism and determination of configuration Stability of rings and ease of rings formation)

c) The shapes of the rings other than six membered: [5]

Shapes of five, six, and seven membered rings. Conformational effects in medium sized rings, Concept of I strain.

UNIT-VI [15]

a) Fused and bridged rings: Fused bicyclic ring systems: [8]

Cis and trans decalins and perhydrophenanthrene. Bridged rings, Nomenclature stereochemical restrictions, and The Bredt's rule, Reactivities.

b) O.R.D. and C.D. : Types of curves, the axial haloketone rule. [7]

The Octant rule. Determination of conformation and configuration.

Recommended Books:

1. V.M. Parikh, Application spectroscopy of organic molecules. (Mehata)
2. D.W. Williams and Flemming, Spectroscopic methods of organic compound.
3. Silverstein and Basallar, Spectroscopic identification of organic compounds V.M. Parikh ORPTION SPECTROSCIPY OF ORGANIC MOLECULES (J. Wiley)
4. P.S. Kalsi Spectroscope of organic compounds (New age publisher)
5. J.R. Dyer. Application of absorption spectroscopy of organic compounds.
6. Jackman and Sterneil , Application of NMR spectroscopy
7. J.D. Roberts, Nuclear magnetic resonance (J. Wiley)
8. Jafee and Orchin, Theory and application of U.V,
9. K. Benjamin. Mass spectroscopy
10. Beynon J H et.al , The mass spectra of organic molecules.
11. Wehli F.W, Marchand A. P. Interpretation of carbon 13 NMR (J. Wiley)
12. W. Kemp, Organic spectroscopy ELBS
13. Willard Merritt and Dean. Instrumental methods of analysis CBS
14. Das and Jame , Mass Spectroscopy.
15. E.L. Eliel : Stereochemistry of carbon compounds.
16. D. Nasipuri : Stereochemistry of organic compounds.
17. P.S. Kalsi: Stereochemistry: conformation and Mechanism.
18. Eliel, Allinger, Angyal and Morrison : Conformational analysis
19. Hallas: Organic stereochemistry
20. Mislow and Benjamin: Introduction to stereochemistry.
21. H. Kagan : Organic stereochemistry.
22. Carl Djerassi ; Optical rotatory dispersion.
23. P. Crabbe : Optical rotatory dispersion and C.D.

Paper -VII: Advanced Synthetic methods and Natural Products

UNIT-I Disconnection approach:

[15]

An introduction to Synthons and synthetic equivalents, disconnection approach, functional group interconversions. One group C-X and two group disconnections in 1,2,1,3 -,1,4-& 1,5- difunctional compounds , Retro- synthesis of Alkene ,acetylenes and aliphatic nitro Alcohols and carbonyl compounds, amines , the importance of the order of events in organic synthesis, chemoselectivity, regioselectivity. Diels Alder reaction, Michael addition and Robinson annulation. Retro- synthesis of aromatic Heterocycles and 3, 4, 5 and 6 membered carbocyclic and heterocyclic rings Reversal of polarity (Umpolung).

UNIT-II

Application of following reagents & reaction in synthesis.

[15]

Complex metal hydrides, lithium dialkyl cuprate, lithium diisopropylamide (LDA) Dicyclohexylcarbodiimide(DCC), Trimethyl silyl iodide, tributyltin hydride, peracids, lead tetra acetate, PPA, Diazomethane, ozone phase transfer catalyst, woodward-prevost hydroxylation, Barton and Shapiro reaction Hoffmann – Löffler-Fretag, Miyamura, Stille, Negishi, Kamada Peterson synthesis

UNIT-III

[15]

a) Selenium dioxide, crown ethers, DDQ, Dess-Martin periodinane, periodic acid & Iodoisobenzyl diacetate. [7]

b) Application of following metal in organic synthesis [8]

Pd, Hg, and Rh, Tl and Si

UNIT-IV Terpenoids

[15]

Structure and synthesis of abietic acid, zingiberene, santonin, cuparenone and caryophyllene.

UNIT-V Alkaloids

[15]

Structure, stereochemistry, synthesis and biosynthesis of the following Structure of morphine, reserpine, ephedrine, (+) Conin.

UNIT-VI

[15]

a) Steroids

[8]

Occurrence, nomenclature, basic skeleton, Diels hydrocarbon and study of the following hormones, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone and cartisone. Biosynthesis of steroids.

b) Prostaglandins

[7]

Occurrence, nomenclature, classification, biogenesis and physiological effects, Synthesis of PGE2 and PGF2

Books Suggested

1. Apsimon: The total synthesis of natural products.
2. Manskey and Holmes: Alkaloids
3. A.A. Newman: Chemistry of Terpenes.
4. P. D B.Mayo: The chemistry of natural products.
5. Simonson: Terpenes.
6. T.W. Goddwin: Aspects of terpenoid chemistry and biochemistry
7. Woguer: Vitamins and Co enzymes.
- 8.P. W. Bently: Chemistry of Natural products,
9. Fieser and Fieser: Steroids
10. I. Finar: Organic chemistry Vol. II and I
11. J.B. Hendrickson, The molecules of nature.
12. Peter Bernfield, The biogenesis of natural products,
13. R.T. Slickenstaff A.C. Ghosh and G.C. Wole , Total synthesis of steroids.
14. The chemistry of natural products, vol. Nakanishi
15. S.Warren: Designing of organic synthesis.
16. J. Fuhrhop & G. Penzlin. : Organic synthesis (2nd ed.)
17. Carruthres: some modern methods of organic synthesis.
18. H.O.House: modern synthetic reaction.
19. Fieser & Fieser : Reagent in organic synthesis
20. R.O.C.Norman: principle of organic synthesis
21. CAREY & Sundharg: Advanced organic Chemistry
22. P.E.REALAND: Organic synthesis
23. Bartan and Ollis : comprehensive organic Chemistry
24. R.Admas: - organic reactions
25. Stone & west: Advances in organometallic Chemistry
26. C.W.Bird: Transition metal intermediate in organic synthesis
27. Swan & black :organometallic in organic synthesis.
28. A. Mitra : synthesis of prostaglandins
29. John Apsimon: Total synthesis of natural products
30. M. K. Mathur, C. K. Narang & R.E.Williams: polymers as aid in organic synthesis
31. P. HODGE & D.C.SHERRINGTON: Polymer supported reaction in organic synthesis.
32. C.J.Gray: Enzyme catalysed reaction s

Paper -VIII: Drug, Agrochemicals & Heterocyclic

UNIT-I

[15]

a) Drug design

[7]

Development of new drugs, procedures followed in drug design, concepts of prodrugs and soft drugs. Theories of drug activity, Quantitative structure activity relationship. Theories of drug activity, Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors

b) Study of the Following types of drugs:

[8]

- a) Antibiotics: Preparation of semi synthetic penicillin, conversion of penicillin into cephalosporin, general account of tetracycline & macrocyclic antibiotics(no synthesis)

- b) Antimalerials: Trimethoprim
c) Analgesic & Antipyretics: Paracetamol, Meperidine, methadone, Aminopyrine.

UNIT-II

[15]

a)

- i) Anti-inflammatory: Ibuprofen, Oxyphenylbutazone, Diclophenac, Indomethacin.
ii) Antitubercular & antileprotic : Ethambutol, Isoniazide & Dapsone
iii) Anaesthetics : Lidocaine, Thiopental.
iv) Antihistamines: Phenobarbital, Diphenylhydramine.
v) Tranquilizers: Diazepam, Trimeprazine.
vi) Anti AIDS: General study
vii) Cardiovascular: Synthesis of dilliazem, quinidine, methyldopa, atenolol, oxyprenol
viii) Anti-neoplastic drugs: Cancer chemotherapy, Synthesis of mechloreaethamine, cyclophosphamide, Mephalan, uracils, mustards. Recent development in cancer chemotherapy. Hormones and natural products.

UNIT-III

[15]

a) Small ring Heterocycles

[8]

Three membered and four membered Heterocycles- synthesis and reactions of aziridines, oxiranes, thiranes, azetidines, oxitanes and thietanes.

b) Benzo fused five membered Heterocycles

[7]

Synthesis and reactions of benzopyrroles, benzofurans and benzothiophenes.

UNIT-IV

[15]

Six membered Heterocycles with one heteroatom

Synthesis and reactions of pyrilium salts and pyrones and their comparison pyridinium and thiopyrylium salts and pyridones. Synthesis and reactions of coumarins, chromones.

UNI-V

a) Six membered Heterocycles with two and more Heterocycles

[7]

Synthesis and reactions of diazines & triazines.

b) Seven membered Heterocycles

[8]

Synthesis and reactions of azepines, oxepines & thiepinines.

UNIT-VI : Agrochemical:

[15]

- a. Carbamate pesticides: Introduction, Carbaryl, Baygon, Aldicarb, Ziram, Zineb
b. Organophosphorus pesticides: Malathion, Monocrotophos, dimethoate, phorate, mevinphos
c. Natural and synthetic pyrethroids : Isolation and structures of natural allethrin, fenvalerate, cypermethrin,
d. Plant growth regulators: General survey synthesis of simple compounds
e. Insect repellents: General survey and synthesis
f. Jovenile hormone: introduction structures JHA importance synthesis
g. Pheromones: introduction, examples, and importance in IPM synthesis of juvabione bombycol, grandisol, and disparure

RECOMMENDED BOOKS

1. Burger : Medicinal Chemistry.
2. A. Kar : Medicinal Chemistry (Wiley East)
3. W. O. Foye : Principals of medicinal chemistry.
4. Wilson, Gisvold & Dorque: Text book of organic medical and pharmaceutical chemistry
5. Pharmaceutical manufacturing encyclopedia.
6. R. M. Acheson : An introduction to chemistry of heterocyclic compounds (Interscience).
7. Joule & Smith : Heterocyclic chemistry (Van Nostrand).
8. R. K. Bansal: Heterocyclic chemistry (Wiley E).
9. L. A. Paquette : Principals of modern heterocyclic chemistry.
10. M. H. Palmer : The structure and reactions of heterocyclic compounds.
11. A. R. Katritzky: Advances in Heterocyclic chemistry (A.P.).
12. Finar: Organic chemistry (Vol. 1 & 2)
13. Cohn & Stumpf : Outline of Biochemistry.
14. Williams : Introduction to the chemistry of enzyme action.
15. The Organic Chemistry of Drug design and Drug action, R. B. Silverman Academic press.
16. Strategies for Organic Drug synthesis and Design, D. Lednicer, J. Willey.
17. Heterocyclic Chemistry, Vol-1-3, R. R. Gupta, M. Kumar and V. Gupta, Springer Veriag.
18. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme
19. Heterocyclic Chemistry, J. A. Joule, K. Mills and G. F. Smith, Chapman and Hall
20. Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Technical
21. Contemporary Heterocyclic Chemistry, G. R. Nikome and W. W. Poudler, Willey.
22. An Introduction to Heterocyclic Compounds, R. M. Acheson, J. Willey
23. Comprehensive Heterocyclic Chemistry, A. R. Katrizky and C. W. Rees
24. N. N. Melikov: The Chemistry of Pesticides and formulations
25. K. H. Buchel: Chemistry of Pesticides
26. R. Cleymlin: Pesticides
27. F. W. Billmeyer: Text book of Polymer Science
28. H. R. Alcock and F. W. Lambe: Contemporary Polymer Chemistry
29. J. M. G. Cowie, Blackie: Physics & Chemistry of Polymers

M.Sc-II (Theory and Dissertation) Physical Chemistry (PCH)

Paper -V: Quantum Chemistry and Statistical thermodynamics

Unit - I: Quantum Mechanics of some simple systems:

[15]

- a) Practical in a box: One dimensional Box - application to spectra of linear conjugated molecular. Degeneracy in multidimensional box.
- b) Potential well of finite depth (Tunneling effect)

c) Rigid rotator,

d) Linear harmonic oscillator, the formal solutions, energy levels, degeneracy, properties of wave functions and selection rules.

Unit - II: The hydrogen Problem: [15]

Schrodinger equation for hydrogen atoms (polar co. ordinates) and its solution. The radial distribution function and its significance, shape of atom orbitals.

Unit - III: A brief introduction to hydrogen like atoms. [15]

Helium atoms. Approximate methods: Perturbation theory and Self-consistent field theory, chemical bonding and hybridization.

Approximate methods: The variation theorem and principles, its use to obtain optimum molecular orbital and energies.

Unit - IV :Modern Theoretical principals : (15)

Exact and inexact differential expressions in two variables. Total differentials. Techniques of partial differentiations. Transformation of variables. Maxima and minima . Integrating factors, Paff differential equations, Caratheodorys theory. Legendre transformations. Derivation of thermodynamic identities . The second law of thermodynamics, classical formulations, mathematical consequences of second law. Entropy changes , Clausius inequality . free energy concept. General condition of equilibrium. Thermodynamic potentials.

Unit - V:Phase space, stirlings appronimation : (15)

Configuration and weights, the most probable configuration. Statistical Equilibrium. Postulates of equal probabilities. Ensembles. Ensemble average and time average of property.

The Boltzmann Distribution law. Principle of the equipartition of energy , Quantum Statistics : BE and FD statistics, Comparison of three statistics, comparison of three statistics and radiation , Fermi - Dirac systems. Fermi energy. Electron gas in metals.

Unit - VI : Molecular partition function: (15)

Expressions for transnational, rotational, vibrational and electronic partition functions, relation between the partition function and thermodynamic properties, rotational contribution to entropy. Free energy functions, ortho and para hydrogen, use of spectroscopic and structural data to calculate thermodynamics functions.

Molecular and statistical interpretation of entropy, third law of thermodynamics and equilibrium constant.

Heat capacity of solids, Einstein and Debye specific heat equations. Characteristic temperature.

References:

1. Introductory Quantum Chemistry by A. K. Chandra. Tata McGraw-Hill. 1988.
2. Basic Physical Chemistry by W. J. Moore, Prentice Hall, 1986.
3. Physical Chemistry, by P. W. Atkins , ELBS, 1986.
4. Quantum Chemistry, W. Kauzmann, Academic press.
5. Quantum Chemistry by Hanns.
6. Theoretical Chemistry by S. Glasstone , Van Nostrand .

7. Physical Chemistry by Alberty .
8. Quantum Chemistry by Prasad
9. Huckel Molecular theory by Keith Yates
10. Elements of statistical thermodynamics - L. K. Nash, Addison Wesley
11. Statistical thermodynamics by B. J. McClland, Chapman and Hall.
12. A Introduction to Statistical Thermodynamics by T. L. Hall
Addison - Wesley
13. Thermodynamics of Irreversible Processes by Iila Prigofine.
14. Thermodynamics of steady state by Denbeigh
15. Advanced physical Chemistry by S. N. Blinder, The Macmilan Company, 1967.
16. Themodynamics by R. C. Srivatsava, S. Saha and A. K. Jain, Prentice-hall, India.
17. Theoretical Chemistry by S. Glasstone.

Paper VI: Chemical Kinetics and Electrochemistry

Unit - I :Chemical kinetics: (15)

Steady State Approximation Collision theory of gas reaction, collision frequency. The rate constant , molecular diameters , collision theory vs. experiment
Kinetics of Fast reactions: Relaxation techniques, pressure jump and temperature jump methods, NMR relaxation, flash photolysis and molecular beam methods.

Unit - II : Theories of reaction rates: (15)

Activated complex theory of reaction rates, reaction coordinate and transition state, formation and decay of activated complex, Eyring equation, thermodynamic aspects

Theory of unimolecular reactions.

Unit - III: Reactions in solution: (15)

Oxidation –reduction reactions: One-electron & two-electron transfer reactions. Inner sphere & outer-sphere reactions, complimentary two equivalent changes ($Tl^+ - Tl^{3+}$ exchange). Unstable oxidation states. Tests for Marcus Hush theory.

Unit - IV : Electrolytic conductance: (15)

Debye - Huckel theory of inter-ionic attraction , ionic atmosphere, time of relaxation, relaxation and electro-phoretic effects, Debye-Huckel-Onsagar equation and its validity for dilute solutions and at appreciably concentrated solutions. Debye-Falkenhagen and Wein effects. Abnormal ionic conductance of hydroxyl and hydrogen ions.

Activity coefficients: forms of activity coefficients and their interrelationship. Debye-Huckel limiting law its applications to concentrated solutions. Debye-Huckel Bronsted equations. Quantitative and qualitative verification of Debye-Huckel limiting law, ion association. Bjerrum theory

Unit - V : Ion solvent interactions and electrolysis: (15)

The Born Model and expression for the free energy of ion- solvent interactions. Thermodynamic parameters for the ion - solvent interactions. Calculations of heats of hydration of ions and the concept of hydration number .

Electrolysis: Decomposition potentials: calculations and determinations. Polarization: types of polarization, over voltage and hydrogen and oxygen over voltage.

Unit - VI: Electrode reactions. (15)

Tafel equations, kinetics of discharge of hydrogen ions . Diffusion over potentials. Fuel cells: significance of fuel cells: hydrogen - oxygen, hydrocarbon - air, natural gas and carbon monoxide, air fuel cells.

Corrosion: concept and importance, mechanism of corrosion and Pourbaix diagrams.

UNIT-IV [15]

Electrokinetic phenomena: Electrical double layer, theories of double layer, electro-capillary phenomena, electro-capillary curve. Electro-osmosis, electrophoreses. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential.

REFERENCE BOOKS

1. An Introduction to Electrochemistry by S. Glasstone
2. Modern Electrochemistry Vol. I & II by J. O. M. Bockris and A.K.N. Reddy .
3. Physical Chemistry by S. Glasstone
4. Electrolytic Solutions by R. A. Robinson and R. H. Stokes
5. Physical Chemistry by P. W. Atkins. ELBS.
6. Chemical Kinetics by K. J. Laidler.
7. Kinetics and Mechanism by A. A. Frost and R. G. Pearson.
8. Fast Reactions by Haque.
9. Theory of chemical reaction rates by K. J. Laidler, McGraw Hill, New York , 1969.
10. Fast Reactions by J. N. Bradley , Clarendon Press Oxford , 1974
11. Physical Chemistry by W. J. Moore.
- 12 Physical Chemistry by P.W. Atkins
- 13 Mechanism of Inorganic Reactions by F. Basolo and R. G. Pearson, John Wiley & Sons Inc., 2nd Edition, 1967.
14. A Guidebook to Mechanism in Organic Chemistry, Peter Sykes, Orient Longmann, 6th Edition, 2003.

Paper VI: Molecular Structure

Unit - I: Introduction of spectroscopy and Rotational Spectra : (15)

Characterization of electromagnetic radiation. The qualification of energy. Regions of Spectrum, transition probability, the width and intensity of spectral transitions.

Classification of molecules according to their moment of inertia. Rotational spectra of rigid and nonrigid diatomic molecules. The intensities of spectral lines. The effect of isotopic substitution. Polyatomic and symmetric top molecules. The Stark effect.

Unit- II Infrared spectroscopy and Raman Spectroscopy: (15)

Diatomic molecules : 1) Molecules as harmonic oscillator, Morse potential energy function, vibrational spectrum, fundamental vibrational frequencies. Force constant, zero point energy, isotope effect. The Anharmonic oscillator, the diatomic vibrating rotator, the interactions of rotations and vibrations.

Polyatomic molecules: Fundamental vibrations and their symmetry, overtone and combination frequencies. The influence of rotations and molecular spin on the spectra of polyatomic molecules. Analysis by Infrared techniques.

Raman Spectroscopy : Rayleigh scattering . Raman Scattering, classical and quantum theories of Raman effect. Rotational Raman Spectra for linear and symmetric top molecules. Vibrational Raman Spectra , rotational fine structure. Polarization of light and the Raman effect . Structure determination from Raman and Infra-red spectroscopy.

Unit - III Electronic Spectroscopy : (15)

General nature of band spectra. Beer- Lambert Law integrated absorption coefficient and oscillator strength. Term symbols for atoms and molecules. The hydrogen atom and hydrogen like species spectrum.

Sequences and progressions, the vibrational course structure and rotational fine structure of electronic band. The Franck-Condon principle, dissociation energy and dissociation products. Birge-Sponer extrapolation. The Fortrat diagram. Predissociation, classification of electronic states. The spectrum of molecular hydrogen. Electronic spectra of polyatomic molecules. Chemical analysis by electronic spectroscopy. ($d-d$), ($\pi-\pi$) and ($\pi-n^*$) transitions. Photochemical mechanism of vision.

Unit - IV: The Electric and Magnetic properties of Molecules: (15)

Electric dipole moment of molecule, polarization of a dielectric , polarizability of molecules, Clausius-Mossotti equation. Debye equation . limitation of the Debye theory , determination of dipole moment from dielectric measurements in pure liquids and in solutions. Dipole moment and ionic character, Bond moment, Group moment, vector addition of moments, bond angles, Diamagnetism and paramagnetism. Volume and mass susceptibilities. Langevin's classical theory of diamagnetism and paramagnetism Atomic and ionic susceptibility. Pascal constants , Curie - Weiss law . Van Vleck general equation of magnetic susceptibility. Determination of magnetic susceptibility. Ferro and ferri magnetism.

Unit - V: Nuclear Magnetic Resonance Spectroscopy: (15)

The nature of spinning particles , interaction between spin and a magnetic field. Population of energy levels, The Larmor precession . relaxation times . the

meaning of resonance and the resonance condition. NMR experiment, significance of shielding constants and chemical shift . the origin and effect spin - spin coupling , factors affecting chemical shift, chemical analysis by NMR. Exchange phenomena , ^{13}C NMR spectroscopy, double resonance and nuclear-overhauser effect.

Unit - VI:

[15]

Electron Spin Resonance Spectroscopy:

Electron spin and Magnetic moment , Resonance condition in ESR and significance of 'g' value . ESR spectra of organic free radicals , McConnell relation Electron Exchange reactions , applications of ESR,

REFERENCE BOOKS

1. Fundamental of molecular spectroscopy by C. N. Banwell Tata McGraw Hill.
2. Physical Chemistry by P. W. Atkins , ELBS, 1986
3. Symmetry, Orbitals and spectra by M. Orchin & H. Jaffe, Wiley , interscience.
4. Chemical applications of group theory by F. A. Cotton Wiley , interscience
5. Symmetry in chemistry by H. Jaffe and M . Orchin , Jhon willey.
6. Group theory and its applications to chemistry by K. V. Ramen , Tata McGraw Hill.
7. Molecular Structure and Molecular Spectra by G. Herzberg, Van Nostrand .
8. Molecular Spectroscopy by I. N. Levine , Wiley interscience.
9. Molecular Spectroscopy by G. M. Barrow.
10. Fundamentals of molecular spectroscopy by C. N. Banwell.
11. Physical chemistry by P. W. Atkins . ELBS. 1986
- 12 Introduction to molecular spectroscopy by G. M. Barrow.
- 13 Molecular spectroscopy by I. N. Levins , Wiley interscience.
- 14 Nuclear magnetic Resonance by J. D. Roberts , McGraw Hill .
- 15 Introduction to Magnetic resonance by A. Carrington and A. D. McLachlan. Harper and Row.
- 16 Electron Spin Resonance , Elementary theory and practical applications by J. E. Wetz and J. R. Boulton , McGraw Hill .
- 17 Introduction to Magnetochemistry by Earnst Shaw. Academic Press
- 18 Electrical and optical properties of molecular behavior by M. Davies, pergman press.
19. Polar molecules by P. Debye , Dover publications.

PAPER-VIII : Solid State and Surface Chemistry

Unit I: The solid state:

(15)

Types of solids, isomorphism and polymorphism, laws of crystallography, lattice types, X-ray diffraction, Bragg's equation, Miller indices, Bragg Method, Debye-Sherrer method of X-ray structure analysis of crystals, indexing of reflections,

identification of unit cells from systematic absence in diffraction pattern, structure of simple lattice and X-Ray intensities, structure factor and its relation to intensity and electron density, phase problem, procedure for an X-ray structure determination.

Unit II: Solid State Reactions: (15)

General principle, types of reactions: Additive, structure sensitive, decomposition and phase transition reactions, tarnish reactions, kinetics of solid state reactions, factors affecting the reactivity of solid state reactions.

Unit III: Electronic Properties and Band Theory: (15)

Metals, insulators and semi conductors, free electron theory and its applications, electronic structure of solids, band theory, band structure of metals, insulator, and semiconductors, doping in semiconductors, p- n junction, super conductors, optical properties, photo-conduction and photoelectric effects, laser action, solid state laser and their applications.

Unit IV: Adsorption and surface phenomenon: (15)

Physisorption and chemisorption , adsorption isotherms, Langmuir and B. E. T. equation and significance in surface area determination, surface films, states of insoluble films, L. B. films and their application, adsorption from solution, adsorption types, surface excess concentration , Gibb's adsorption equation : derivation , significance and experimental verification , catalytic activity of surfaces.

Unit V: Micelle: (15)

Surface activity, surface active agents and their classification, micellisation, critical micelle concentration (cmc) thermodynamics of micellisation , factors affecting cmc, methods of determination of cmc , reverse micelle , solubisation of water insoluble organic substances , use of surfactants in oil recovery ,

Unit VI: Liquid gas and liquid interfaces: (15)

Surface tension, capillary action, methods of determination of surface tension, surface tension across curved surfaces, vapor pressure of droplet (Kelvin equation) , surface spreading , spreading coefficient, cohesion and adhesion energy, contact angle, constant angle hystereis, wetting and detergency.

REFERENCE BOOKS

1. A guide to laser in chemistry by Gerald R., Van Hecke, Keny K. Karokitis
2. Principals of solid state, H. V. Keer, Wiley Eastern,
3. Solid state chemistry, N. B. Hannay
4. Solid state chemistry , D. K. Chakrabarty , New Age International
5. An Introduction to Crystallography : F. G. Philips
6. Crystal Structure Analysis: M. J. Buerger
7. The Structure and properties of materials:

- Vol. III Electronic properties by John Wals
8. Electronic processes in materials : L. U. Azroff and J. J. Brophy
 9. Chemistry of imperfect crystal : F. A. Kroger
 10. Elements of X-ray Diffraction by B. D. Cullity, Addison- Weily.
 11. Physical chemistry of surfaces: A. W. Adamson.
 12. Theory of adsorption and catalysis by Alfred Clark ,
 13. Chemisorption by B. M. W. Trapnell and H.O. Hayward.
 14. Introduction to colloids and surface chemistry by D. J. Shaw.
 15. Theories of chemical reaction rates by A. J. K. Laidler
 16. Surface chemistry by J. J. Bikermann

M.Sc. – II (Theory and Dissertation) Analytical Chemistry

Paper-V : General Analytical Techniques and Applied Analytical Chemistry

Unit-I: Theory of Volumetric and Gravimetric Analysis: (15)

Standard solutions Indicators, theory of indicators , types of titrations, Acid , base , precipitation, Redox and complexometric titrations, Acid–base titrations in nonaqueous media , solvent characterisation , leveling effect , applications of non – aqueous titrations , MnO_2 in pyrolusite, $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$ and $\text{NaOH} + \text{Na}_2\text{CO}_3$ Mixture analysis , Gravimetric Analysis purity of the precipitate – Co precipitation's and post precipitation , precipitation from homogeneous solution , organic precipitation.

Unit-II: Ion Exchange separation: (15)

Theories of ion exchange , exchange capacity , screening effects, Penetrations of electrolytes in ion exchange resin , sorption of complex ions , ion exchange equilibria , column operation , theory of breakthrough curve , elution steps , use of non aqueous solvents in ion – exchange separation. Separation of halides , Rare earths and

Unit-III : Thermal Methods of Analysis : (15)

Effect of heat on Materials, Chemical decomposition and T. G. Curves, Analysis of T.G. curve to show nature decomposition reactions , the product and qualities of compounds expelled, applications, instrumentation , T.G. in controlled atmosphere DTA, instrumentation and Methodology, application, DSC, theory , instrumentation and applications, Thermometric titrations method and applications.

Unit-IV: Analysis of Minerals and Ores: (15)

Bauxite, haematite, dolomite, phosphates, monazite, pyrites and the chemicals from sea.

Unit-V; Analysis of metals and alloys: (15)

Foundry materials, analysis of coal, ferroalloys, and special steels, slags, fluxes, brass and bronze.

Unit-VI ; analysis of soil and fertilizers:

(15)

Method of soil analysis, soil fertility its determination, determination of inorganic constituents of plant materials, Chemical analysis as measure of soil fertility, analysis of fertilizers.

Recommended Books:

1. Hillebrand Lhundel, Bright and Hoffiman, Applied Inorganic Analysis, John Wiley.
2. Snell and Biffen, Commercial Methods of Analysis.
3. P.G. Jeffery, Chemical Methods of Rock Analysis, Pergamon.
4. Buchel, Chemistry of Pesticides. J Wiley.
5. Rieche, Outlines of Industrial Organic Chemistry, ButterWorth.
6. F.A.Henglein, Chemical Technology, Pergamon.
7. Kent, Riegl's Industrial Chemistry, Rainhold.
8. Chopra and Kanwar, Analytical Agriculture Chemistry, Kalyani Publishers.
9. Aubert and Pintes, Trace Elements in Soils.
10. Bear, Chemistry of Soil.
11. Hauson, Plant Growth Regulators, Noyes.
12. P.G. Jeffery and D.J. Hatchinson, Chemical Methods of Rock Analysis.
13. F.J. Weleher, Standard Methods of Chemical Analysis, A Series of Volumes Robert and Krigeger Publishing Company.
14. I. M. Kolthoff and PJ Ewing, Treatise o Analytical Chemistry, A series of Volumes.
15. R.D. Reeves and R.R. Brooks, Trace element Analysis of Geological Materials, John Wiley & Sons NewDehli.
16. W.M. Johnson and J.A. Maxwell, Rock and Mineral Analysis, John Wiley and Sons, New York.
17. W.F. Hildebrand, G H C Landell and H A Bright, Applied Inorganic Analysis, John Wiley 2nd Edition.
18. A. I. Vogel : A text book of Quantitative inorganic Analysis , Lonqmans. 2) O. Samuelson : Ion Exchange separation in analytical chemistry (Jhon wiley , 1963)
19. Y. Marcus and A. S. Kertes : Ion Exchange and solvent Extraction of metal complexes . (Wiley – interscience , 1969)
20. J. A. Marinsky and Y . Marcus : Ion exchange and solvent Extraction (Marcel Dekker, INC , New York , 1973)
21. G. H. Morrison and H, Freiser : Solvent Extraction in Analytical Chemistry (Jhon wiley New York, 1958)
22. A . K Da , S. M . Khopkar and R. A. chalmers : solvents Extraction of metals (Von Nostrant Ravinhold, 1970)
23. J. Stary , the solvent extraction of metals chelates (Pargaman)
24. Willard , Merrit and settle : Instrumental Methods of analysis.

Paper-VI: Organic analytical Chemistry

Unit-I: Hyphenated Techniques: (15)

Advanced techniques of analysis: UV-Visible, IR, ^1H & ^{13}C NMR, Mass spectrometry, GC-MS, HPLC-MS, HPTLC-MS and their applications.

Unit-II: Pharmaceutical Analysis (15)

Introduction to drugs, their classification, sources of impurities in pharmaceutical raw materials such as chemical, atmospheric and microbial contaminants etc. Limit tests, limit tests for impurities like, Pb, As, Fe, moisture, chlorides, sulfates, Boron, free halogen, selenium etc. Analysis of some commonly used drugs like sulfadiazole, antihistamines, barbiturates, vitamins (A, B₆, C, E, K) etc.

Unit-III: Analysis of dyes and paints (15)

Types of dyes, and their analysis.

Composition and analysis of paints, determination of volatile and non-volatile constituents, flash points, separation of pigments, estimation of binders and thinners

Unit-IV: Analysis of pesticides Analysis of organochlorine, organophosphorus and carbamate pesticides. (15)

Unit-V: Analysis of oils, fats, soaps and detergents (15)

Introduction to natural fats and oils, Analysis of oils and fats: Softening point, Conger point, Titre point, cloud point, Iodine, Saponification, acid, hydroxyl, R-M and Polenske value, Elaiden test. Introduction to soaps, analysis of soap (saponifiable, unsaponifiable) and for unsaponified matter in soaps, Estimation of free alkali and phenol in soap. Classification of detergents (in Brief): Analysis of active ingredients from detergents (methylene blue and Hyamine-1622 method); Estimation of CMC, Chlorides, total phosphates etc.

Unit- VI: Analysis of cosmetics (15)

- Composition of creams and lotions: Determination of water, propylene glycol non-volatile matter and ash content. Determination of borates, carbonates sulphate, phosphate, chloride, titanium and Zinc oxide.
- Analysis of face powder: Estimation of boric acid, Mg, Ca, Zn, Fe, Al, and Ba.
- Analysis of ingredients of hair dyes.

Reference Books:

- F. J. Welcher: Standard methods of Chemical analysis, 6th Ed. Vol. I and II (D. Van Nostrand Comp.)
- I. M. Kolthoff: Treatise on Analytical Chemistry Vol. I & II
- F. D. Snell: Encyclopedia of industrial Chemical Analysis Vol. 1 to 20 (John Wiley)
- Riech: Outline of Industrial Chemistry.
- K. H. Buchel: Chemistry of Pesticides (John Wiley)
- Indian, Pharmacopoeia, British Pharmacopoeia and U. S. Pharmacopoeia.
- V. M. Parikh: Absorption spectroscopy of organic molecules (Addison Wesley)
- Willard, Merritt, Dean and Settle: Instrumental methods of analysis (CBS)

9. D. H. Williams and J. Fleming: Spectroscopic methods in organic chemistry (Mc Graw Hill)
10. Silverstein : Spectroscopic Identification of organic compounds (John Wiley)
11. Jackmann and Sternhill : Applications of NMR spectroscopy of organic Chemistry (Pergamon Press)
12. J. D. Roberts : Nuclear Magnetic Resonance (Mc Graw Hill)
13. K. Benjamin : Mass Spectrometry
14. Nichollas: Aids to the Analysis of foods and Drugs.
15. A. H. Beckett and J. B. Stanlake; Practical Pharmaceutical Chemistry Vol. I & II (CBS publishers)
16. S. Ranganna: Handbook of analysis and quality control for fruits and vegetable products (McGraw Hill)
17. Ramalu: Analysis of pesticides
18. Mumbai)
19. M. Ash and L. Ash: A formulary of cosmetic preparations. (G. Goodwin)
20. Kurl Bauer, Dorothea Garhe, Horst Surburg: Common fragrance and flavour materials, (VCH publisher, New York)
21. F. J. Welcher: Standard Methods of Chemical analysis Vol I & II (6th Ed.)
22. S. N. Mahendru: Analysis of food products (Swan Publishers)

Paper-VII: Elective Methods in Chemical Analysis

Unit-I: Polarography: (15)

Theory, apparatus: derivative polarography, modified polarographic techniques, sinusoidal AC polarography, pulse polarography, chronopotentiometry and their application in qualitative and quantitative analysis,

Unit –II : (15)

a) Ion selective electrodes: (7)

Terminology, types and construction of electrodes, glass electrode, solid state and precipitate electrodes, liquid – liquid membrane electrodes, enzyme and gas electrodes, and applications.

b) Electrophoresis: (8)

Introduction: paper electrophoresis: Technique, factors affecting migration of ions, capillary and zone electrophoresis and applications.

Unit – III : Fluorescence and Phosphorescence Spectrophotometry; (15)

Structural factors, photoluminescence intensity as related to the concentration, instrumentation for phosphorescence measurements, problems.

Unit-IV : Kinetic Methods: (15)

Theoretical basis of kinetic methods of analysis, methods of determining amount of the substance , Tangent Method, Fixed Time and Concentration method. Addition Method, Oxidation Reactions of H₂O₂ with thiosulphate, iodide and amino, Enzyme catalyzed reactions. Inhibitors and Activators.

Unit – V : Photoelectron spectroscopy: (15)

Basic principles, photoelectric effects, Photoionization process, Koopman's theorem, photoelectron spectra of simple molecules, ESCA, chemical shift, Auger electron spectroscopy – basic idea.

Unit – VI: X – ray spectroscopy: (15)

Introduction, X-Ray generation, Properties of X-radiation, X-Ray Instrumentation, X-Ray Absorption, Fluorescence and Diffraction methods of analysis and their applications.

Recommended Books:

1. H. Kaur, Instrumental Methods of Chemical Analysis. Pragati Prakashan , Meerut.
2. W H Willard, L L Merritt and J A Dean, Instrumental Methods of Analysis.
3. S. M.Khopkar, Basic Concepts in Analytical Chemistry.
4. D. Skoog and D. West, Principle of Instrumental Analysis.Holl Seamlers.
5. E. Berlin, Principles and Practice of X-Ray Spectrometric Analysis, Plenum, NewYork.
6. J. Winefordner, S. Schulman and T O Haver :Luminescence Spectrometry in Analytical Chemistry.Wiely Interscience NewYork.
7. H. Mark and G Rachnitz, Kinetics in Analytical chemistry. Interscience NY.
8. R.D. Braum, Introduction to Instrumental Analysis.
9. Willard, Deritt, Dean and Settle, Instrumental methods of Analysis.
10. F. J. Welcher, standard Methods of chemical Analysis Vol.3,PartA & B.
11. G.W. Ewing, Instrumental Methods of Analysis 4th and 5th editions.
12. Chatawal and Anand, Instrumental Methods of Analysis.
13. Bassett, Denney-Jeffer and Mendham, Vogel's Textbook of Quantitative Inorganic Analysis,(5th edition).
14. Electro-analytical chemistry, edited by H.W.Nurnberg.
15. Kortum and Bockris, A Textbook of Electrochemistry.
16. D.A. Maclines, Principles of Electrochemistry.
17. Stulic, Ion selective electrodes (John Wiley).

Paper-VIII: Environmental Chemical Analysis and Control

Unit-I: Sampling in analysis : Definition, theory and techniques of sampling , sampling of gas , liquids and solids , Criteria of Good sampling , Minimization of Variables , transmission and storage of samples , high pressure ashing techniques (HPAT), particulate matter , its separation in gas stream, Filtering and gravity separation. Analysis of particulate matter like asbestos, mica, dust and aerosols etc.

[15]

Unit-II: Environment its characteristics and Classification: Metallic and non-metallic pollutants, Cr, Hg, Pb,Cd,Cu,As etc. Their physiological manifestation, source, analysis and control of inorganic compounds. (15)

Unit-III: Chemistry of Air pollutants, Characterization. Source, methods of analysis of air pollutants ; CO,CO₂, NO_x,NH₃,H₂S,SO₂,etc. Monitoring Instruments, Potable and Industrial water, major and minor components, dissolved oxygen(DO) Chemical oxygen

demand(COD) Biochemical oxygen demand(BOD) and their measurements and significance in waste water treatments, Threshold odour number. [15]

Unit-IV: Quality of Industrial waste Water analysis for organic and Inorganic constituents, Chemistry of odour and its measurements, Radioactive wastes and its control, Sewage and sludge analysis. Treatment, disposal and source of phenolic residue, Analytical methods, treatment by using stream. Gas stripping, ion exchange, solvent extraction, oxidation method and microbiological treatment. (15)

Unit-V: Analysis of Minerals and Ores: (8)

A) Bauxite, haematite, dolomite, phosphates, monazite, pyrites and the chemicals from sea.

B) Analysis of metals and alloys: (7)

Foundry materials, analysis of coal, ferroalloys, and special steels, slags, fluxes, brass and bronze.

Unit-VI : analysis of soil and fertilizers: (15)

Method of soil analysis, soil fertility its determination, determination of inorganic constituents of plant materials, Chemical analysis as measure of soil fertility, analysis of fertilizers.

Recommended books;

1. A.K. De : Standard Methods of Waste and Waste water analysis.
2. S.M. Khopkar, Environmental Chemistry ; Environmental pollution analysis.
3. M.S. Creos and Morr, Environmental Chemical Analysis, American publication(1988)
4. A.K. De, Environmental Chemistry, New Age International publishers.Moghe and
5. Ramteke, Water and waste water analysis : (NEERI)
6. A.C. Stern, Air pollution: Engineering control vol.IV(AP)
7. P.N.Cheremisinoff and R.A.Young, Air Pollution control and Design.Hand Book Vol.I&II (Dekker)
8. R.B.Pohasek, Toxic and Hazardous waste disposal, Vol.I&II (AAS)
9. M.Sitting, Resources Recovery and Recycling, Handbook of industrial Waste.
10. B.K.Sharma, Industrial Chemistry.
11. S.P.Mahajan, Pollution Control in Process Industries.
12. R.A.Horne, Chemistry of our Environment.
- 13..Hillebrand Lhundel, Bright and Hoffiman, Applied Inorganic Analysis, John Wiley.
14. Snell and Biffen, Commercial Methods of Analysis.
- 15 P.G. Jeffery, Chemical Methods of Rock Analysis, Pergamon.
- 16 Buchel, Chemistry of Pesticides. J Wiley.
- 17 Rieche, Outlines of Industrial Organic Chemistry, ButterWorth.
18. F.A.Henglein, Chemical Technology, Pergamon.
19. Kent, Riegl's Industrial Chemistry,Rainhold.
20. Chopra and Kanwar,Analytical Agriculture Chemistry, Kalyani Publishers.
21. Aubert and Pintes, Trace Elements in Soils.
22. Bear, Chemistry of Soil.

23. Hauson, Plant Growth Regulators, Noyes.
24. P.G.Jeffery and D.J. Hatchinson, Chemical Methods of Rock Analysis.
25. F.J.Weleher, Standard Methods of Chemical Analysis, A Series of Volumes Robert and Krigeger Publishing Company.
26. I. M.Kolthoff and PJ Ewing, Treatise o Analytical Chemistry, A series of Volumes.
27. R.D. Reeves and R.R. Brooks, Trace element Analysisof Geological Materials, John Wiley & Sons NewDehli.
28. W.M. Johnson and J.A.Maxwell,Rock and Mineral Analysis, John Wiley and Sons, NewYork.
29. W.F.Hildebrand, G H C Landell and HABrighot, Applied Inorganic Analysis, John Wiley 2nd Edition.
30. K.J.Das, Pesticide Analysis(MD).