SHIVIJI UNIVERSITY, KOLHAPUR

M.Sc. (T & D) Chemistry Syllabus

Annual System

M.Sc. (Theory and Dissertation)
Subject: Chemistry

The M.Sc. (T&D) course is chemistry 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.

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<tr>
<th>Semester</th>
<th>No of Paper</th>
<th>Total Marks</th>
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<tr>
<td>Part-I</td>
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<td>Dissertation</td>
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(To be submitted to the end of second year)
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 4x20 80 marks  
with internal options  

[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 IMPLEMENTATION**:  
   Revised Syllabus will be implemented from June 2010 onwards.  

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. ELIGIBILITY 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 specialization)

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\(\pi\)-P\(\pi\), P\(\pi\)-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, ferrodoxins and iron sulphur proteins, ion transport across membranes, Biological nitrogen fixation, PS-I, PS – II, Oxygen uptake proteins.

Unit-IV  15 h
Electronic, Electric and Optical Behavior of Inorganic Materials

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, peroxy compounds of boron, carbon, sulphur, structure and bonding in oxyacids of nitrogen, phosphorous, sulphur and halogens, interhalogens, pseudo-halides.

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:

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
13) M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Reinhold, EWAP
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
23) Willam L. Jooley, Modern Inorganic Chemistry
24) Manas Chanda, Atomic Structure and Chemical bonding
25) N. N. Greenwood and A. Earnshaw, Chemistry of elements , Pergamon
26) Chakraburty, Solid State Chemistry, New Age International
27) S. J. Lippard, J.M. Berg, Principles of bioinorganic Chemistry, University Science Books
28) G. L. Eichron, Inorganic Biochemistry, Vol I and II, Elesevier
29) Progress in Inorganic chemistry , Vol 18 and 38, J. J. Loppard, Wiley
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
40) Willam L. Jooley, 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. Arnikar, Essentials of Nuclear 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, Vilsmeir reaction, Gattermann-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)
b) Stereochemistry: (8)

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: KMnO₄, 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
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
7. Oxidation by-(Marcel Dekker) Augustin
16. Organic reaction mechanism (Benjamin) R. Breslow.
UNIT-I
THERMODYNAMICS-I

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

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
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

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
2. Text book of Physical Chemistry – S. Glasstone
3. Principles of Physical Chemistry – Marron and Pruton
7. Physical Chemistry of macromolecules- D. D. Deshpande, Vishal Publications.
11. Introduction to Photochemistry-Wells
12. Photochemistry of solutions-C. A. Parker, Elsevier
UNIT-I
Errors and treatment of Analytical Chemistry

UNIT-II
Chromatographic methods:

UNIT-III
Computer Science:

UNIT-IV
a) Ultraviolet and visible spectrophotometry (UV-VIS) (08)
b) Infrared Spectroscopy (IR) (07)
UNIT-V

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, Principal, 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.
5. Applications of spectroscopic techniques in Organic chemistry- P.S. Kalsi.
10. Introduction to chromatography : Bobbit.
13. Instrumental Methods of Inorganic Analysis(ELBS) : A.I. Vogel.
15. The principals of ion-selective electrodes and membrane transport: W.E.Morf.
17. Principal of Instrumental Analysis- D. Skoog and D. West.
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.

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, spinspinsplitting, 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 195pg & 119sm NMR.

Introduction, principle, Instrumentation and applications of following techniques photo
acoustic Spectroscopy (PAS) photo electron Spectroscopy (PES), auger electron Spectroscopy (AES)

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

UNIT-VI
A] Electron spin Resonance [ESR]
Principles of ESR, hyperfine splitting in simple systems, Instrumentation, factors Affecting G values, applications to inorganic complexes.
B] Nuclear Quadra pole Resonance Spectroscopy [NQR]
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.
4. F.A. Cotton, chemical application of group theory, Weily eastern
5. Figgis, Introduction to ligand field theory field
6. Schaefer & Gilman: Basic principles of ligand field Theory, J. Wiely
7. P.R. Backer: Molecular symmetry and Spectroscopy A.P.
8. Ferraro Ziomeek, 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.Weily
13. Nakanisha: Spectroscopy and structure J. Weily
14. Ferroro: Metal ligand and related vibrations
15. CNR Rao Spectroscopy in Inorganic Chemistry Vol I,II,III
17. Dudd, chemical Spectroscopy Elsevier
18. Popel : H.N.M.R. Spectroscopy J.Weily
20. P.K. Bhattacharya: Group Theory & Its Chemical Applications
23. Diffraction Method, Wormald, Oxford University, Press, 1973
UNIT-I
Theories of Metal-Ligand bonding [15]
Molecular Orbital treatment, Octahedral (with and without pi bonding) tetrahedral and square planar 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.

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 (SN1) 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, $[\text{Co(CN)}_5]^3$: A redox & catalytic reagent.

UNIT-VI

**Photochemistry**

Photochemistry of Coordination compounds, electronically exited 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. Weily
2. Graddon: Introduction to Coordination Chemistry. J. Weily
4. Graddon: Introduction to coordination Chemistry, Parasnom
5. Lewis and Wilkins: Coordination Chemistry. J. Weily
6. Martel: Coordination Chemistry Vol I, II VNR
7. Earnshaw: Introduction to Magneto Chemistry
8. Mabbs & Machin Magnetism & transition metal complexes Chamman hall
10. L.N. Maley: Magneto Chemistry
11. Datta & Shymal Elements of Magneto Chemistry
15. William L. Jolly: Modern Inorganic Chemistry, Mecgrow Hill USA,1984
18. E.S. Tould, Inorganic Chemistry
23. Wells, Introduction to Photochemistry.

**Paper-VII: NUCLEAR CHEMISTRY**

UNIT-I

Systematic of alpha, beta and gamma decays

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 asymmetric 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 [15]
Radiation detection and measurements.
Ionization current measurements, multiplicative ion collector, methods not based on ion collection, auxillary Instrumentation and health physical instruments and counting staticsits.
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
6. An N.Nesmeyannoy: Radiochemistry: Mir
8. N.Jay: Nuclear Power Today Tomorrow: ELBS
11. Nuclear and Radiation Chemistry: B.K. Sharma, Krishna Publication
12. A Introduction to Nuclear Physics: R. Babber. And Puri

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.


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

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, NOₓ, SO₂, H₂S, CO₂, analysis of toxic heavy metals, Cd, Cr, As, Pb, Cu, Separation of Co, Cu,
Mg, Mn, Fe, analysis of \( \text{SO}_4^{2-}, \text{PO}_4^{3-}, \text{NO}_3^- \), \( \text{NO}_2^- \) 
- 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

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, sewozio 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): Favorikii, 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, phtodissociation 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 \( \alpha,\beta \) unsaturated compounds, cyclohexaditiones, intermolecular cycloaddition reactions, dimerisation and oxetane 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-\textit{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, fullerence C60, Tropone, tropolone azulene, fulvene, tropylum salts, ferrocene, Three and five membered systems. Crown ether complexes, cyclodextrins, cryptands, catenanes and rotaxanes, bonding in fullerenes.

**UNIT-VI** [15]
\( \text{a)Free radical reactions:} \)
Types of free radical reactions, detection by ESR, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance. Reactivity for aliphatric 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, Sandmeyers reaction. Free radical rearrangement, Hunsdiecker reaction.

**Recommended Books:**

1. Lehar and Merchant: Orbital Symmetry.
3. Kan: Organic Photochemistry
4. Cixon and Halton : Organic photochemistry
5. Arnold: Photochemistry
6. N. Turro : Modern molecular photochemistry
8. Ginsburg: Nonbenzenoid aromatic compound
10. E. Cler : The aromatic sextet.
11. Lloyd: Carbocyclic non- benzenoid aromatic compounds.
12. W. B. Smith; Molecular orbital methods in organic chemistry.
13. Gratt; Aromaticity.
(orient- Longmans)- Peter Sykes
15. Organic Reaction Mechanism (Benjamin)- R. Breslow
16. Mechanism and structure in Organic Chemistry
   (Holt Reinhart Winston)- B. S. Gould
17. Organic chemistry (McGraw Hill)- Hendrikson, cram and Hammond
18. Basic principles of organic chemistry (Benjamin)
19. J. D. Roberts and M. C. Caeserio.

**Paper -VI: Spectroscopic and Stereochemistry**

**UNIT-I**

a) **Ultraviolet Spectroscopy**

Woodward- Fisher rules for conjugated dienes and carbonyl compounds; Calculation of $\lambda_{\text{max}}$. Ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

b) **IR Spectroscopy**

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**

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; ammines; 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**

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:**

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

UNIT-V

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]
   Stereospecificism 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

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)
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 )
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
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.
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.
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 tetracetate, PPA, Diazo methane, ozone phase transfer catalyst, woodward-prevost hydroxylation, Barton and Shapi ro reaction Hoffmann – Loffler-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, cuparenonne 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. Newmen: Chemistry of Terpenes.
5. Simonson: Terpenes.
6. T.W. Goddwin: Aspects of terpenoid chemistry and biochemistry
8. P. W. Bently: Chemistry of Natural products,
9. Fieser and Fieser: Steriods
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,
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
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**

**a) Drug design**

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:**

**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  

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, oxypropenol


UNIT-III  

a) Small ring Heterocycles

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

b) Benzo fused five membered Heterocycles

Synthesis and reactions of benzopyrroles, benzofurans and benzothiophenes.

UNIT-IV  

Six membered Heterocycles with one heteroatom

Synthesis and reactions of pyrillium salts and pyrones and their comparison pyridinium and thiopyrillium salts and pyridones. Synthesis and reactions of coumarins, chromones.

UNIT-V  

a) Six membered Heterocycles with two and more Heterocycles

Synthesis and reactions of diaazines & triazines.

b) Seven membered Heterocycles

Synthesis and reactions of azepines, oxepines & thiepines.

UNIT-VI : Agrochemical:

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. Juvenile 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)
4. Wilson, Gisvold & Dorque: Text book of organic medical and pharmaceutical chemistry
5. Pharmaceutical manufacturing encyclopedia.
12. Finar: Organic chemistry (Vol. 1& 2)
18. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme
22. An Introduction to Heterocyclic Compounds, R. M. Acheson, J. Willey
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:**

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.**

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 :**


**Unit - V: Phase space, stirlings approximation :**


**Unit - VI : Molecular partition function:**


References:

5. Quantum Chemistry by Hanns.
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.

Unit - III: Reactions in solution: (15)

Unit - IV: Electrolytic conductance: (15)


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

**UNIT-IV** [15]

**REFFERENCE BOOKS**
1. An Introduction to Electrochemistry by S. Glasstone
3. Physical Chemistry by S. Glasstone
4. Electrolytic Solutions by R. A. Robinson and R. H. Strokes
5. Physical Chemistry by P. W. Atkins. ELBS.
12 Physical Chemistry by P.W. Atkins

**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.


**Unit - III Electronic Spectroscopy:** (15)


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


**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:**

**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 McGrew Hill.
2. Physical Chemistry by P. W. Atkins, ELBS, 1986
4. Chemical applications of group theory by F. A. Cotton Willey, interscience
5. Symmetry in chemistry by H. Jaffe and M. Orchin, Jhon willey.
11. Physical chemistry by P. W. Atkins. ELBS. 1986
12. Introduction to molecular spectroscopy by G. M. Barrow.
14. Nuclear magnetic Resonance by J. D. Roberts, Mcgrew Hill.
18. Electrical and optical properties of molecular behavior by M. Davies, pergman press.

**PAPER-VIII : Solid State and Surface Chemistry**

**Unit I: The solid state:**
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:**

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:**

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:**


**Unit V: Micelle:**

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:**

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 hysteresis, wetting and detergency.

**REFFERENCE 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 Walss
9. Chemistry of imperfect crystal : F. A. Krogen
12. Theory of adsorption and catalysis by Alfred Clark ,
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, living effect, applications of non–aqueous titrations, MnO2 in pyrolusite, Na2Co3 + NaHCo3 and NaOH + Na2CO3 Mixture analysis, Gravimetric Analysis purity of the precipitate – Co precipitation’s and post Post precipitations, precipitation from homogenous solution, organic precipitation.

Unit-II: Ion Exchange separation: (15)
Theories of ion exchange, exchange capacity, screening effects, Penetrations of electrolytiones in ion exchange resin, sorption of complex ions, ion exchange equiliria, column operation, theory of break through 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. Cures, 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:**

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:**

2. Snell and Biffen, Commercial Methods of Analysis.
11. Hauson, Plant Growth Regulators, Noyes.
23. J. Stary , the solvent extraction of metals chelates (Pargaman)
Paper-VI: Organic analytical Chemistry

Unit-I: Hyphenated Techniques: (15)
Advanced techniques of analysis: UV-Visible, IR, $^1$H & $^{13}$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 likes sulfadugs, 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: Softning point, Congent 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)
a) Composition of creams and lotions: Determination of water, porpylene glycol non-volatile matter and ash content. Determination of borates, carbonates sulphate, phosphate, chloride, titanium and Zinc oxide.
b) Analysis of face powder: Estimation of boric acid, Mg, Ca, Zn, Fe, Al, and Ba.
c) Analysis of ingredients of hair dyes.

Reference Books:
2. I. M. Kolthoff: Treatise on Analytical Chemistry Vol. I & II
4. Riech: Outline of Industrial Chemistry.
5. K. H. Buchel: Chemistry of Pesticides (John Wiley)
7. V. M. Parikh: Absorption spectroscopy of organic molecules (Addision Wesley)
8. Willard, Merrite, Dean and Settle: Instrumental methods of analysis (CBS)
10. Silverstein: Spectroscopic Identification of organic compounds (John Wiley)
12. J. D. Roberts: Nuclear Magnetic Resonance (McGraw Hill)
13. K. Benjamin: Mass Spectrometry
17. Ramalu: Analysis of pesticides
21. 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, chronopotentometry 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)

Unit – V: Photoelectron spectroscopy: (15)
Basic principles, photoelectric affects, Photoionization process, Koopman’s theorem, photoelectron spectra of simple molecules, ESCA, chemical shift, Auger electron spectroscopy – basic idea.

**Unit – VI: X – ray spectroscopy:**  
(15)

**Recommended Books:**
2. W H Willard, L L Merritt and J A Dean, Instrumental Methods of Analysis.
3. S. M. Khopkar, Basic Concepts in Analytical Chemistry.
7. H. Mark and G Rachnitz, Kinetics in Analytical chemistry. Interscience NY.
11. G.W. Ewing, Instrumental Methods of Analysis 4th and 5th editions.

**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.

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

[15]
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, Seweage 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:**  
2. S.M. Khopkar, Environmental Chemistry ; Environmental pollution analysis.  
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)  
10. B.K. Sharma, Industrial Chemistry.  
11. S.P. Mahajan, Pollution Control in Process Industries.  
15 P.G. Jeffery, Chemical Methods of Rock Analysis, Pergamon.  
16 Buchel, Chemistry of Pesticides. J Wiley.  
22. Bear, Chemistry of Soil.
23. Hauson, Plant Growth Regulators, Noyes.
24. P.G.Jeffery and D.J. Hutchinson, Chemical Methods of Rock Analysis.
30. K.J. Das, Pesticide Analysis (MD).