SYLLABUS

Updated June 2006

M.Sc. CHEMISTRY

SEMESTER: I -IV

Department of Chemistry
(FIST-DST Funded and UGC (SAP) Sponsored)
Saurashtra University

SAURASHTRA UNIVERSITY

DEGREE OF MASTER OF SCIENCE
(CHEMISTRY & BIOCHEMISTRY)

O. M. Sc. 1:

Candidates for the Examination for the Degree of Master of Science must have

(i) Obtained the degree of Bachelor of Science of this University or a Degree recognized as equivalent thereto, at least with second class.

(ii) Passed in all papers including practicals, if any, prescribed by the relevant Board of Studies from time to time for each of the Semester examination held at the end of each term for the Degree of Master of Science after keeping required minimum attendance as laid down on that behalf.

O. M. Sc. 2:

To pass the whole M. Sc. Examination, student should clear M. Sc. Semesters I to IV and examinations within a period of five years from the date of his/her registration. He/She will be required to register himself as a fresh candidate and keep the attendance and appear and pass all semester examinations afresh from first onwards in order to obtain the Degree of Master of Science.

O. M. Sc. 3:

No candidate for the M. Sc. Degree examination can select a subject other than one offered by him/her as a special subject at the B.Sc. (Sp.) examination or as a principal subject at the B.Sc. Degree examination.

O. M. Sc. 4:

Notwithstanding anything contained in any ordinances or regulations, a candidate passing the B.Sc. examination with the subject of Physics of this University can select Electronics subject at the M. Sc. examination as a special case, provided he/she completes the bridge for electronics during the first year of the M. Sc. Class.

O. M. Sc. 5:

A candidate who has passed the M. Sc. Examination of this University in one specialization of the subject will be permitted on the submission of a few applications and payment of a fresh fee to appear in the other specialization of the same subject provided he/she keeps fresh terms in the specialization of the subject for the M. Sc. Examination.

Provided further that the marks obtained by the candidate in the previous Examination of M. Sc. Part-I/Semester I & II will be carried forward in the total marks in the subject and the class will be awarded accordingly but he/she will not be eligible for a Prize, Scholarship or any other Award at the Examination.

O. M. Sc. 7:

Subject to the provisions laid down in Ordinance M. Sc. 2, a candidate who has passed the M. Sc. semester I & II of this University and if there is a break in the studies for any reason and if there is a change in the courses from semester system to annual part Examination system, the candidate will be admitted to M. Sc. Part II and the marks obtained by the candidate in his previous examination of this University in M. Sc. semester I and II will be carried forward and the result of the M. Sc. Final Examination will be declared accordingly on the basis of 1000 + 800 = 1800 Marks.

R. M. Sc. 1:

The M. Sc. Degree may be taken by written examination and practicals (if any) or partly by papers including practicals (if any) and dissertation.

R. M. Sc. 2:

The examination will comprise the following subjects and a student will be required to select one of the following subjects namely:

(1) Mathematics, (2) Statistics, (3) Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) MCA, (8) MIT, (9) Experimental Biology, (10) Biosciences-AS,PS & MicroBio, (11) Electronics, (12) Biochemistry, (13)Wild Life Science, (14) Biotechnology and (15) Polymer Science

R. M. Sc. 3:

In the subject of Chemistry & Bio-Chemistry, there will be four theory papers each of 100 marks in each semester i.e. Semester I to IV and there will be 200 marks of practicals related to theory papers in each semester. There will be a viva voce examination of 50 marks at the end of each semester. Thus, there will be total 1600 marks of theory, 800 marks of practicals and 200 marks of viva voce based on the theory papers. The dissertation option will be given in the semester

III and IV. The dissertation will be submitted before the commencement of the theory examination.

R. M. Sc. 4:

There will be theory and practical examinations at the end of each semester. The viva voce examination will be conducted at the end of each semester.

A candidate failing in more than three theory papers out of eight papers at the end of Semester-I and II will not be allowed to keep term. The candidate must have at least 80% presence in theory as well as practicals. In any circumstances if candidate fails in fulfilling the required presence, the term will not be granted for appearing in the examination.

R. M. Sc. 5:

The passing standard in theory, practicals and viva voce examination will be 40% in each head of passing.

The final class will be awarded as under:

a) The candidate securing greater than equal to 70% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded a distinction class.

b) The candidate securing below 70% but less than equal to 60% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded first class.

c) The candidate securing the aggregate percentage from 48 to less than 60% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded a second class.

R. M. Sc. 6:

The eligibility for securing admission at M. Sc. Polymer Science, the candidate must have passed B.Sc. with Chemistry / Biochemistry, and P.G. Diploma in Polymer Science.

Semester - I

	Marks
C-101 Inorganic Chemistry	100
C-102 Organic Chemistry	100
C-103 Physical Chemistry (Statistical and Chemical Thermodynamics)	100
C-104 Analytical Chemistry	100
C-105 & 106 Practicals	200
C-107 Viva voce	50

Semester – II

C-201 Inorganic Chemistry	100
C-202 Organic Chemistry	100
C-203 Macromolecular Physical Chemistry-I	100
C-204 Spectroscopy	100
C-205 & 206 Practicals	200
C-207 Viva voce	50

Semester - III

INORGANIC CHEMISTRY

C(I)-301 Separation Techniques	100
C(I)-302 Inorganic Spectroscopy	100
C(I)-303 Symmetry and Group Theory	100
C(I)-304 Bioinorganic Chemistry	100
C(I)-305 & 306 Practicals / Dissertation	200
C-(I)-307 Viva voce	50

Semester – IV

C(I)-401 Selected Topics in Chemistry	100
C(I)-402 Selected Topics in Inorganic Chemistry	100
C(I)-403 Coordination Chemistry	100
C(I)-404 Bonding in Complexes	100
C(I)-405 & 406 Practicals / Dissertation	200
C-(I) 407 Viva voce	50

Semester - III

ORGANIC-PHARMACEUTICAL CHEMISTRY

C(OP)-301 Separation Techniques	100
C(OP)-302 Organic Synthesis- A Disconnection Approach	100
C(OP)-303 Organic And Pharmaceutical Chemistry	100
C(OP)-304 Heterocyclic Chemistry	100
C(OP)-305 & 306 Practicals / Dissertation	200
C(OP)-307 Viva voce	50

Semester – IV

C(OP)-401 Selected Topics in Chemistry	100
C(OP)-402 Chemistry of Natural Products	100
C(OP)-403 Stereo Chemistry	100
C(OP)-405 & 406 Practicals / Dissertation	200
C(OP)-307 Viva voce	50

Semester - III

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-301 Separation Techniques	100
C(PM)-302 Macromolecular Physical Chemistry-II	100
C(PM)-303 Electrochemistry	100
C(PM)-304 Chemistry of Materials- I	100
C(PM)-305 & 306 Practicals / Dissertation	200
C(PM)-307 Viva voce	50

Semester – IV

C(PM)-401 Selected Topics in Chemistry	100
C(PM)-402 Nuclear and Radiochemistry	100
C(PM)-403 Electro Analytical Techniques	100
C(PM)-404 Chemistry of Materials-II	100
C(PM)-405 & 406 Practicals / Dissertation	200
C(PM)-407 Viva voce	50

Semester - III

ANALYTICAL-PHARMACEUITICAL CHEMISTRY

C(AP)-301 Separation Techniques	100
C(AP)-302 Pharmaceutical Technology	100
C(AP)-303 Advanced Analytical Methods and Industrial Analysis	100
C(AP)-304 Environmental Chemistry	100
C(AP)-305 & 306 Practicals / Dissertation	200
C(AP)-307 Viva voce	50

Semester - IV

C(AP)-401 Selected Topics in Chemistry	100
C(AP)-402 Pharmaregulatory Affairs	100
C(AP)-403 Electroanalytical Techniques	100
C(AP)-404 Selected Methods of Analysis	100
C(AP)-405 & 406 Practicals / Dissertation	200
C(AP)-407 Viva voce	50

M.Sc. SEMESTER I

C-101: **INORGANIC CHEMISTRY**

1. **Quantum Mechanics and its applications:** MO-VB Theory: Born-Oppenheimer approximation, Hydrogen Molecule ion. LCAO-Mo and VB treatments of hydrogen molecule. Electron Density, forces and their role in chemical bonding. Hybridization and valence MO's of H_2O, NH_3 and CH_4 .Huckel pi-electro theory and its applications to Ethylene, Butadiene and Benzene. Idea of Self-consistent field method.
2. **Magneto chemistry**: Definition of Magnetic Properties, Types of magnetic bodies,Diamagnetism and Pascal's Constant, Russell-Saunders or **LS** Coupling, Multiple width Large compared to kT, Multiple width small compared to kT, Stereo chemical applications of Magnetic Properties of the First Transition Series, Lanthanides and actinides, Determination of magnetic susceptibility by Gouy's Method, Derivation of Van Vleck formula for Susceptibility.
3. **Mössbauer spectroscopy:** Introduction of Mössbauer effect, Isomer-Shift, Magnetic hyperfine interactions. Quadrupole moment. Electric field gradient. Quadrupole splitting. Applications in structure determination.

4. **Uses of Inorganic reagents in inorganic analysis :** General discussion and uses of some inorganic reagents: Potassium bromate ($KBrO_3$), potassium iodate (KIO_3), ammonium vanadate (NH_4VO_3), ceric suphate [$Ce(SO_4)_2$], ethylene diamine tetra acetic acid (EDTA)

5. **Uses of Organic reagents in inorganic analysis:** Cupferron, DMG, dithiozone, aluminon, oxine, dithiooxamide, α-benzoinoxime, α-nitro-β-naphthol, α-nitroso-β-naphthol, diphenyl carbazone, diphenyl carbazide, anthranilic acid, tannin, pyragallol, benzidine, salicylaldoxime, o-phenanthroline

Reference Books

1. Physical Method in Chemistry, R.S.Drago, Saunders College Publishing.

2. Quantum Chemistry, R.K.Prasad, New Age.

3. Introductory Quantum Chemistry, A.K. Chandra, Tata MacGraw -Hill.

4. Quantum Mechanics, Chatwal & Anand, Himalya Publishing House.

5. Introduction To Magnetochemistry, Alan Earnshaw, Academic Press.

6. Elements of Magnetochemistry, Dutta & Syamal, S. Chand & Company.

7. Textbook of Inorganic Chemistry Vol .I &II, A.Singh & R.Singh, Campus International Publication

8. Advanced Inorganic Chemistry, Cotton Wilkinson, W S E Wiley

9. Vogel's Text book of Quantitative Inorganic Analysis, ELBS

M.Sc. SEMESTER I

C-102: ORGANIC CHEMISTRY

(ORGANIC REACTION MECHANISMS)

1. **Reaction path way:** Homolytic and Heterolytic fission, Different types of arrow notation, Electrophile and Nucleophile.
2. **Reactions Intermediate:** Carbonium ion, Carbanion, Free radical, Carbene, Nitrene, Benzene, Enamines.
3. **Organic Reactions like: (1)** Aldol, (2) Baeyer-Villiger, (3) Barbier-Wieland, (4) Barton, (5) Bechamp, (6) Birch, (7) Bouveault, (8) Chi Chi Babin, (9) Clemmensen, (10) Dieckmann, (11) Darzen, (12) Dakein, (13) Diels Alder, (14) Ene, (15) Elbs persulphate, (16) Favorskii, (17) Friedal-crafts, (18) Grignard, (19) Hofmann Loffler Freytag, (20) Hydroboration (21) Leuckart, (22) Mannich, (23) Meerwien-pondorf, (24) Michaedl addition, (25) Oppenauer, (26) Perkin, (27) Reimer-Tiemann, (28) Reformatsky, (29) Robinson-annulation, (30) Rosenmund, (31) Shapiro, (32) Sharpless asymmetric epoxidation, (33) Stobbe, (34) Storke enamine, (35) Wittig, (36) Wolff Kishner, (37) Wilgerodt and other important name reactions not listed above.
4. **Molecular rearrangements like:**

   Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid,Favorskii, Arndt-eistert synthesis, Neber, Beckmann, Hoffman, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction.
5. **Molecular rearrangements:**

   Pinacol-pinacolone, Wagner-meerwein, Demjanov, Benzil-Benzilic acid,Favorskii, Arndt-eistert synthesis, Neber, Beckmann, Hoffman, Curtius, Schmidt, Baeyer-Villiger, Shapiro reac
6. **Important Reagents:**

   (1) Baker yeast, (2) D.D.Q., (3) Dicyclohexyl carbodimide, (4) 1,3-Dithiane, (5) Gillman's reagent, (6) Lithium diisopropylamine (L.D).A.A), (7) Lithium dimethyl cuprate, (8) Osmium tetroxide, (9) Selenium dioxide, (10) Trimethyl

silyliodide, (11) Tri-n-butylene hydride, (12)Woodward and Prevost hydroxy-ation, (13) Wilkinson's catalyst, (14) Phase transfer catalyst, (15) Crown ethers and Merrifield resin, (16) Peterson's synthesis and other reagents not listed above.

7. **Organic conversions based chemical reactions:**

Reference Books

1. Organic Reaction Mechanism (II edition) - V. K. Ahluwalia, R. K.Parasar.

2. Reaction Mechanism and Reagents In Organic Chemistry -Gurdeep RChatwa

3. Organic Chemistry (VI edition) - R.T Morrison, R.N. Boyd. Prentice Hall of India Pvt Ltd, (2003)

4. Organic Chemistry - I.L. Finar, 6th Edition (Low price) Pearson Education, 2003

5. Organic Chemistry- (V edition) - John Mc Murry), Asian Book Pvt Ltd, New Delhi

7. Advanced organic chemistry (IV edition) - Jerry March

8. Reaction Mechanisms and Problems in Organic Chemistry–P.Chattopadhyay, Asian Book Pvt Ltd, New Delhi (2003)

9. Reactive Intermediates in Organic Chemistry-J. P. Trivedi, Univ. Granth Nirman Board

10. Principles of Reaction Mechanism in Organic Chemistry - Parmar-Chawla

11. A text book of Organic Chemistry, - Raj K. Bansal, New Age Inrternational (P) Ltd. 4th Edition 2003

12. Organic Chemistry, T.W. Graham Solomn, Craig B. Fryble, Low Price 8th Edition, John Wiley & Sons, Inc.

13. Organic Chemistry, V. K. Ahluwalia & Madhuri Goyal, Narosa Publishing House, (2000).

14. Molecular Orbital Theory for Organic Chemists, A. Streitweiser, Jr, Wiley International (1961) and Subsequent Edition.

M.Sc. SEMESTER I

C-103 : **PHYSICAL CHEMISTRY**

(STATISTICAL AND CHEMICAL THERMODYNAMICS)

1. **Statistical Thermodynamics**: Basic Terms: probability, cell, phase space, micro and macro states, thermodynamic probability, statistical weight factor, assembly, ensemble and its classification and statistical equilibrium. Derivation of Boltzmann-Maxwell, Bose-Einstein and Fermi- Dirac statistics, Partition function and derivations of translational, rotational, vibrational and electronic partition functions and thermodynamic functions such as internal energy, heat capacity, entropy, work function, pressure, heat content, etc. Partition function and third law of thermodynamics. Applications of partition function to monoatomic gases, diatomic molecules, equilibrium constant and equilibrium constants of metathetic reactions. Problems.
2. **Fugacity and Activity:** Definition of fugacity and its determination by graphical, equation of state, approximate and generalized methods. Variation of fugacity with temperature and pressure. Fugacity of solids and liquids. Mixture of ideal gases and real gases. Activities and Activity coefficients in liquid solution. Problems.
3. **The Debye-Huckel Theory:** Ionic interactions in solutions. Electrical potential of ionic atmosphere. Electrical free energy and activity coefficients. Mean ionic activity coefficients (D-H limiting law).Applications of D-H theory: quantitative and qualitative, solubility in presence of added electrolyte and osmotic coefficient. The D-H theory in more concentrated solutions. D-H theory and equilibrium constant. Problems.
4. **The properties of solutions**: Ideal solutions: Properties, the Duhem Margules equation, vapor pressure curves. Composition of liquid and vapor in equilibrium influence of temperature on gas solubility and solid-liquid equilibria.

   Non ideal solutions: Deviation from ideal behavior, vapor pressure curves, Liquid and vapor compositions. General equations for liquid mixtures. Partially miscible liquids.

Dilute solutions: Henry's law. Determination of molecular weights from freezing and boiling points. Problems.

5. **Free energy and Chemical reactions:** Chemical equilibrium and the equilibrium constant: Equilibrium in homogeneous gaseous systems. Homogeneous reactions in liquid solutions. Homogeneous reactions in dilute solutions. Chemical equilibria in heterogeneous systems. Free energy change in chemical reactions: The reaction isotherm, standard free energy of reaction, the direction of chemical change. Variation of equilibrium constant with pressure and temperature. Influence of temperature on heterogeneous reactions. Integration of the Van't Hoff equation. Variation of standard free energy with temperature. Simultaneous equillibria. Formation of standard free energies and entropy changes and their applications. Problems.

Reference Books

1. Thermodynamics for Chemists by Samuel Glasstone.
2. Statistical Thermodynamics by L. K. Nash.
3. Thermodynamics by Gurdeep and Rajesh.

M.Sc. SEMESTER I

C-104: ANALYTICAL CHEMISTRY

1. **Introduction:** The nature of analytical chemistry, The role of analytical chemistry, Classification of analytical methods (classical and instrumental) Quantitative analytical methods. An internal role for chemical analysis.
2. **Selected topics on Environmental Chemistry:** Definitions of Air pollution, Energy Balance between Earth-Atmospheric system, Particulates Types Classifications, Organic Particulates, Particulate collection techniques, Importance of Particulates, Photolytic cycle, Photochemical smog chemistry.

   Water analysis parameters, Sampling and preservation techniques, Terminology & Preliminary exposures of Equalization, Proportioning, Volume reduction, Neutralization, Sedimentation, Chemical coagulation, Oxidation Ports, Aerators, Various other methods involving dissolved inorganic, Organic Colloidal solids. Activated chemical sludge, disperse growth aeration, Coagulation, Tricking Filter. Classification of primary secondary and tertiory treatments and definition.
3. **Food analysis:** Moisture, Ash, Crude, Protein, Fat, Crude-fiber, Carbohydrate, Ca, K, Na, and PO4, Oil & fat, Food adulteration and their testing, Contamination of food.
4. **Flamephotometry:** Principle, Theory, Instrumentation & Applications.
5. **Flourimetry and Phosphorimetery:** Principles, Theory, Instrumentation & Applications.
6. **Turbidimetery and Nephelometery:** Principles, Theory, Instrumentation & Applications.
7. **Forensic Science:** General Introduction & Applications in various fields.

Reference Books:

1. Fundamentals of analytical chemistry - D. A. Skoog, D. M. West, F. J. Holler and Crouch.
2. Analytical Chemistry - G. D. Christian.

3. Quantitative Analysis – R. A. wDay Jr. And A. L. Underwood.

4. Analytical Chemistry - Principles – J. K. Kennedy and W. B. Saunders.

5. Instrumental Methods of Chemical Analysis – B. K. Sharma.

6. Food Analysis – S. N. Mahindru.

7. Instrumental Methods of Chemical Analysis – Willard, Merit and Dean.

8. Vogel's Textbook of quantitative Inorganic Analysis – L. Barrt et. al. ELBS.

9. Environmental Chemistry – A. K. De.

10. An Introduction to air pollution – R. K. Trivedi and P. K. Goel.

11. Principles of Environmental Chemistry – H. Kolhandaraman and Geetha Swaminathan.

12. Atmospheric Pollution – Black W. (McGrow Hill Company) New York.

13. A Textbook of Environmental Chemistry and Pollution Control – S. S. Dara (S. Chanda & Co.) New Eelhi.

14. Ecology of Polluted water and Toxicology – K. D. Mishra.

15. Environmental Guidelines and Standards in Indian - P. K. Goel & K. P. Sharma.

16. Enzyme Biotechnology – G. Tripathi.

17. Industry, Environment and Pollution – Arvind Kumar and P. K. Goel.

18. Manual on water & waste water analysis - Neeri

19. Water Pollution - Dr. V. P. Kudesia.

20. Basic concepts of Environmental Chemistry - Des W. Connel.

21. Manual on Water and Wastewater analysis - Dr. B. B. Sundarsan.

22. Liquid waste of Industry: Theories Practices and Treatment by Nelson L. Nemerow.

M.Sc. SEMESTER I

C-105 & 106 : PRACTICALS

1. Organic Chemistry:

(i) Organic preparation: Two stage preparation.

(ii)Organic spotting (with TLC monitoring and spectral interpretation).

2. Inorganic Chemistry:

(i) **Inorganic preparations**-metal complexes.

(ii) **Qualitative analysis**-six radicals separation.

3. Physical Chemistry:

(i) Instrumentation:

(a) Conductometry : Mono and biprotic acids, mixtures of acids against strong/weak bases, argentometric, complexometric, replacement titrations, verification of Onsagar's equation, dissociation of weak acids.

(b) Potentiometry: acid-base, redox and argentometric titrations.

(c) pH metry: acid-base titration, pK_a of acids and $E^0_{QH2.}$

(d) Ultrasonics: Acoustical parameters of liquids.

(e) Refractometry: Binary mixtures and solids.

(f) Polarimetry: Optically active compounds.

(g) Spectrophotometry: Lambert-Beers Law, binary mixture, kinetics of iodination, etc.

(ii) Physicochemical Exercises:

(a) Reaction dynamics: Zero, first and second order reactions.

(b) Partition coefficient: Dimerization of acids, $I\text{-}I_2$ system, Cu^{2+} - NH_3 complexes.

(c) Thermodynamics: Heat of Solution, Partial molar volume, etc.

(d) Steam distillation: Molecular weight determination.

4. Analytical Chemistry:

1. Practicals based on food analysis: Milk, honey, oil, tea-leaves, turmeric powder, etc.

2. Drug analysis: aspirin, Benzyl benzoate, etc.

3. Volumetric and gravimetric exercises: Ester, peroxides, other ions, etc.

4. Industrial products: Estimation for purity and assay.

C-107 : VIVA-VOCE EXAMINATION

M.Sc. SEMESTER II

C-201: INORGANIC CHEMISTRY

1. **Organometallic Compounds:** Introduction and Nature of bonding in organometallic compounds of transition metals: σ-bonded organometallic compounds: Introduction, Classification and synthesis of σ-bonded organotransition metal compounds, general characteristics, chemical reactions, bonding and structure. π–bonded organometallic compounds : Introduction and Classification of π–bonded organometallic compounds (a) η^2–alkene complexes: Preparative methods, physical properties, chemical properties, bonding of structure. (b) η^3 allyl (or enyl) complexes preparation, physical of chemical properties.
2. **Bioinorganic chemistry:** Introduction to bioinorganic chemistry. Classification and role of metal ions according to their action in Biological System. Essential trace elements and chemical toxicology: Introduction of trace elements. The essential ultratrace metals and non-metals. Iodine and thyroid hormones, toxic elements, toxicity and deficiency. Transport and storage of proteins: Metalloporphyrins, oxygen carriers-hemoglobin and myoglobin, Physiology of blood.
3. **Electron spin resonance:** Introduction to Electron Spin Resonance, technique of electron spin resonance, interaction between nuclear spin and electron spin:- hyper fine splitting, calculation and energies of Zeeman levels, calculations of energies, frequency and the ESR spectrum when one electron influenced by a single proton and one electron delocalize over two equivalent protons.

4. **Ion-Exchangers and their applications:** General introduction, classification of ion-exchangers and their applications in the separation of following:
   1. Zinc and Magnesium
   2. Chloride and bromide
   3. Cobalt and Nickel
   4. KMnO4 and $K_2Cr_2O_7$

Reference Books

1. Principle and Application of Organotransition Metal Chemistry, Collman & Hegsdus, University Science Books.
2. The Organometallic Chemistry of the Transition Metals ,R.H. Crabtree, John Wiley.
3. Organometalic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
4. Principle of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg,University Science Books.
5. The Inorganic Chemistry of Biological Processes, M.N. Hughes, John Wiley & Sons.
6. Bioinorganic Chemistry, G.R. Chatwal and A.K. Bhagi, Himalaya Publishing House.
7. Modern Spectroscopy, J.M. Hollas, John Wiley.
8. Textbook of Inorganic Chemistry Vol.I &II, A.Singh & R.Singh, Campus International Publication
9. Advanced Inorganic Chemistry, Cotton Wilkinson, W S E Wiley
10. Separation Chemistry, R. P .Budhiraja, New Age International
11. Vogel's Text book of Quantitative Inorganic Analysis, ELBS Press

M.Sc. SEMESTER II

C-202 : ORGANIC CHEMISTRY

(SELECTED TOPICS IN ORGANIC CHEMISTRY)

1. **Pericyclic Reactions:**
   - (a) Introduction: Type and stereo chemistry.
   - (b) Theoretical basis of pericyclic reach M. O. theory and symmetry property reactant and product orbital.
   - (c) Cycloaddition reaction [2+2] and [4+2].
   - (d) Electrolytic reaction and sygmotropic rearrangement.
2. **Photochemistry:** Introduction, Electronic transition, Job lenskii diagram, photosensitizations, photochemistry of carbonyl compound, unsaturated system, aromatic and Heterocyclic comp.
3. **Aromaticity:** Nonbenzene aromatic compounds, azulenes, Tropolener (4n+2) Huckel rule and it's applications.

Reference Books

1. Organic reaction Mechanism (II edition) - V. K. Ahluwalia, R. K.Parasar

2. Reaction Mechanism and reagents in organic chemistry -Gurdeep R. Chatwal

3. Organic chemistry (VI edition) - Morrison Boyd.

4. Organic Chemistry - Finar

5. Organic chemistry - (V edition) - Mc Marry)

6. Heterocyclic Chemistry - Raj K. Bansal

7. Advanced organic chemistry (IV edition) - Jerry March

8. Reaction mechanisms and problems in organic chemistry – P. Chattopadhyay

9. Reactive intermediates in organic chemistry - J. P. Trivedi

10. Principles of reaction mechanism in organic chemistry - Parmar-Chawla

11. Fundamentals of photochemistry - Rohtgi-Mukherjee

12. Stereochemistry of organic compound - P.S. Kalsi

13. Pericyclic reactions - S. M. Mukherjee

14. Organic Photochemistry - J. Coxon & B. Halton

15. Introduction Photochemistry - A. Cox. & T. Camp.

M.Sc. SEMESTER-II

C-203: MACROMOLECULAR PHYSICAL CHEMISTRY-I

1. **Basic concept of polymer chemistry**: Classification of polymers. Types of polymer chains. Stereo regular polymers. Polymer nomenclature. Functionality and polymerization concept.
2. **Chain polymerization:** Free radical polymerization: Methods of initiating free radical polymerization. Chain transfer reactions. Kinetics of free radical polymerization and chain transfer reactions. Factor affecting radical polymerization and properties of the resulting polymer.

   Ionic (Catalytic) polymerization**:** Kinetics of cationic and anionic polymerization. Coordination polymerization. Molecular weight distribution. Copolymerization and its kinetics. Evaluation of reactivity ratios.

   Methods of free radical polymerization: Bulk polymerization, solution polymerization, emulsion polymerization and solid phase polymerization. Poly-recombination. Problems.
3. **Polycondensation**: Reaction route of polyfunctional compounds. Kinetics of polycondensation reaction. Molecular weight control in polycondensation. Nonlinear polycondensation. Statistics of linear polycondensation. Effect of monomer concentration and temperature on direction of polycondensation reaction. Polycondensation equilibrium and molecular weight of polymer. Factors affecting the rate of polycondensation and molecular weight of the polymer. Method of polycondensation: Melt, interfacial, solution and solid phase polycondensation. Problems.
4. **Stepwise polymerization and ring scission polymerization**: Thermodynamics of ring transformation to a linear polymer. Effect of temperature and monomer concentration on ring-polymer equilibrium. Kinetics and mechanism of ring scission polymerization. Effect of activator concentration and temperature on ring scission polymerization and molecular weight of the polymer.

Reference Books

1. A First Course in Polymer Chemistry, Mir Publishers, Moscow.
2. Physical Chemistry of Polymers, A Tager, Mir Publishers, Moscow.
3. Text-book of Polymer Science, F. W. Billmeyer, Willey Interscience.
4. Polymer Chemistry, Bruno Vollmert. Springer, New York.
5. Principles of Polymer Systems, F. Rodriguez, McGraw Hill.
6. Polymer Science, V. R. Gowariker, N. V. Vishwanathan and J. Shreedhar, Willey Eastern Ltd., New Delhi.
7. Physical Chemistry of Macromolecules, D. D. Deshpande, IIT, Bombay
8. Polymer Chemistry An Introduction, Malcolm P. Stevens, Addition-Wesley Publishing Company, Inc.

M.Sc. SEMESTER-II

C-204: SPECTROSCOPY

1. **Ultraviolet Spectroscopy:** Electromagnetic spectrum & its absorption by organic molecules, Electronic transitions & selection rules, Bear-Lambert law, Designation of UV bands, Instrumentation, UV absorption of organic compounds Carbonyl compounds, Unsaturated carbonyl compounds, dienes, Conjugated polymers. Applications.
2. **Infrared Spectroscopy:** Introduction basic theory Instrumentation, combination, overtones, fermi resonance & mechanical coupling, spectral features of major functional groups & factors affecting. Detailed study of vibrational Frequency of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, & conjugated. Interpretation of IR spectra of some representative compounds. Application.
3. **Nuclear Magnetic Resonance Spectroscopy:** Introduction, nuclear spin, energy absorption & relaxation. Basic ideas about instrument, chemical shift & factors affecting it, magnetic anisotropy, spin-spin coupling, coupling constant, Pople notation, first order & non first order splitting for two, three & four interacting nuclei., long range coupling, interpretation of PMR spectra of some representative compounds, simplification of spectra, shift reagents, NOE, FT NMR, Applications.
4. **Mass Spectrometry:** Principle & theory, Instrumentation, different ionization techniques, (EI, CI, FAB, FD) General modes of fragmentation, fragmentation patterns of various classes of compound, Maclafferty rearrangement, with representative compounds. Applications.
5. **Carbon- l3 NMR Spectroscopy:** General considerations, chemical shift, aliphatic, olefinic, alkyne, aromatic, heteroaromatic & carbonyl carbon, coupling constants, 2 D NMR.
6. **Problems based on Spectroscopy:**

Reference Books

1. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.

2. Specrometric identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.

3. Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus, Wiley.

4. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.

5. Spectroscopy Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw-Hill.

6. Spectroscopy of Organic Compounds, P. S. Kalsi, New Age International Ltd.

M.Sc. SEMESTER II

C-205 & 206 : PRACTICALS

1. Organic Chemistry:

(i) Organic preparation: Two stage preparation.

(ii)Organic spotting (with TLC monitoring and spectral interpretation).

2. Inorganic Chemistry:

(i) **Inorganic preparations**-metal complexes.

(ii) **Qualitative analysis**-six radicals separation.

3. Physical Chemistry:

(i) Instrumentation:

(a) Conductometry : Mono and biprotic acids, mixtures of acids against strong/weak bases, argentometric, complexometric, replacement titrations, verification of Onsagar's equation, dissociation of weak acids.

(b) Potentiometry: acid-base, redox and argentometric titrations.

(c) pH metry: acid-base titration, pK_a of acids and $E^0_{QH2.}$

(d) Ultrasonics: Acoustical parameters of liquids.

(e) Refractometry: Binary mixtures and solids.

(f) Polarimetry: Optically active compounds.

(g) Spectrophotometry: Lambert-Beers Law, binary mixture, kinetics of iodination, etc.

(ii) Physicochemical Exercises:

(a) Reaction dynamics: Zero, first and second order reactions.

(b) Partition coefficient: Dimerization of acids, $I\text{-}I_2$ system, Cu^{2+} - NH_3 complexes.

(c) Thermodynamics: Heat of Solution, Partial molar volume, etc.

(d) Steam distillation: Molecular weight determination.

4. Analytical Chemistry:

1. Practicals based on food analysis: Milk, honey, oil, tea-leaves, turmeric powder, etc.

2. Drug analysis: aspirin, Benzyl benzoate, etc.

3. Volumetric and gravimetric exercises: Ester, peroxides, other ions, etc.

4. Industrial products: Estimation for purity and assay.

C-207 : VIVA-VOCE EX

M.Sc. SEMESTER-III

INORGANIC CHEMISTRY

C(I)-301 : SEPARATION TECHNIQUES

1. **Adsorption & partition chromatography:** History, Classification, Definition of terms; Principle & basic theory. Column adsorption chromatography: Technique, Applications.
2. **Partition chromatography:** (i) Column (ii) paper (iii) TLC. Technique & Applications.
3. **Band broadening & column efficiency:** Factors affecting, Plate theory & Rate theory of chromatography, Definition of terms, Limitations of theory.
4. **HPLC:** Instrumentation, Working and Applications.
5. **GLC:** Principle, Instrumentation, Working, Stationary phases, Applications.
6. **Ion Exchange chromatography:** Principle & Applications.
7. **Affinity chromatography:** Principle & Applications.
8. **Hyphenated techniques:** GC-MS, GC-TLC, LC-MS etc. Principle & Applications.
9. **Recent Advances in Chromatographic techniques.**

Reference Books

1. Thin layer chromatography, E. Stahl.
2. Chromatography, Heptman.
3. HPTLC, Dr.P.D. Sethi.
4. High Performance liquid chromatography, Dr.P.D. Sethi
5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W.B. Saunders.
6. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
7. Principles of Instrumental analysis, D.A. Skoog and W.B. Saunders.

M.Sc. SEMESTER III

C(I)-302 : INORGANIC SPECTROSCOPY

1. **Nuclear-Quadrupole resonance:** Introduction, Origin of transition. Experimental techniques. Towne's and Dailey's Formula, Structural information from NQR illustrated by suitable examples.
2. **Nuclear Magnetic Resonance:** NMR studies of nuclei other than proton, Applications in inorganic complexes, Shift Reagents
3. **Electron Spin Resonance:** E.S.R. Spectra of Transition metal complexes, Basic principles, Hyperfine Splitting, Zero field splitting, Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants, measurement techniques, Applications.
4. **Mössbauer spectroscopy:** Mössbauer effect, Mössbauer isotopes, Isomer-Shift and factors affecting it. Magnetic hyperfine interactions. Quadrupole moment. Electric field gradient. Quadrupole splitting. Applications in structure determination.
5. **Photoelectron Spectroscopy** : Basic Principles, Photo Electric Effect, Ionisation Process, Koopman's Theorem, Photoelectric Spectra of simple molecule, Basic idea of Auger electro spectroscopy.

Reference Books

1. Modern Spectroscopy, J.M.Hollas,John Wiley
2. Physical Methods in Chemistry , R.S.Drego , Saunders Collge
3. Introduction to Molecular Spectroscopy, G.M.Barrow, McGraw Hill
4. Structural methods in Inorganic Chemistry, Ebsworth & Rankin, ELBS
5. Introduction to Photoelectron Spectroscopy, P.K.Ghosh, John Wiley
6. Introduction to Megnetic Resonance, Carrington and Maclachalan, Harper &Row

M.Sc. SEMESTER III

C(I)-303 : SYMMETRY AND GROUP THEORY

1. **Symmetry and Group Theory :** Symmetry elements and symmetry operations, definitions of group, subgroups, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schonflie's symbols, representations of groups by matrices (representation for the C_n,C_{nv},C_{nh},D_{nh} etc. groups to be worked out explicitly). Character of a representation. The great orthogonality theorem and its importance. Character tables and their use in chemical bonding, Molecular orbital theory and hybridisation.
2. **Strong field and Weak field approximation:** Derivation of Sine formula, Weak Field approximation : Splitting of the free ion terms of d^2 in an octahedral field, calculation in weak field approximation the energy of various terms : $^3A_{2g}$,$^3T_{2g}$ and $^3T_{1g}$ derived from $^3F(d^2)$in an Oh field. Strong Field approximation : Determining multiplicities by the method of descen ding symmetry. Calculation of energy of various terms within the frame-work of strong field approximation.

Reference Books

1. Chemical Application Of Group Theory, F.A.Cotton,W E S Wiely
2. Advanced Inorganic Chemistry, Cotton Wilkinson, W S E Wiley
3. Introduction to Ligand Field, B.N.Figgis, Inc. New York
4. Coordination Compounds, S.F.A.Kettle, ELBS
5. Introduction to Ligand Field Theory, BellHausen, McGraw Hill
6. Group Theory and Its Application to Chemistry, K.V.Raman, Tata McGraw Hill

M.Sc. SEMESTER III

C(I)304 : BIOINORGANIC CHEMISTRY

1. **Transport and storage of metals:** Transport and storage of Alkali and Alkaline Earth Metals, Ionophores, Na/K (Sodium/Potassium)pump, Calcium Pump, Scheme for (Ca^{2+},Mg^{2+})-ATPase, Ferritin, Transferrin, Transport and storage of Iron in Plants, storage of Iron in microorganisms.
2. **Electron carriers:** Cytochromes Electron Carriers, Classification of Cytochromes, Cytochromes *c,* Cytochromes *b*, Cytochromes P-450.
3. **Metalloenzymes:** Mechanism of Enzyme Action, Metal Ions in Catalysis, Isomerases and Synthetases,Adenosylcobalmin and Cynocobalmin (Vitamin - B_{12}), Absorption, Transport and Metabolic Function of Vitamin B_{12}, Nitrogen Cycle and its Fixation, Iron-Sulphur(Fe-S) Proteins.
4. **Photoredox and Non-protein Metallobiomolecules:** Chlorophyll (The Magnesium porpyrins), Photosynthesis, Light Reaction, Dark Reaction: The Calvin Cycle
5. **Metals and its Complexes as Therapeutic Agents:** General Remarks, Anticancer Drugs(Platinum Complexes) Antiarthritis Drugs (Gold, Copper and its Complexes)

Reference Books

1. Principle Of Bioinorganic Chemistry, S.J.Lippard and J.M.Berg, University Science Books.
2. The Inorganic Chemistry of Biological Processes, M.N.Hughes, JohnWiley & Sons.
3. Bioinorganic Chemistry, G.R.Chatwal and A.K.Bhagi, Himalaya Publishing House.
4. Inorganic Biochemistry vols. I and II ed., G.L.Eichhorn,Elsevir.
5. Advance Inorganic Chemistry, Cotton & Wilkinson, Weily Elsevier.

M.Sc. SEMESTER III

C(I)-305&306 : PRACTICALS

1. **Qualitative Analysis:** Analysis of a mixture containing eight radicals, including two less common metal ions - W, Tl, Ti, Mo,Se, Zr, Th, Ce,V, Li.
2. **Inorganic Preparations:** Preparation of selected inorganic compounds and their estimation by usual methods to determine percentage purity of the compounds prepared.
3. **Flame Photometric Determination:** Sodium and Potassium when present together, Lithium/Calcium.
4. **Water Analysis:** Identification and determination of some cations and anions like Cl^-, SO_4^{--}, NO_3^-, NO_2^- , HCO_3^- , Ca^{++}, Mg^{++}, Na^+, K^+, etc., measurement of C.O.D. and B.O.D., Total Hardness, pH, Conductivity of the sample.

Reference Books

1. Vogel's Qualitative Inorganic Analysis, G.Svehla ,Orient Longman.
2. Advance Inorganic Analysis, Subhash-Satish, Pragati-Prakashan.
3. Text book of Quantitative Inorganic Analysis, Vogel's, ELBS.
4. Inorganic Preparation, J.Palmar, Wealy.
5. Fundamental of Analytical Chemistry, Skoog&West, Holt,Rinehart And Winston Inc.
6. Environmental Chemistry, A.K. De , Wiley Eastern.

C-307 : VIVA-VOCE EXAMINATION

M.Sc. SEMESTER-IV

INORGANIC CHEMISTRY

C(I)-401: SELECTED TOPICS IN CHEMISTRY

1. **Statistical data analysis:**
   i. Classification and definitions of errors. Accuracy, precision, standard and pooled precision deviations. The t-test when an accepted value is known, paired t-test, t-test
   ii. with multiple samples. Rejection of data (Q-test), control charts and linear least squares. Statistical consideration in radio activity.
2. Use of computer in chemistry and industry datamining patents, intellectual property rights & documentation aspects in various regulatory affairs.
3. Unit processes & unit operations, Nitration, oxidation, reduction, sulphonation, Animation, & other unit processes.
4. Size reduction, Mixing, crystallization, distillation, purification methods, chiral separation scale up operations from lab to Kilo scale & pilot plant operations.
5. Catalysis in industrial applications. Phase Transfer catalyst, concept of Green Chemistry & atom economy isolation of natural product based drugs & Aromatics & neutraceuticals.
6. **Nano Technology:**
   i. Introduction of nano materials and their size, the fundamental science behind nanotechnology.
   ii. Ref. Nanotechnology, M. Ratner and D. Ratner, Pearson
7. Pro-drugs, drug delivery systems, polymorphism
8. Selected topics in natural and synthetic food colours, synthetic dyes in current use

Note: Visit to industries related to above course study and report writing of visit (compulsory assignment for each candidate)

M.Sc. SEMESTER-IV

C(I)-402: SELECTED TOPICS IN INORGANIC CHEMISTRY

1. **Catalysis:** Homogeneous and Heterogeneous catalysis involving metal complexes and organometallic compounds. Oxidative addition reductive elimination, Insertion and desinsertion reactions, Hydroformylation, Hydrogenetion, Carboxilation and Polymerisation. Fischertrosch process. Watergas shift reaction.

2. **Inorganic Polymers:**

   (i) **Silicon Polymers**: Organo Silicon Polymers. Synthesis and their uses.

   (ii) **Coordination Polymers**: Nature and reaction yielding coordination polymers. Synthesis of coordination polymer. Use of polymeric ligands in synthesis of coordination polymers.

   (iii) **Boron Polymers**: Different Boron polymers having B-H,B-N,B-P,B-B, B-O and B-C bonds. Various uses of Inorganic polymers.

3. **Organometallic Compounds:** η^4-cyclobutadyne Complexes, η^5-cyclpentadynyl d-block metal Complexes, fluxional Organometallic Compounds, Preparative methods, typical reactions and applications.

Reference Books

1. Advance Inorganic Chemistry, Cotton & Wilkinson, Weily Elsevier.
2. Inorganic Polymers , Chatwal, Himalya Publishing.
3. Principle and Application Of Organotransition Metal Chemistry, Collman & egsdus, University Science Books.
4. The Organometallic Chemistry of the Transition Metals ,R.H. Crabtree, John Wiley.
5. Organometalic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
6. Metallo-Organic Chemistry, A.J. Pearson, Wiley.

M.Sc. SEMESTER-IV
C(I)-403: COORDINATION CHEMISTRY

1. **Reaction Mechanism**:

Substitution Reaction of Octahedral Complexes: The nature of Substitution Reaction, Theoretical approach to Substitution mechanism, Nucleophilic reactivity, Nature of central atom, Kinetic application of crystal field theory, Substitution reaction of Co(III) complexes, Replacement of co-ordinated water, Acid catalysis.

Stereochemical changes in Octahedral Complexes: Molecular rearrangement complexes, Reaction of geometrical and optical isomers, Isomerisation and recemisation of octahedral complex, Ligand stereospecificity.

Substitution Reaction of Square-Planer Complexes: Trans effect and its theories, Mechanism of substitution reaction of Platinum (II) complexes. Oxidation-Reduction Reaction: Outer sphere mechanism, Inner sphere mechanism, two electron transfer, Application to synthesis of coordination compounds.

2. **Complex Equilibria:** Introduction, Computation of stability constant from equilibrium data, Basic principle, Mathematical functions and their interrelationships.

Method of computing stability constant: Method based on Half integral n values, Correction method, Graphical methods. Numerical methods. Experimental determination of composition and stability **:**Spectroscopic methods, Methods of continuous variations, pH-metric Irving-Rossotti method.

Reference Books

1. Inorganic Reaction Mechanism, J.O. Edwards, Benjamin.
2. Mechanism Of Inorganic Reactions, F.Basolo & R.G.Pearson, Wiley New York.
3. Determination of Stability constants, Rossotti and Rassotti.
4. Chemistry of Metal Chelate Compounds, Martell & Calvin, John Wiley & Sons.
5. Chemistry of Complex Equilibria, T.M.Beck.
6. Coordination Chemistry, D Benerjia, Tata McGraw Hill.

M.Sc. SEMESTER-IV

C(I)-404: BONDING IN COMPLEXES

1. **Theoretical Principles of Crystal Field Theory:** Brief introduction to spherical harmonics. The shape of d-orbitals. Derivation of crystal field potential for the tetragonal cubic and square plannar arrangement of ligands around metal ion. Transformation of these potential from Cartesian to spherical harmonics.

   Effect of V(oct)and d^1 system: (i)Evaluation of the various integral involved.(ii)Solution of the secular determinant to obtain energies and corresponding wave functions.(iii) Crystal field splitting diagram for Oh,Td, square plannar systems. Simple application of CFSE.

   Many electron system: (i) R.S.Coupling. Hund's and ground level (ii) Determination of the function (L,M_ℓ,S,M_s).Corresponding to the terms $^3F,^3P,^1G,^1P$ and ^1S obtained from d^2 system by R.S.coupling.

2. **Application of group Theory to Vibrational Spectroscopy:** Symmetry and shapes of AB_2, AB_3, AB_4, AB_5,and AB_6, mode of bonding of ambidentate ligands, ethylene dimine and diketonato complexes, application of resonance Raman spectroscopy.

3. **Electronic Spectra and Magnetic Properties of Transition Metal Complexes :** Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states),calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereo chemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover

Reference Books

1. Chemical Application Of Group Theory, F.A.Cotton,W E S Wiely.
2. Advanced Inorganic Chemistry, Cotton Wilkinson, W S E Wiley.
3. Introduction to Ligand Field, B.N.Figgis, Inc. New York.
4. Coordination Compounds, S.F.A.Kettle, ELBS.
5. Introduction to Ligand Field Theory, BellHausen, McGraw Hill.

6. Inorganic Reaction Mechanism, J.O. Edwards, Benjamin.
7. Mechanism of Inorganic Reactions, F.Basolo & R.G.Pearson, Wiley New York.

M.Sc. SEMESTER-IV

C(I)-405&406 : PRACTICALS

1. **Ore and Alloy analysis:**
2. **Spectrophotometric Determination:** Determination of Composition and stability constant by Job's Method of continuous variations, Mole-ratio method, Slope – Ratio method.
3. **Chromatography Sepration:** Separation of cations and anions by (i) Paper chromatography- Circular and assending (ii) Column Chomatograpy –ion exchange (iii) Thin-layer chromatography- separation and Determination of Rf values.
4. **pH metry:** Determination of stability constant of complexes by pH metry method.

Reference Books

1. Inorganic Reaction Mechanism, J.O. Edwards, Benjamin.
2. Mechanism Of Inorganic Reactions, F.Basolo & R.G.Pearson, Wiley New York.
3. Fundamental of Analytical Chemistry, Skoog&West, Holt,Rinehart And Winston Inc.

C-407 : VIVA-VOCE EXAMINATION

M.Sc. SEMESTER-III

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-301: SEPARATION TECHNIQUES

1. **Adsorption & partition chromatography:** History, Classification, Definition of terms; Principle & basic theory. Column adsorption chromatography: Technique, Applications.
2. **Partition chromatography:** (i) Column (ii) paper (iii) TLC. Technique & Applications.
3. **Band broadening & column efficiency:** Factors affecting, Plate theory & Rate theory of chromatography, Definition of terms, Limitations of theory.
4. **HPLC:** Instrumentation, Working and Applications.
5. **GLC:** Principle, Instrumentation, Working, Stationary phases, Applications
6. **Ion Exchange chromatography:** Principle & Applications.
7. **Affinity chromatography:** Principle & Applications.
8. **Hyphenated techniques:** GC-MS, GC-TLC, LC-MS etc. Principle & Applications.
9. **Recent Advances in Chromatographic techniques.**

Reference Books

1. Thin layer chromatography, E. Stahl.
2. Chromatography, Heptman.
3. HPTLC, Dr.P.D. Sethi.
4. High Performance liquid chromatography, Dr.P.D. Sethi
5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W.B. Saunders.
6. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
7. Principles of Instrumental analysis, D.A. Skoog and W.B. Saunders.

M.Sc. SEMESTER-III

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-302 : ORGANIC SYNTHESIS – A DISCONNECTION APPROACH

1. **A Disconnection Approach:** Introduction to disconnection, concept of synthon, synthetic equivalent, functional group inter conversion, concept and design of synthesis, criteria of good disconnection.
2. **One group disconnection:** Disconnection and synthesis of alcohols, olefins, simple ketones, acids and its derivatives.
3. **Two group disconnection:** Disconnections in 1,3-dioxygenated skeletons, preparation of 8-hydroxy carbonyl compounds, α,β-unsaturated carbonyl compounds, 1,3-dicarbonyls, 1,5-dicarbonyls and use of Mannich Reaction.
4. **Illogical two group disconnections:** Disconnection and synthesis of 2-hydroxy carbonyl compounds, 1,2-diols, 1,4 and 1,6-dicarbonyl compounds.
5. **Pericyclic reactions:** Disconnections based on Diels-Alder reaction and its use in organic synthesis.
6. **Disconnection and Synthesis of acyclic and cyclic heterocompounds:** Synthesis of ethers, amines, nitrogen and oxygen containg five and six membered heterocycles.
7. **Ring Synthesis:** Special methods for small rings preparations, synthesis of three and four membered ring compounds.
8. **Protecting groups:** Protection of organic functional groups, protecting reagents and removal of protecting groups.
9. **Umpolung of reactivity:** Umpolung of carbonyl group, synthesis based on umpoling carbonyl group, synthesis of 1,2 and 1,3 diketones, cyclic ketones etc.
10. **Chiron approach to synthesis:** Basic approach and a few examples to illustrate utility of Chiron approach.
11. **Synthesis of some complex molecules:** Synthesis of Mesoporphyrin, Cephalosporin C and Conenzyme-A.

Reference Books

1. Designing organic synthesis - S. Warren, Wiley.
2. Some modern methods for organic synthesis - W. Carruthers.
3. Principles of organic synthesis - R. Norman & J. M. Coxon.
4. Advanced organic chemistry Part B – F.A. Carey & R. J. Sundberg.
5. Organic synthesis - concept, methods & starting materials – J. Fuhrhop.
6. Modern synthetic reactions - H.O. House, W.A. Benjamin.
7. Disconnection approach - Warren

M.Sc. SEMESTER-III

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-303 : ORGANIC & PHARMACEUTICAL CHEMISTRY

(A) History of medicinal chemistry various types of classifications, synthesis and usage of synthetic & natural product drugs from following class.

(B) Synthesis:

1. **Central Nervous system:** Anaesthetic (Local & general), Analgesics, Antipyretics, (Steroidal and Nonsteroidal anti-inflammatory drugs), Sedative & hypnotic Tranquilizers (Major & Minor), Antiepileptics, Anticonvulsants, Antidepressants & antimaniacs, Drugs used in movement disorder, Antiemetics CNS stimulants & activators
2. **Musculoskeletol Disordor drugs:** NSAIDS, Anti arthritic drugs, Neuromuscular Drugs, Muscle relaxants, Topical Analgesics
3. **Cardiovascular drugs: A**ntiarrhythm, Antihypertensives, Antianginal drugs Vasodilators (Peripheral & Coronary), Coagulants & anticoagulants, Antithrom botic & Antiplatelet drugs
4. **Respiratory system drugs:** Antitussives, expectorants and mucolytics, Respiratory stimulants, Antiasthematics
5. **Gastrointestinal Tract Drugs:** Antacids, Antiulcer & Antisecretory, Anti - Spasmodics, Antidiarrheals, Laxatives & lubricants
6. **Genito urinary system Drugs: U**rinary infectives, Diuretics & Anti-diuretics, Analgsics , Spermicidal, Contraceptives
7. **Drugs on Skin diseases:**Topical steroids, Topical antifungals, Drugs for Acne vulgaris, psoriasis and seborrhoeics, Topical antiinfectives
8. **Allergy & immunology:** Antiallergic & antihistamin, Immunosuppressants Vaccines & immunoglobulins
9. **Hormones:** Anebolic and androgenic steroids, Conticosteroids, Oestrogen, progeslogers and contracoptrus, Thyroids & antithyroid drugs, Antidiabetic & hyper glycemics, Fertiity agents, Antiobesity drugs, Hypolipidaemic agents
10. **Antigont drugs:**
11. **Antiinfections & antiinfestation:**

12. **Anticancer introduction to chemotherapeutic agents:** Antimalarials Antiprotogoals, Antileprosy, Antitubercular, Antifungal, Antianaerobics Anthelmintics & antiinfestive drugs, Antiviral,
13. **Antibiotics and Antibacterials:** Pencillins, Cophelosphorins, Fluroquinolones Aminoglycosides, Macrolides & other antibiotics, Chloramphenicol, Tetracycline, Oxazolidine diones, Sulfonamides
14. **Miscallaneous:** Organometallic drugs, Diagnostic agents
15. **Recently introduced drugs**

Reference Books

1. Wilson and Gisvsld's Textbook of Organic Medicinal & Pharmaceutical Chemistry, Ed. Robert F. dorge.
2. The Organic Chemistry of drug design and drug action, R. B. Silverman.
3. Strategies for organic drug synthesis & design, D. Lednicer John Wiley.
4. Principles of Medicinal Chemistry, William O. Foye, Lippincott, William and Wilkins.
5. Total synthesis of Natural products, Apsimon (Series).
6. Textbook of Medicinal Chemistry by A. Kar, Asian Age. Publication.
7. Pharmaceutical substances by A. Kaleemann & Engle.

M.Sc. SEMESTER-III

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-304 : HETEROCYCLIC CHEMISTRY

1. Nomenclature of Heterocyclic compounds:

2. Heterocycle Analogues of Cyclopropane:

1) Preparation and properties of azirine and oxirane.

2) Preparation of diazirine and oxaziridine.

3. Heterocyclic Analogues of Cyclobutane:

1) Preparation and properties of azetidine, oxetene, oxetane, thietane.

4. Heterocyclic Analogues of Cyclopentane:

1) Preparation and properties of pyrrole, furan, thiophene.

2) Preparation of phosphole, benzaluminol.

3) Preparation and properties of indole, benzofuran, thianaphthene.

4) Preparation of isoindole, indolizine, dibenzofuran, isobenzofurans, carbazole.

5. Heterocyclic Analogues of Benzene:

1) Preparation and properties of pyridine and pyran.

2) Preparation of 2-pyrones and 4-pyrones.

6. Heterocyclic Analogues of Naphthalene:

1) Preparation and properties of quinoline, isoquinoline, acridine and phenanthridine.

2) Preparation of benzopyran, benzo-2-pyrones and benzo-4-pyrone.

7. Compounds with two Heteroatoms in a Five Membered Ring:

1) Preparation and properties of pyrazole, imidazole.

2) Preparation of isoxazole, oxazole, isothiazole, thiazole.

8. Compounds with Two Heteroatoms in a Six Membered Ring:

1) Preparation of pyridazine, pyrimidine, pyrazine, oxazine, thiazine, dioxane, quinazolene, quinaxoline, cinnoline.

9. Compounds containing more than Two Heteroatoms:

1) Preparation of pteridine, triazenes, sydnones.

10. Heteroatoms in seven and eight membered ring:

1) 1) Synthesis of azepine, thiepine, diazepine.

11. Selected study of fused heterocycles

Reference Books

1. Heterocyclic chemistry-R.K. Bansal
2. An introduction to the chemistry of Heterocyclic compds. - R.H.Acheson
3. Chemistry of Heterocyclic compounds-J.J. Trivedi
4. Heterocyclic chemistry-R.R. Gupta, M.Kumar & V. Gupta, Springer
5. The chemistry of Heterocycles - T. Eicher & S. Hauptmann
6. Heterocyclic chemistry - J.A. Joule, K. Mills & G.F. Smith
7. Comprehensive Heterocyclic chemistry - A. R. Katritzky and C. W. Rees
8. Heterocyclic chemistry - T. L. Gilchrist

M.Sc. SEMESTER-III

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-305 & 306: PRACTICALS / DISSERTATION

Practicals: Chromatographic techniques (i) paper chromatography (ii) TLC (iii) column chromatography (iv) GC

Multi-step synthesis of organic compounds using TLC and spectral study.

Extraction of organic compounds from natural sources and their separation – HPLC, GLC etc.

Organic mixture separation

Dissertation: The selected student will undertake a research dissertation and other independent studies on full-time basis for a period of six months. The candidates will be given the option of selecting a research problem in a preferred area that falls within the disciplines of courses undertaken. The project could be conducted at the Department of Chemistry or at his/her working place if necessary laboratory facilities are available. For the latter option to be viable a suitable person holding postgraduate qualifications and willing to supervise the candidate, should be available at the work place. In such instances, the research dissertation should also be supervised by a member of the Board of Study in Chemical Sciences or of the Department of the University. At the end of the research project the candidates are required to present their results in the form of a dissertation and a seminar.

C(OP)-307 : VIVA-VOCE EXAMINATION

M.Sc. SEMESTER-IV

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-401 : SELECTED TOPICS IN CHEMISTRY

1. **Statistical data analysis:** Classification and definitions of errors. Accuracy, precision, standard and pooled precision deviations. The t-test when an accepted value is known, paired t-test, t-test with multiple samples. Rejection of data (Q-test), control charts and linear least squares. Statistical consideration in radio-activity.
2. **Computer in Chemistry:** Use of computer in chemistry and industry data mining patents, intellectual property rights & documentation aspects in various regulatory affairs.
3. **Unit processes operations:** Nitration, oxidation, reduction, sulphonation, Amination, & other unit processes.
4. **Unit operations:** Size reduction, Mixing, crystallization, distillation, purification methods and drying. Chiral separation scale up operations from lab to Kilo scale & pilot plant operations.
5. **Catalysis in industrial applications:** Phase Transfer catalyst, concept of Green Chemistry & atom economy isolation of natural product based drugs & Aromatics & neutraceuticals.
6. **Nano Technology:** Introduction of nano materials and their size, The fundamental science behind nanotechnology.
7. **Pro-drugs, drug delivery systems, polymorphism:**
8. **Selected topics**: Natural and synthetic food colors, synthetic dyes in current use.

Note: Visit to industries related to above course study and report writing of visit (compulsory assignment for each candidate)

Reference Books

1. Nanotechnology - M. Ratner and D. Ratner, Pearson
2. Unit processes in organic synthesis - P.H. Groggins

3. Outune of chemical technologies - Dryden

4. Computer and Common Sense - R. Hunt & J. Shelley

5. Computational Chemistry – A.C. Norris

6. Microcomputer quantum mechanics - J. P. Kiangbeck, Adam Hilger

7. Principles of Instrumental Analysis - D.A. Skoog and J.L. Loary, W.B. Saunders

8. Biopharmaceutics and Pharmacokinetics by Bhramankar, Valabh prakashan.

M.Sc. SEMESTER-IV

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-402 : CHEMISTRTY OF NATURAL PRODUCTS

1. **Natural products:** Classification, method of isolation, structure determination and synthesis where specified.
2. **Alkaloids:** Chemistry of Recinone and Atropine. Synthesis of Morphine, Nicotine, Colchinine, Strychnine, Cinchonine.
3. **Vitamins:** Introduction and Chemistry of Vitamin A, E and K. Synthesis of Riboflavin, Pyridoxene Vitamin C, Niacin, Pentothenic acid, folic acid.
4. **Plant pigments:** Porphin and porphyrins, chemistry of Haemin, chemical relationship with chlorophyll.
5. **Nucleic acid:** Nucleoside, Nucleotide, fine structure of protein.
6. **Terpenoids:** Introduction, classification, chemistry of Farnesol, Zingiberine. Synthesis of santonine.
7. **Chemistry of starch and cellulose:** Constitution of starch and cellulose.
8. **Steroids:** Constitution of cholesterol (no synthesis), chemistry of progesterone and testosterone. Synthetic hormones : Hexosterol and stilbosterol, ACTH.

Reference Books

1. Natural products: Chemistry and Biological significance – J. Madd, R. S. Davidson, J. B. Hobbs, D.V. Banthrope.
2. Organic chemistry, Vol 2., - I..L. Finar.
3. Stereoselective synthesis: A practical approach - M. Nogradi.
4. Chemistry, Biological and Pharmacacological properties of medicinal plants from the Americas - Ed. Kurt, M. P. Gupta and A. Marston.
5. New trends in Natural product chemistry – Alta – Ur- Rahman and M.I. Choudhary.

M.Sc. SEMESTER-IV

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-403 : STEREOCHEMISTRY

1. **Fundamental of Stereochemistry:** Important terminology of stereochemistry, nomenclature etc., resolution, asymmetric synthesis, R and S configuration, E and Z isomer, optical activity due to molecule dissymmetry (allenes, spirans, diphenyl system).
2. **Conformational Analysis:** Chirality, mono-, di- and polysubstituted cyclohexane, decaline derivatives, cholesterol.
3. **Stereo chemistry of fused ring and bridge ring and spirans:**
4. **Stereo selective and stereo regulator polymerization and other related topics:**
5. **Stereochemistry of N, S, P, As, S and B compounds:**
6. **Advance topics in stereochemistry.**

Reference Books

1. Organic chemistry - I.L. Finar
2. Stereochemistry - J.P. Trivedi
3. Stereochemistry - D. Nasipuri
4. Stereochemistry of organic compounds - P.S. Kalsi.
5. Stereoselective synthesis : A practical approach, - M. Nogradi, VCH

M.Sc. SEMESTER-IV

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-404 : ADVANCED MEDICINAL CHEMISTRY

1. **Introduction to Medicinal Chemistry:** Important terminology.
2. **Drug Design:** i) Development of new drugs, procedures followed in drug design, concepts of lead identification and lead modification, structure-activity relationship (SAR), factor affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism and spatial considerations.

   ii) History and development of QSAR. Physicochemical parameters: Lipophilicity, electronic parameters, steric parameters, Shelton and surface activity parameters and redox potentials. Free Wilson analysis, Hansch analysis, Relationship between Free-Wilson and Hansch analysis. Other statistical methods.
3. **Pharmacokinetics:** Introduction to drug absorption, disposition, drug metabolism, elimination. Important pharmacokinetics parameters in defining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process. Concept of prodrug and soft drug.
4. **Pharmacodynamics:** Introduction, concept of drug receptors interactions. Theories of drug activity relationship, treatment of diseases by enzyme stimulation and enzyme inhibition, elementary treatment of drug receptor interaction, LD_{50}, ED_{50}, MIC and MEC etc. (Mathematical derivations of equation excluded).Membrane active drugs (Sulphonamides), xenobiotics and significance of drug metabolism in medicinal chemistry.
5. **Introductory exposure of topics related to physiology, biochemistry and molecular biology.**
6. **Pharmacognocy:** Natural products as pharmaceuticals, important techniques in isolation of natural products, Case study of total synthesis of natural drug substances.
7. **Chirality**: Chiral synthesis, racemic drugs, separation and strategies for enantiomeric pure drugs.

8. **Combinatorial Chemistry**: Including automation, solid supported and solution phase of synthesis and related other methodologies, preparation study of targeted or focused libraries.
9. **Selected topics in Medicinal Chemistry**: Topics of recent advances of current interest from literature.

Reference Books

1. Introduction to Medicinal Chemistry, A Gringuage, Wiley-VCH.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F. Dorge.
3. An Introduction to Drug Design, S.S. Pandey and J.R. Dimmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Sixth Edition, Ed.M.E.vWolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
6. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
7. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.
8. Pharmaceutical Substances., Kleemann, Vol-I & II., Fourth edition., Thieme.
9. Principles of Medicinal Chemistry., William Foye, Fourth Edition., Lippincott, William and Wilkins.
10. Analytical Profile of Drug Substances (Series)., Florey.,
11. Merck Index., Thirteenth edition., Merck & Co.
12. Total synthesis of Natural products, Apsimon (Series).
13. Principles of Medicinal Chemistry by S.S. Kadam, Mahadik, Bothera, Nirali Publication, 11th edition.
14. Pharmacology and Pharmacotherapeutics by R.S. Satoskar, Bhandarkar, Popular Prakeshan.
15. Bio Pharmaceutics and Pharmacokinetics by Bhramankar, Valabh prakashan.

M.Sc. SEMESTER-IV

ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-405 & 406 : PRACTICALS / DISSERTATION

Practicals: Multi-step Synthesis of Organic Compounds using TLC & spectral study.

Qualitative Analysis- three component mixture separation.

Spectrophotometric (UV/VIS) Estimation of pharmaceuticals.

Dissertation: The selected student will undertake a research dissertation and other independent studies on full-time basis for a period of six months. The candidates will be given the option of selecting a research problem in a preferred area that falls within the disciplines of courses undertaken. The project could be conducted at the Department of Chemistry or at his/her working place if necessary laboratory facilities are available. For the latter option to be viable a suitable person holding postgraduate qualifications and willing to supervise the candidate, should be available at the work place. In such instances, the research dissertation should also be supervised by a member of the Board of Study in Chemical Sciences or of the Department of the University. At the end of the research project the candidates are required to present their results in the form of a dissertation and a seminar.

C(OP)-407 : VIVA-VOCE EXAMINATION

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-301: SEPARATION TECHNIQUES

1. Adsorption & partition chromatography: History, Classification, Definition of terms; Principle & basic theory. Column adsorption chromatography: Technique, Applications.

2. Partition chromatography: (i) Column (ii) paper (iii) TLC. Technique & Applications.

3. Band broadening & column efficiency: Factors affecting, Plate theory & Rate theory of chromatography, Definition of terms, Limitations of theory.

4. HPLC: Instrumentation, Working and Applications.

5. GLC: Principle, Instrumentation, Working, Stationary phases, Applications.

6. Ion Exchange chromatography: Principle & Applications.

7. Affinity chromatography: Principle & Applications.

8.Hyphenated techniques: GC-MS, GC-TLC, LC-MS etc. Principle & Applications.

9. Recent Advances in Chromatographic techniques.

Reference Books

1. Thin layer chromatography, E. Stahl.

2. Chromatography, Heptman.

3. HPTLC, Dr.P.D. Sethi.

4. High Performance liquid chromatography, Dr.P.D. Sethi

5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W.B. Saunders.

6. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.

7. Principles of Instrumental analysis, D.A. Skoog and W.B. Saunders.

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)- 302: MACROMOLECULER PHYSICAL CHEMISTRY-II

1. Molecular weights and size: Purification and fractionation of polymers: Fractional precipitation, partial dissolution, gradient elution and GPC methods.

2. Molecular weight determination: End-group analysis, cryoscopy, ebulliometry, membrane osmometry, vapor pressure osmometry, light scattering (asymmetric and Zimm plot methods), GPC and Ultracentrifugation (Sedimentation velocity and equilibrium methods).

3. Solution viscosity and molecular size: Determination of viscosity and types of viscosities. Determination of intrinsic viscosity, Huggin's constant and Kraemer's constant. Intrinsic viscosity and molecular weight. Intrinsic viscosity and size, Chain branching.

4. Super molecular structure of polymers: Physical methods of investigation of molecular structure of polymers: Optical and electron microscopy, X-ray, electron and neutron diffraction techniques. Morphology of crystalline polymers: Lamellar single crystals, fibrillar and globular crystals; Spherulites.

5. Phase transition in polymers: State of matter and phase state. First and second order phase transitions. Crystallization and glass transition. Factors affecting crystallizability and glass transition temperature. Effect of molecular weight and plasticizers on Tg. Glass transitions of copolymers. The relation between Tg and Tm. and importance of Tg. Mechanism and kinetics of polymer crystallization. Thermodynamics of melting and crystallization. Melting temperatures of polymers. Free volume and packing density of polymers. Problems.

Reference Books

1. Physical Chemistry of Polymers, A Tager, Mir Publishers, Moscow.
2. Text-book of Polymer Science, F. W. Billmeyer, Willey Interscience.
3. Polymer Science, V. R. Gowariker, N. V. Vishwanathan and J. Shreedhar, Willey Eastern Ltd., New Delhi.
4. Physical Chemistry of Macromolecules, D. D. Deshpande, IIT, Bombay

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)- 303: ELECROCHEMISTRY

1. **Fundamentals of electrochemistry**: Classification of conductors. The mechanism of electrolysis. Electrolytic dissociation theory. Evidences for the ionic theory. Influence of the solvent on dissociation. Faraday's laws of electrolysis.
2. **The Theory of electrolytic conductance**: The degree of dissociation and inter ionic attraction. The ionic atmosphere and relaxation time. Mechanism of electrolytic conductance. Validity of Debye- Huckel - Onsager equation. Determination of degree of dissociation.
3. **The Migration of ions**: Transference numbers and ionic velocities. The Hittorf method and the moving boundary method. Transference numbers in mixtures. Abnormal transference numbers. Examples.
4. **Acids and bases**: Definitions, types of solvents, dissociation of constants of acids and bases. Determination of dissociation constants. Acidity function, effect of solvent and temperature on dissociation constant and ionic product of water. Examples.
5. **Amphoteric electrolytes**: Dipolar ions and evidences for their existence. Dissociation of amino acids, isoelectric points and neutralization curves of ampholytes.
6. **Polarization and over voltage**: Electrolytic polarization. Dissolution and deposition potentials. Determination of anode and cathode potentials and concentration polarization. Decomposition voltages of aqueous solutions. Metal deposition over voltage. Mechanism of anodic and cathodic phenomena. Ionic diffusion as the slow process. Thickness of diffusion layer. Influence of temperature and agitation on diffusion layer. Ionic discharge is the slow process. Establishment of equilibrium on the electrode is the slow process. Hydrogen over voltage. Influence of current density, pH and temperature on over voltage. Theories of over voltage. Oxygen over voltage. Electrolysis of water. Examples.

Reference Books

1. An Introduction of Electrochemistry, S. Glasstone. Affiliated East West Press, New Delhi.
2. Electrochemistry, B. K. Sharma. Goel Publishing House.
3. Modern Electrochemistry Vol.2 JO'M Bockri's and A. K. N. Reddy, Plenum Press, New York.
4. The Principles of Electrochemistry, Duncan A. Mac Innes Dover Publication Inc. New York.

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)- 304: CHEMISTRY OF MATERIALS-I

1. **Liquid Crystals**: Definition and classification of liquid crystals. Synthesis of simple and polymeric liquid crystals. Effect of chemical constituents and lateral substituents on liquid crystal behavior. Applications of liquid crystals.
2. **Superconductors**: Introduction and classification of superconductors Advancement in super conductors. Applications of superconductors in various fields.
3. **Diffraction techniques**: X-ray, electron and neutron diffraction. Principles and laws of crystallography. Types of X-rays. Reciprocal lattice concept and diffraction conditions. Determination of lattice type and unit cell dimensions. The structure factor and intensity calculation. Imperfection in solids. Problems.
4. **QSAR**: Introduction, Classification of QSAR parameters; hydrophobic, Electronic, Theoretical and steric, Advantages and disadvantages of QSAR.
5. **Ultrasonics:** Introduction, applications and determination of thermodynamic parameters. Effect of concentration, temperature, nature of solvents and solutes and effect of substituents on acoustical properties.
6. **Computational Chemistry:** Introduction to computational Chemistry, standard computation methods, molecular modeling, computational techniques in the Drug-Design Process.

Reference Books

1. Liquid Crystals and Plastic Crystals, Vol. 1, W. Gray and P. A. Windsor Ch.4.1 and 4.2
2. Elements of X-ray Crystallography, L. V. Azaroff, Mc Graw-Hill N.Y.
3. Physical Chemistry, P. C. Rakshit.
4. Physical Chemistry, Danial Alberty, Mc Graw-Hill.
5. Text book of Physical Chemistry, S. Glasstone, Macmilan.
6. Principles of the Solid State, H. V. Keer, New Age, New Delhi.

7. Sonochemistry: The use of ultrasound in chemistry. T. J. Mason, Royal Chemistry, 1990.

8. Molecular modeling, Andrew Leach.

9. Computational Chemistry, G. H. Grant and W. G. Richard, Oxford 1995.

10. A Computational Approach to Chemistry, D. M. Hirst, Blackwell Scientific Publication, Oxford 1990.

C (PM) -305 & 306: PRACTICALS

C(PM)- 307 : VIVA-VOCE EXAMINATION

M.Sc. SEMESTER-IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)- 40I SELECTED TOPICS IN CHEMISTRY

1. Statistical data analysis:

i. Classification and definitions of errors. Accuracy, precision, standard and pooled precision deviations. The t-test when an accepted value is known, paired t-test, t-test

ii. with multiple samples. Rejection of data (Q-test), control charts and linear least squares. Statistical consideration in radio activity.

2. Use of computer in chemistry and industry determining patents, intellectual property rights & documentation aspects in various regulatory affairs.

3. Unit processes & unit operations, Nitration, oxidation, reduction, sulphonation, Animation, & other unit processes.

4. Size reduction, Mixing, crystallization, distillation, purification methods, chiral separation scale up operations from lab to Kilo scale & pilot plant operations.

5. Catalysis in industrial applications. Phase Transfer catalyst, concept of Green Chemistry & atom economy isolation of natural product based drugs & Aromatics & neutraceuticals.

6. Nano Technology:

i. Introduction of nano materials and their size, the fundamental science behind nanotechnology.

ii. Ref. Nanotechnology, M. Ratner and D. Ratner, Pearson

7. Pro-drugs, drug delivery systems, polymorphism

8. Selected topics in natural and synthetic food colours, synthetic dyes in current Use.

Note: Visit to industries related to above course study and report writing of visit (compulsory assignment for each candidate)

M.Sc. SEMESTER-IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)- 402 : NUCLEAR AND RADIO CHEMISTRY

1. Brief introduction of radioactivity, mass defect, binding energy, mean binding energy of stable nuclei. Disintegration theory: Nuclear stability and group displacement law. Synthesis of radioisotopes: ^{14}C, ^{3}H, ^{35}S, ^{36}Cl, ^{82}Br, ^{131}I, ^{32}P. Contribution of the discovery of artificial radioactivity in the field of heavy element chemistry.

2 **Detection and measurement of radioactivity:** Ionization chamber, Geiger- Muller, proportional, scintillation counters, Wilson cloud chamber, Health physics instrumentation: Film badges, Pocket ion chambers, portable counters and survey meters, Accelerators: Van de Graff and cyclotron.

3 **Nuclear fission and fusion. Nuclear reactor:** Characteristics of nuclear reactors and their applications. Nuclear reactors in India. The four factor formula:The reproduction factor, reactor power, life and critical size of reactor, and breeder

4 **Isotope effects and isotopic exchange reactions:** Isotope effect: Definition, physical and chemical isotope effects. Generalities of isotope effects. Isotopic exchange: basic concept, characteristics of isotopic exchange, mechanism of isotopic exchange, kinetics of homogenous and heterogeneous isotopic exchange reactions, self-diffusion, and surface measurements.

5 Primary radiation – Chemical Process, Direct interaction of radiation with matter, ionization, excitation, neutron impact. Basic reactions involving active species produced in the primary act, and Radiation dosimetry.

6 **Tracer:** selection of radioisotopes as tracer, Application of radioisotopes as tracers-analytical, physico- chemical, medical, agriculture and industrial applications. Neutron activation analysis. Radiometric titrations and isotope dilution techniques. Radiopharmaceutical, radioimmunoassay and radiation sterilization.

Reference Books

1. Nuclear Chemistry and its applications – By. Haissionsky – Addison Wesley
2. Nuclear and Radio Chemistry – By. G. Friedlander, J. W. Kennedy, E. S. Macias and J. M. Miller – A Wiley – Interscince Publication, John Wiley and Sons –
3. III rd Edition.
4. Radio Chemistry – By An. N. Nesmeyanov, Mir Publishers.
5. Artificial Radioactivity – By. K. Narayana Rao and H. J. Arnikar – Tata McGraw Hill Publishing Company Ltd. New Delhi

M.Sc. SEMESTER-IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM) –403: ELECTROANALYTICAL TECHNIQUES

1. **Basic electro analytical chemistry:** Electrochemical cells, cell potentials, electrode potentials, calculation of cell potentials and currents in electrochemical cells. Types of polarization. Types of electro analytical methods. Problems.
2. **Ion selective electrodes:** Types of ion-selective electrodes: Glass, liquid ion-exchange membrane, neutral carrier membrane, coated wire, gas sensing, air gap and biomembrane electrodes. Theory of ion selective electrode and ion-selectivity coefficient. Problems.
3. **Polarography and voltametry:** Introduction and classification of polarographic techniques: DC, AC, differential, pulse and square wave polarography. Types of polarographic currents, principles and instrumentation. Derivation of Ilkovic equation Applications of polarographic techniques. Striping vvoltmetry. Problems
4. **Amperometric titrations:** Principles and amperometric titration techniques: Dropping mercury electrode, rotating platinum microelectrode and dead stop
5. **Electro gravimetry and coulometry:** Current-voltage relationship during electrolysis. Effect of current on cell potential and over voltage. Selectivity of electrolysis. Electrolysis at constant working electrode potentials. Typs of coulometric methods: Potentiostatic and amperostatic. Principles, instrumentation and applications. Problems.

Reference Books

1. Introduction to Instrumental Analysis, R. D. Braun, McGraw-Hill Book Company, New Delhi
2. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edn. Pearson Education Asia
3. Analytical Chemistry, An Introduction, D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch,7th. Edn., Saunders College publishing, N. Y.
4. Principles of Instrumental Analysis, D. A. Skoog and J. J. Leary, 4th Edn., N. Y.
5. The Principles of Electrochemistry, A. Duncan, Mac Innes Dover Publication Inc. N. Y.

M.Sc. SEMESTER-IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)-404: CHEMISTRY OF MATERIALS II

1. **Thermal analysis of materials:** Importance and applications of thermal analysis in various fields of chemistry. Effects of various operating parameters on thermal analysis. Derivation of general kinetic relationship. Single and multiple heating rate methods for DSC/DTA and TGA techniques.(For DSC/DTA: Kissinger, Ozawa, Borchardt and Daniels, Reich and Freeman-Carroll methods. For TGA: Freeman-Anderson, Chatterjee, Friedman, Ozawa and Flynn and Wall methods). Determination of thermal stability indexes, softening temperature, flammability and glass transition temperature. Problems.
2. **Visco-elastic behavior of polymers:** Introduction, Linear visco-elastic behavior: Maxwell and Kelvin-Voigt models and creep behavior. Stress relaxation and dynamic mechanical behavior. Mechanical spectra. Effect of molecular weight, cross link density, crystallinity, tacticity, plasticizers, blending and copolymerization on mechanical properties. Mechanical tests: Stress-strain properties in tension. Fatigue test, impact test, tear resistance, abrasion resistance, hardness.
3. **Optical properties:** Transparent, opaque and translucent materials, color, gloss, haze and transparency.
4. **Electrical properties:** Volume resistivity, dielectric constant and loss factor, dielectric strength, arc resistance and electronic properties. Electrical conductivities of solid polymers. Contact electrification and electrets. Frequency and temperature dependence of dielectric constant and loss. Factors affecting dielectric properties. Problems
5. **Composite materials:** Introduction, principles, properties and classification of fiber- reinforced composites. Particulate composites dispersion - hardened composites. Mechanism of strengthening.
6. **Polymer processing:** Types of plastics, elastomers and fibers. Compounding and processing techniques: Calendaring, diecasting, rotational casting, film casting,

compression molding, injection molding, blow molding, extrusion molding, thermo forming and foaming.

Reference Books

1. Text-book of Polymer Science, F. W. Billmeyer, Willey Interscience.
2. Polymer Science, V. R. Gowariker, N. V. Vishwanathan and J. Shreedhar, Willey Eastern Ltd., New Delhi.
3. Physical Chemistry of Macromolecules, D. D. Deshpande, IIT, Bombay
4. Nanotechnology, M. Ratner and D. Ratner. Pearson.

M.Sc. SEMESTER-IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM) 405 & 406 : PRACTICALS

C(PM)-407 : VIVA-VOCE EXAMINATION

M.Sc. SEMESTER-III

ANALYTICAL PHARMACEUTICAL CHEMISTRY

C(AP) 301: SEPARATION TECHNIQUES

1. **Adsorption & partition chromatography:** History, Classification, Definition of terms; Principle & basic theory. Column adsorption chromatography: Technique, Applications.
2. **Partition chromatography:** (i) Column (ii) paper (iii) TLC Technique, Applications.
3. **Band broadening & column efficiency:** Factors affecting, Plate theory & Rate theory of chromatography, Definition of terms, Limitations.
4. **HPLC:** Instrumentation, Working and Applications.
5. **GLC:** Principle, Instrumentation, Working, Stationary phases, Applications.
6. **Ion Exchange chromatography:** Principle & Applications.
7. **Affinity chromatography:** Principle & Applications.
8. **Hyphaneted techniques:** GC-MS, GC-TLC, LC-MS etc. Principle & Applications.
9. **Recent Advances in Chromatographic Techniques**.

Reference Books

1. Thin layer chromatography, E. Stahl.
2. Chromatography, Heptman.
3. HPTLC, Dr.P.D. Sethi.
4. High Performance liquid chromatography, Dr.P.D. Sethi
5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W.B. Saunders.
6. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
7. Principles of Instrumental analysis, D.A. Skoog and W.B. Saunders.

M.Sc. SEMESTER-III

ANALYTICAL PHARMACEUTICAL CHEMISTRY

C (AP) 302: PHARMACEUTICAL TECHNOLOGY

1. Principles involved in and methods used for extraction of crude drugs, preparation of tinctures spirits, lotions, creams, ointments, cosmetics and internally administered solution.
2. Pharmacopeal standards and limit test for trace elements arsenic, iron, lead, mercury, cadmium , chloride, sulphate, initiate etc..
3. Study of antimicrobial and antifungal activity microbiological assay of vitamins and antibiotics.
4. **Natural Products:** Extraction, Isolation, Characterization of essential constituents of medicinally important plants.
5. **Solvent Extraction methods in analysis:** The distribution law, Extraction Process, liquid-liquid extraction, Factors affecting extraction, Techniques for solvent extraction, completion of analysis, Classification, Types of Extraction System, Transition of substances from an aqueous phase solid-liquid extraction.
6. **Pharmaceutical analysis.**

Reference Books

1. Pharmaceutical Analysis- Takery Higuchi and Einas Brochmann – CBS publication.
2. Quantitative analysis of Drugs in pharmaceutical Formulations – P. D. Shethi
3. Chemistry of Natural Products – S. V. Bhat, B. A. Nagasampagi
4. Natural Products – Grudeep and Chatwal
5. Indian, British and U. S. Pharmacopea

M.Sc. SEMESTER-III

ANALYTICAL PHARMACEUTICAL CHEMISTRY

C (AP) 303: ADVANCED ANALYTICAL METHODS AND INDUSTRIAL ANALYSIS

1. **Radio analytical techniques**: Introduction, Units of radiation, Classification of radioactive isotopes, Detection and measurement of radioactivity, Tracer technique and application, Radio chromatography, Isotopic dilution analysis, Activation analysis, Neutro absorptiometry, Radiometric analysis.
2. **X-ray Analysis**: Introduction, Mosley law, Absorption of X-rays, X-ray detection and measurement, X-ray instrumentation, X-ray spectrometers, X-ray emission absorption methods, Bragg's law, Diffraction methods, X-rays production and detection, Quantities analysis.
3. **Surface analysis by electron spectroscopy:** Principle of electron spectroscopy, Auger emission spectroscopy, Instrumentation for electron spectroscopy, Applications of auger electron spectroscopy, electron spectroscopy for chemical analysis, chemical shifts in ESCA, Analytical applications of ESCA.
4. **Polarimetry and spectropolarimetry:** Introduction, Polarized light, Optical activity, Specific rotation measurement of rotatory power, Optical rotatory, dispersion and circulardichroism, Instrumentation and applications, Saccharimetry.
5. **Analysis of Industrial products:** Pesticides and Insecticides analysis based on ISI specification of BHC, DDT, Phosphomidon, Dichlorovos, Endosulphan, Phorate, Malathion, Parathion etc. Soap and synthetic detergent analysis, Protective coating analysis: Paint, Varnish, and Lacquers etc. Cement and Fertilizers.

Reference Books

1. Fundamentals of analytical chemistry - D. A. Skoog, D. M.West, F. J. Holler and Crouch
2. Analytical Chemistry – G. D. Christian
3. Quantitative Analysis –R. A. Day Jr. and A. L. Underwood

4. Analytical Chemistry – Principles –J. K. Kennedy and W. B. Saunders
5. Instrumental Methods of Chemical Analysis- B.K. Sharma
6. Principles of Instrumental Analysis – D. A. Skoog and W. B. Saunders
7. Instrumental Methods of Chemical Analysis – Willard, Merit and Dean
8. Vogel's Textbook of quantitative Inorganic Analysis – L. Barrt et al. ELBS
9. Hand Book of Instrumental Techniques for Analytical Chemistry – Frank Settle

M.Sc. SEMESTER-III

ANALYTICAL PHARMACEUTICAL CHEMISTRY

C (AP) 304: ENVIRONMENTAL CHEMISRY

1. Important terminology & definitions, introduction to sources of air & water pollutants, Earth-atmospheric energy balance system. Types of particulates & their collection methods.
2. Methods of sampling, sampling techniques in air and water analysis, methods & instrumentation used in pollution control & monitoring
3. Principles, chemical reactions & method of analysis of important air pollutants, water & waste water analysis in a different parameters (anionic, cationic, DO, COD, BOD, heavy metals, etc.) biological role of toxic elements, Various cycles involved in atmospheric chemistry.
4. **Water pollution treatment**: Principles and current practices, primary, secondary & tertiary treatments importance of biological treatments, case study of environmental treatment plan of typical industries (chemical, Pharmaceutical, chrome, plating, dyes , leather, etc.).
5. Biodiversity and other ecological aspects, sustainable development, green chemistry, ecofriendly processes, atom economy, management of environmental problems in chemical industries identification of regional problems
6. Environmental laws, statutory requirements, environmental impact assessment study, visit and study report of environmental problems, solutions, ETP in different industries.

Reference Books

1. Environmental Chemistry by A. K. De.
2. An Introduction to air pollution by R. K. Trivedi and P. K. Goel.
3. Principles of Environmental Chemistry by H. Kolhandaraman and Geetha Swaminathan.
4. Atmospheric Pollu8tion By Black. W. (McGrow Hill Company) New York.

5. A Textbook of Environmental Chemistry and Pollution Control by S. S. Dara (S. Chand & Company) New Delhi.
6. Ecology of Polluted waters and Toxicology by K. D. Mishra.
7. Environmental Guidelines and Standards in Indian by P. K. Goel & K. P. Sharma.
8. Enzyme Biotechnology by G. Tripathi.
9. Industry, Environment and Pollution by Arvind Kumar and P. K. Goel.
10. Manual on water & waste water analysis by Neeri.
11. Water Pollution by Dr. V. P. Kudesia.
12. Basic concepts of Environmental Chemistry by Des W. Connell.
13. Manual on Water and Wastewater analysis by Dr. B. B. Sundarsan.
14. Liquid waste of Industry: Theories Practices and Treatment by Nelson L. Nemerow.

C (AP) -305 & 306: PRACTICALS

1. Industrial Products Analysis: Agrochemicals Dyes Drugs Miscellaneous.
2. Ores and Alloys.
3. Analysis of Water.
4. Instrumental Analysis.

C(AP)-307 : VIVA-VOCE EXAMINATION

M.Sc. SEMESTER-IV

ANALYTICAL PHARMACEUTICAL CHEMISTRY

C(AP) 401: SELECTED TOPICS IN CHEMISTRY

1. Statistical data analysis:

i. Classification and definitions of errors. Accuracy, precision, standard and pooled precision deviations. The t-test when an accepted value is known, paired t-test, t-test

ii. with multiple samples. Rejection of data (Q-test), control charts and linear least squares. Statistical consideration in radio activity.

2. Use of computer in chemistry and industry determining patents, intellectual property rights and documentation aspects in various regulatory affairs.

3. Unit processes & unit operations, Nitration, oxidation, reduction, sulphonation, Animation and other unit processes.

4. Size reduction, Mixing, crystallization, distillation, purification methods, chiral separation scale up operations from lab to Kilo scale & pilot plant operations.

5. Catalysis in industrial applications. Phase Transfer catalyst, concept of Green Chemistry & atom economy isolation of natural product based drugs & Aromatics & neutraceuticals.

6. Nano Technology:

a. Introduction of nano materials and their size, the fundamental science behind nanotechnology.

b. Ref. Nanotechnology, M. Ratner and D. Ratner, Pearson

7. Pro-drugs, drug delivery systems, polymorphism

8. Selected topics in natural and synthetic food colors, synthetic dyes in current use

Note: Visit to industries related to above course study and report writing of visit (Compulsory assignment for each candidate)

M.Sc. SEMESTER-III

ANALYTICAL PHARMACEUTICAL CHEMISTRY

C (AP) 402: PHARMA REGULATORY AFFAIRS

1. **Pharmaceutical products-their manufacturing.**
2. **Analytical aspect.**
3. **Documentation required for filing parent.**
4. **Product registration and their requirement looking to WHO-GMP.**
5. **European DMF.**
6. **US-FDA regulations.**
7. **ICH guidelines.**
8. **Pharmacopael and extra Pharmacopaeal entry.**
9. **Chemical physical biological (Clinical), data documentation.**
10. **Patent writing art and introduction of concept of non-infringing patent ability**
11. **looking to GATT-WTO scenario.**
12. **Computer based data mining in drug research.**
13. **Pharmaceutical product management aspect.**

Reference Books

1. Guidelines on GMP/GLP by S. Lyer.

M.Sc. SEMESTER-III

ANALYTICAL PHARMACEUTICAL CHEMISTRY

C(AP) 403: ELECTROANALYTICAL TECHNIQUES

1. **Basic electro analytical chemistry:** Electrochemical cells, cell potentials, electrode potentials, calculation of cell potentials and currents in electrochemical cells. Types of polarization. Types of electro analytical methods. Problems.
2. **Ion selective electrodes:** Types of ion-selective electrodes: Glass, liquid ion-exchange membrane, neutral carrier membrane, coated wire, gas sensing, air gap and biomembrane electrodes. Theory of ion selective electrode and ion-selectivity coefficient. Problems.
3. **Polarography and voltametry:** Introduction and classification of polarographic techniques: DC, AC, differential, pulse and square wave polarography. Types of polarographic currents, principles and instrumentation. Derivation of Ilkovic equation Applications of polarographic techniques. Striping volumetric. Problems.
4. **Amperometric titrations:** Principles and amperometric titration techniques: Dropping mercury electrode, rotating platinum microelectrode and dead stop
5. **Electro gravimetry and coulometry:** Current-voltage relationship during electrolysis. Effect of current on cell potential and over voltage. Selectivity of electrolysis. Electrolysis at constant working electrode potentials. Typs of coulometric methods: Potentiostatic and amperostatic. Principles, instrumentation and applications. Problems.

Reference Books

1. Introduction to Instrumental Analysis, R. D. Braun, McGraw-Hill Book Company, New Delhi .
2. Vogel's Textbook of Quantitative Chemical Analysis, 6thEdn. Pearson Education Asia
3. Analytical Chemistry, An Introduction, D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch,7th. Edn., Saunders College publishing, N. Y.
4. Principles of Instrumental Analysis, D. A. Skoog and J. J. Leary, 4th Edn., N. Y.
5. The Principles of Electrochemistry, A. Duncan, Mac Innes Dover Publication Inc. N. Y.

M.Sc. SEMESTER-III

ANALYTICAL PHARMACEUTICAL CHEMISTRY

C (AP) 404: SELECTED METHODS OF ANALYSIS

1. **Automation in chemical analysis:** Introduction, difference of automatic and automated instrument, merits and demerits of automation, unit operation in chemicals analysis, flow injection analysis-principle, instruments and applications, discrete automatic systems, elemental analyzer, centrifugal analyzer
2. **Atomic spectroscopy:** Origins of atomic spectra, production of atoms and ions, atomic emission spectrometry, atom absorption spectrometry
3. **Thermal methods of chemical analysis:** Thermogravimetry, Differential thermal analysis, Thermometry titration and Differential scanning calorimetry: Principle, methodology, instrumentation and applications
4. **Raman spectroscopy:** Raman effect, Mechanism of Raman effect, Advantages and differences of Raman spectroscopy over IR spectroscopy, Difference between fluorescence and Raman spectroscopy, Nature of Raman spectra, Theory spectroscopy, Raman effect and molecular structure, Advances and limitation of Raman spectroscopy
5. **Electro chromatography:** Principle of electrophoresis, experimental assembly zone electrophoresis, Curtain electrophoresis, Applications of electro chromatography, Reverse osmosis, Electro dialysis, Capillary electrophoresis and applications.
6. **Ion Exclusion Chromatography:** Mechanism, matrices used, theory, and applications.

Reference Books

1. Fundamentals of analytical chemistry - D. A. Skoog, D. M.West, F. J. Holler and Crouch
2. Analytical Chemistry – G. D. Christian
3. Quantitative Analysis –R. A. Day Jr. and A. L. Underwood
4. Analytical Chemistry – Principles –J. K. Kennedy and W. B. Saunders
5. Instrumental Methods of Chemical Analysis- B.K. Sharma

6. Principles of Instrumental Analysis – D. A. Skoog and W. B. Saunders
7. Instrumental Methods of Chemical Analysis – Willard, Merit and Dean
8. Vogel's Textbook of quantitative Inorganic Analysis – L. Barrt et al. ELBS
9. Hand Book of Instrumental Techniques for Analytical Chemistry – Frank Settle

C (AP) -405 & 406: PRACTICALS

1. Separation methods of Analysis: Paper Chromatography, TLC, Column Chromatography, Ion-Exchange Chromatography.
2. Solvent Extraction Techniques.
3. Visit to various industries, research institutes, laboratories for analytical methodologics used.
4. Viva Voce Examinations.

C(AP)-407 : VIVA-VOCE EXAMINATION