SAURASHTRA UNIVERSITY

SYLLABUS

M. Sc. CHEMISTRY

Semester I IV [CBCS]

Theory and Practical

[Effective from June 2016]

M.Sc. SEMESTER-I

C-101: INORGANIC CHEMISTRY

4 CREDITS

100 MARKS

1. Quantum Chemistry 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. Huckelπ-electron theory and its applications to ethylene, butadiene and benzene.Idea of self-consistent field method.

2. Magneto chemistry

Introduction, definition, types of magnetic bodies, Russell-Saunders and LS coupling. Derivation of Russell-Saundersterms, spin-orbit interaction, thermal energy and magnetic property. Magnetic moment for different multiple widths,multiple width large compared to kT, multiple width small compared to kT. Multiple widthcomparable to kT.Stereo chemical applications of magnetic properties of the first transition series, lanthanides and actinides, determination of magnetic susceptibility by different methods.Derivation of Van Vleck formula for susceptibility.

3. Fundaments of Mössbauerspectroscopy

Introduction of Mössbauer Spectroscopy. Principle and evaluation of Mössbauereffect. Recoil energy, Doppler effect. Experimental techniques.Isomer shift, quadrupole splitting and applications.

4. Uses of Inorganic reagents in inorganic analysis

General discussion and uses of some inorganic reagents: Potassium bromate ($KBrO_3$), potassium iodate($KI0_3$), ammonium vanadate (NH_4VO_3), ceric sulphate [$Ce(S0_4)_2$], ethylenediaminetetra acetic acid (EDTA).

5.Chemistry in nanoscience and technology

Introduction, definition of nanomaterials andnano technology.History of nanomaterials, causes of interest in nanomaterials, properties and types. Synthesis of nanomaterials, their characterization techniques and applications of nanomaterials .

Reference Books

1. Introduction to Quantum Chemistry, A. K. Chandra, McGraw-Hill.
2. Advanced Inorganic Chemistry, Cotton Wilkinson, W S E Wiley.
3. Vogel's Text book of Quantitative Inorganic Analysis, ELBS Press.
4. Elements of Magneto Chemistry, Shyamal&Datta East- West Press.
5. Quantum Chemistry, Ira N. Levine, Prentice-Hall International.
6. Textbook of Inorganic Chemistry Vol.I& II, A.Singh & R.Singh, Campus.
7. Physical Methods in Chemistry, R.S.Drago , Saunders College.

8. Introduction to Magnetochemistry, Alan Earnshaw, Academic Press.
9. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood publishing, Chichester) 1999.
10. Nano Science and Nanotechnology in Engineering, by V. K. Varadhan, A. S. Pillai, D. Mukharjee, M. Dwivedi and L. Chen, World Scientific Publishing Company, Pvt. Ltd.
11. Nano: the Essentials, T. Pradeep, Tata Mc Graw Hill, 2007.
12. Nanotubes and Nanowires, C.N.R. Rao, A. Govindaraj, Royal Society of Chemistry,2011.

M.Sc. SEMESTER-I

C-102: ORGANIC CHEMISTRY

4 CREDITS

100 MARKS

1. **Organic reactive intermediates and reaction mechanism**
   Generation, stability and reactivity of intermediates, addition, elimination and substitution reactions.Determination of reaction pathways. Hammett equation and LFER relationship.
2. **Name reactionand its application in organic synthesis**
   Barbier–Wieland degradation , Prins, Barton, Vilsmer-Haack, *Bouveault–Blanc reduction,* Willgerodt-Kindler reaction, Biginelli reaction, Birch-reduction,Hofmann-Loffler Freytag, Hantzch, Elbs-persulphate, McMurry reaction, Noyori annulation reaction, Passerini, Reformatsky, Suzuki coupling, Stille coupling Sharplessasymetric epoxidation, Stobbecondensation, and Ugi reaction.
3. **Rearrangements**
   Advances in Fries rearrangement, Beckmann rearrangement, Benzilbenzilicacid, Favorskii, Neber, Sommelet Hauser, Curtius, Schimidt, BaeyerVilliger.
4. **Important Reagents**
   DCC, Gilman reagent, PTC andcrown ethers, Merrifield resin, Woodward and Prevost hydroxylation, reagent for hydroboration, TMS-I, Wilkinson's catalyst, DDQ.

Reference Books

1. Organic Chemistry by G. Marc. Loudon, Oxford University Press (2002).
2. Organic Reaction Mechanism (2^{nd} edition) – V.K. Ahluwalia and R.K. Parasar.
3. Reaction Mechanism and Reagents in Organic Chemistry – Gurdeep R. Chatwal.
4. Organic Chemistry by Morrission and Boyd, Prentice Hall Pvt Ltd (6^{th} edition), (2003)
5. A Text Book of Organic Chemistry-R.K.Bansal, New Age International Pvt.Ltd. 4^{th} edition (2003).
6. Advanced Organic Chemistry (4^{th} edition) – Jerry March.
7. Reactive Intermediates in Organic Chemistry. J. P. Trivedi, University GranthNirman Board.
8. Organic Chemistry by V.K.Ahluwalia, Madhuri Goyal, Narosa Publishing House, (2000).
9. Organic Synthesis (2^{nd} edition) by M.B. Smith, Mcgraw-Hill, Inc. (2001).
10. Some Modern Methods of Organic synthesis (4^{th} edition), W.Carruthers, Cambridge University Press (2004).
11. Organic Chemistry by J.Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press (2000).
12. Organic Chemistry by J. Mcmurry, Asian Books Pvt. Ltd., 5^{th} edition (2001).
13. Name Reaction in Organic Synthesis, Foundation Books Pvt. Ltd. (2006)

M.Sc. SEMESTER-I

C-103: PHYSICAL CHEMISTRY

4 CREDITS

100 MARKS

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, determination of fugacity by graphical, equation of state, approximate and generalized methods.Variation of fugacity with temperature and pressure.Mixture of ideal gases and real gases.Activities and Activity coefficients in liquid solution.Problems.
3. **The Debye-Huckel Theory**
   Ionic interactions in solutions.Mean ionic activity coefficients (D-H limiting law).Applications of D-H theory: quantitative and qualitative, solubility and D-H theory,solubility of sparingly soluble salt in presence of inert electrolyte. 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, liquid and vapor compositions.
   Dilute solutions: Determination of molecular weight by freezing and boiling point methods.Problems.
5. **Electrochemical cells**
   Classification, chemical cells with and without transference, concentration cells with and without transference, liquid junction potential.
   Commercial cells: Dry cell, lead accumulator, nickel iron accumulator, zinc silver accumulator.

Reference Books

1. Thermodynamics for Chemists by Samuel Glasstone.
2. Statistical Thermodynamics by L. K. Nash.
3. Statistics in Chemistry by P. H. Parsania.
4. Thermodynamics by Gurdeep and Rajesh.
5. Glimpses of Physical Chemistry by ShipraBaluja and FalguniKaria.
6. Chemical Kinetics by Gurdeep Raj.
7. Chemical Kinetics by K. J. Laidler.
8. Electrochemistry by B. K. Sharma.

M.Sc. SEMESTER-I

C-104: ANALYTICAL CHEMISTRY

4 CREDITS

100 MARKS

1. **Basic concept of Analytical Chemistry**

   Introduction, scope and objectives, Classification of analytical methods.Basics of classical and instrumental methods of analysis.Method of selection, sample processing, steps of total quantitative analysis, the tools of analytical chemistry and good laboratory practises.
   Basic of volumetric methods of analysis: General principle, concentration units, standard solution and standardization, detection of end point, indirect and back titration techniques. Minimization of titration errors, types of reactions in titrimetric analysis.
   Non-aqueous titrations: Role of solvents, properties of solvents, autoprotolysis and dielectric constant. Titration of acids-bases, solvent system, titrants, standard titration curves, effect of water, end point detection, application to determination of carboxylic acid, phenols and amines.

2. **Spectroanalytical Techniques**

   Fundamental of spectroscopy,electromagnetic radiations and their properties.Introduction to absorption and emission spectroscopy.Lambert-Beer law.
   Atomic absorption spectroscopy: Basic principle, theory, instrumentation and applications. Advantages over flame photometry.
   Fluorometry and Phosphorimetry: Introduction, principle, theory, instrumentation and applications.
   UV-Visible spectrophotometric titrations.

3. **Edible oil Analysis**

   Basic terminology, analytical importance and quantitative determination of oil, fat, wax, iodine value, saponification value, RMPK value, hydroxyl value, moisture, etc.
   Detection of oil adulterants: (1) Argemone oil, (2) Rice bran oil, (3) Sesame oil, and (4) Palm oil.

Reference Books

1. Vogel Textbook of Quantitative Analysis, 3rd and 7th Edition.
2. Analytical Chemistry by Gary D. Christian, 6thedition(1994), John Wiley and Sons Inc. New York,
3. Principle of Instrumental Analysis by Douglas A. Skoog, 5th Edition (1998)-Saunders College of Publishing Philladelphia, London.
4. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House Fifth Revised and Enlarged Edition.
5. H.H. Willard, L.L. Merrit, J.A. Dean, Instrumental Methods of Analysis, 5thEdn. Van Nostrand, 1974 and 6thEdn. CBS (1986).
6. Instrumental Methods of Chemical Analysis by B.K. Sharma, Goel Publishing House, Meerut(UP).

7. H. Kaur, Spectroscopy, 6th Edn. PragatiPrakashan, 2001.
8. D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch Fundamentals of Analytical Chemistry 8th Edn. Saunders College Pub.2001.
9. G.G. Bizch, M. Spencer, G. Cameron, Food Science, 3rd Edn. Pergamon Press. 1986.
10. Hand Book of Food Analysis by S.N. Mahindru, Swan Publishers, New Delhi.
11. Analytical Chemistry by H. Kaur, PragatiPrakashan Meerut.

M.Sc. SEMESTER-I

C-105: PRACTICALS

6 CREDITS

150 MARKS

INORGANIC CHEMISTRY

1. **Inorganic Qualitative Analysis**

   Analysis of a mixture containing six radicals including one less common metal ion: W, Tl, Ti, Mo,Se, Zr, Th, Ce,V and Li.

   Minimum 15 mixtures containing inorganic salts like $CuSO_4$, KBr , TiO_2 , KI, Na_2CrO_4, $CaCO_3$, $Zr(NO_3)_3$, $NaNO_3$, ZnS, Na_2SO_4, SeO_2, NaCl, K_2SO_4, $(NH_4)_2SO_4$, $(NH_4)_2MoO_4$, $BaCl_2$, $ZnCO_3$, $Al_2(SO_4)_3$, V_2O_5, ZnS, $Ni(NO_3)_2$, KNO_2, $Th(NO_3)_3$, KCl, $CdCO_3$, $CuCl_2$, $LiCO_3$, K_2SO_4, $AlPO_4$, H_3BO_3, $(NH_4)_2SO_4$, $CeSO_4$, $CdCl_2$, $Th(NO_3)_3$, $NaNO_3$, $ZnCO_3$, $AlPO_4$, $LiCO_3$, $Pb(NO_3)_2$, $NaNO_2$,$Zr(NO_3)_3$, Na_2WO_4, $MnSO_4$, $NaHSO_3$, SeO_2, K_2CrO_4, $FeSO_4$, $(NH_4)_2SO_4$, $(NH_4)_2MoO_4$, Na_3AsO_3, Na_3AsO_4, $(NH_4)_2SO_4$, K_2SO_4, $CeSO_4$, As_2O_3, NH_4Cl, $NiSO_4$, $LiCO_3$, $MgCO_3$, $NaNO_2$, $Mg_3(PO_4)_2$, V_2O_5, H_3BO_3, $SrCO_3$, $Th(NO_3)_3$, Na_3AsO_3, Na_3AsO_4, $BaCO_3$ and $LiCO_3$.

2. **Inorganic Preparation Binuclear and Mono Nuclear Metal Complexes**

   Preparation of selected inorganic metal complexes and their estimation by volumetric/gravimetric/colorimetric techniques to determine the percentage purity of the complexes prepared.

   a. Tetrammine cupric sulphate $[Cu(NH_3)_4]SO_4 \cdot H_2O$.
   b. Tri (thiourea) cuprous sulphate $[Cu(NH_2CSNH_2)_3]_2 SO_4 2H_2O]$.
   c. Tri (thiourea) cuprous chloride $[Cu(NH_2CSNH_2)_3] Cl$.
   d. Hexa ammine nickel(II) chloride $[Ni(NH_3)_6] Cl_2$.
   e. Hexathiourea–plumbus nitrate $[Pb(NH_2CSNH_2)_6] (NO_3)_2$.
   f. Potassium trioxalato chromate $K_3 [Cr(C_2O_4)_3]$.
   g. Potassium trioxalato aluminate $K_3 [Al(C_2O_4)_3]$.
   h. sodium trioxalate ferrrate(III) $Na_3 [Fe(C_2O_4)_3] 9H_2O$.
   i. Hexamminecobalt(III) chloride $[Co(NH_3)_6] Cl_3$.
   j. Pentathioureadicuprous nitrate $[Cu(NH_2CSNH_2)_5] (NO_3)_2$.
   k. Iron(III) acetylacetonate $Fe(acac)_3$ / $Fe(C_5H_7O_2)_3$

3. **Quantitative Analysis**

   Estimation of the metal complexes by different techniques to determine the percentage purity quantitatively of the complexes.

   a. Cu-EDTA (Volumetrically) and Cu-KCNS(Gravimetrically).
   b. Ni- EDTA (Volumetrically) Ni- DMG (Gravimetrically.)
   c. Co- EDTA (Volumetrically).
   d. Cr- EDTA–$Pb(NO)_2$ (Volumetrically, Back Titration).
   e. Al- EDTA –$ZnSO_4$ (Volumetrically, Back Titration).
   f. Oxalate -$KMnO_4$(Volumetrically).

ORGANIC CHEMISTRY

1. **Multistep Preparation**
   a. m-Nitro aniline from nitrobenzene.
   b. Hydro quinone diacetate from hydroquinone.
   c. p-Methyl acetanilide from p-toluidine.
   d. p-,Bromo-aniline from aniline.
   e. 7-Hydroxycoumarine from resorcinol.
   f. Hippuric acid from glycine.
   g. Aspirin from salicylic acid
   h. Phthalamide from phthlic acid.
   i. Magneson-II (4,(4' nitro benzene azo 1)naphthol) from p-nitroaniline.
   j. Benzimdazol from o-nitroaniline.
   k. Resacetophenone from resorcinol.
2. **Qualitative Analysis of Bi-functional Compounds:**
   a. Anthranilic acid
   b. p-Aminobenzoic acid
   c. o-Chlorobenzoic acid
   d. m-Nitrobenzoic acid
   e. o/m/p-Nitroaniline
   f. Bi-phenyl amine
   g. N,N-Dimethyl aniline
   h. Resorcinol
   i. Ethyl acetoacetate
   j. P-Dichlorobenzene
   k. o/p-Cresol
   l. o/m/p-Toluidine
   m. Benzanilide
   n. Acetamide
   o. α/β-Naphthole,etc.

NOTE: Other bifunctional compounds may be asked in examination.

PHYSICAL CHEMISTRY

Conductometry

1. To determine the concentration of HCl / CH_3COOH / Oxalic acid/ HCl + CH_3COOH+ CuSO4/ Satd BA/ NH_4Cl/CH_3COONa/ mix of CH_3COONa + NH_4Cl.
2. To study the complexation of Ni^{+2} with EDTA.
3. To determine the equivalent conductance and dissociation constant of a weak electrolyte and to verify Oswald's dilution law.
4. To determine the equivalent conductance of a strong electrolyte and hence to verify the Ostwald's equation.
5. To determine the degree of hydrolysis and hydrolysis constant NH_4Cl/ CH_3COONa.

pHMetry

6. To determine the dissociation constant of benzoic/acetic / lactic acid.
7. To determine the concentration and amount of acid in a mixture of hydrochloric acid and acetic acid.
8. To determine the concentration and dissociation constants of a dibasic acid (oxalic acid).
9. To determine the dissociation constant of acetic acid (Buffer).

Potentiometry

10. To determine the normality and dissociation constant of the given acid (satd. BA).

11. To determine the normality and dissociation constants of the given dibasic acid (oxalic acid).

12. To determine the normality ofhydrochloric acid and acetic acid in the mixture.
13. To determine the standard redox potential and thermodynamic parameters of the Fe^{+2} ion.
14. To determine the concentration of KCl and the solubility product of AgCl.
15. To determine the normality of each halide in the mixture of halides.
16. To determine the standard oxidation potential of the quin hydroneelectrodel.

Spectrophotometry

17. To examine Lambert-Beer law in concentrated solution.
18. To study the rate of iodination.
19. To determine the composition of binary mixture containing potassium permanganate and potassium dichromate.

Ultrasonics

20. To determine the acoustical parameters of a given liquid.

Chemical kinetics

21. To determine the reaction velocity and reaction rate constant for the reaction between acetone and iodine.
22. To determine the heat and entropy of vaporization of a given liquid by kinetic approach.

23. To determine the kinetic parameters and temperature coefficient of reaction between $KBrO_3$ and KI.

24. To determine the kinetic parameters and the temperature coefficient of the reaction between $K_2S_2O_8$ and KI.

Thermodynamics

25. To determine the solubility and heat of solution of benzoic acid in toluene.

26. To determine the partial molar volume and the composition of unknown mixture of ethanol/methanol and water.

Partition function

27. To determine the distribution coefficient of benzoic acid between toluene and water at room temperature and hence to prove the dimerization of benzoic acid in toluene.

28. To determine the equilibrium constant for the reaction between iodide and iodine by the method of distribution.

Refractometer

29. To determine the molar refraction and refractive index of a given salt.
30. To study the variation of refractive index with composition of a given liquid and also to determine the composition of unknown mixture.

Polarimeter

31. To determine the concentration of an unknown solution of optically active compound.
32. To determine the specific and molecular rotation of cane sugar and hence intrinsic rotation.

ANALYTICAL CHEMISTRY

1. Preparation and standardization of 0.1N HCl, 0.1N H_2SO_4 and 0.1N HNO_3, against 0.1N NaOH solution as well as other strength of solutions. Find mean, standard deviation and other statistical parameters.
2. Preparation and standardization of 0.1N and 0.5N solution of NaOH and standardized against potassium hydrogen phthalate and succinic acid. Find mean, standard deviation, t-test and F-test.
3. Preparation and standardization of 0.1N or 0.1M I_2 solution and standardized against standard thiosulphate solution and other standardization solutions.
4. To determine the amount of iodine in iodized salt.
5. To determine the amount of vitamin-C (ascorbic acid) in a given sample.
6. To determine the percentage of reducing sugars in Honey sample.
7. To determine the saponification value of an oil or fat sample.
8. To determine the percentage of tannin in tea leaves.
9. To determine the percentage of calcium gluconate in the given commercial sample by complexometric titration.
10. To determine the amount of aspirin in a given sample.
11. To determine the iodine value of an oil or fat.
12. To estimate the amines using bromate-bromides solution (Bromination) method.
13. To estimate the calcium and magnesium in the given mixture solution of both by EDTA complexometric method. (50ml of mixture solution of Ca^{+2} and Mg^{+2} (25ml Ca^{+2} solution from $CaCO_3$ 10gm/L and 25ml Mg^{+2} solution ($MgCO_3$ 8.4 gm/L) use minimum quantity of dil. HCl (1ml) for Ca^{+2} and Mg^{+2} solution).
14. To determine chloride and bromide ion by precipitation titration method.
15. To determine barium gravimetrically and copper by volumetrically in a given mixture.
16. To determine the total protein content and solid content in sample of milk. (Formaldehyde method).
17. To determine the percentage of phthalic anhydride and maleic anhydride and find mean, and standard deviation.
18. To determine amount of iron (III) in solution by photometric titration (static) with EDTA.
19. To determine the amount of Cu^{+2} using DMG by spectrophotometric method.
20. To determine available chlorine in bleaching materials.

M.Sc. SEMESTER-I

C-106: VIVA VOCE

2 CREDITS

50 MARKS

Based on theory C-101 to C104 and practicals.

M. Sc. SEMESTER-II

C-201: INORGANIC CHEMISTRY

4 CREDITS

100 MARKS

1. Organometallic Compounds

Introduction, nature of bonding in organornetalliccompounds of transition metals.

σ-bonded organometallic compounds: Introduction, classification and synthesis of σ-bonded organotransitionmetal 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 and chemical properties, bonding of structure. (b) η^3allyl (or enyl) complexes: preparation, physical of chemical properties.

2. Fundaments of 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-hemoglobinand 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, ESR spectrum when one electron influenced by a single proton and one electron delocalized over two equivalent protons.

4. Ion-Exchangers and their applications

General introduction, classification of ion-exchangers and their applications in the separation of 1. Zinc and Magnesium, 2. Chloride and bromide, 3. Cobalt and Nickel, 4. Cadmium and Zinc.

5. Uses of Organic reagents in Inorganic Analysis

Cupferron, DMG, dithiozone, aluminon, oxine, dithiooxamide, α-benzoinoxime, α-nitro-(3-naphthol, α-nitroso-3-naphthol, diphenyl carbazone, diphenyl carbazide, anthranilic acid, tannin, pyragallol, benzidine. salicylaldoxime, o-phenanthroline.

Reference Books:

1 Advanced Inorganic Chemistry, Cotton Wilkinson, W S E Wiley.
2 Vogel's Text book of Quantitative Inorganic Analysis, ELBS Press.

3 Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.
4 Bioinorganic Chemistry, Chatwal andBhagi, Himaliya Publishing House.
5 Physical Methods in Chemistry, R.S.Drago, Saunders College.
6 The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
7 Metallo-Organic Chemistry, A.J. Pearson, Wiley.
8 The Inorganic Chemistry of Biological Processes, M.N.Hughes, John Wiley & Sons.

M. Sc. SEMESTER-II

C-202: ORGANIC CHEMISTRY

4 CREDITS

100 MARKS

1. **Photo Chemistry**

   Fundamental of photochemistry**, p**rinciples of photo chemistry, singlet and triplet states, properties and nomenclature of excited states. Physical properties of excited molecules as explained by improved Jablonskii diagram, photo chemistry of carbonyl compounds. Pphoto chemistry of olefins. Recent reactions in photochemistry

2. **Pericyclic Reactions**

   Orbitals, molecular orbital symmetry, molecular orbital of ethylene, 1,3- butadiene, 1,3,5–hexatriene and allyl systems, concerted reactions, classification of pericyclic reactions, derivation of selection rules through construction of correlation diagrams for cyclo-addition reactions and for electrocyclic reactions with 4n and $4n+2\pi$ electrons, conrotatory and disrotatory motions for electrocyclic ring opening and ring closure.

   FMO approach for derivation of Woodward-Hoffman selection rules for cycloaddition and electrocyclic reactions, suprafacial and antarafacial cycloadditions.

   1,3-Dipolar cycloaddition reactions, classification and applications. Sigmatropic reactions, suprafacial and antarafacial rearrangements, [1,j], sigmatropic rearrangement of hydrogen, [1,j] and [i,j] Sigmatropic reactions of carbon, selection rules for [i,j]-sigmatropic rearrangements using FMOs. The Cope and the Claisen rearrangements.

3. **Aromaticity**

   Concept of aromaticity, non-aromaticity and anti-aromaticity, Huckel's rule and its applications to simple and non-benzenoid aromatic compounds, cyclopentadiene, azulene, tropolone system, annulenes, hetero annulenes, and fullerenes (C60).

Reference Books

1. Organic Chemistry by G. Marc. Loudon, Oxford University
2. Organic Chemistry by J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press.
3. Advanced Organic Chemistry (4^{th}edition) by Jerry March.
4. Organic Chemistry by Morrission and Boyd, Prentice Hall Pvt.Ltd (6^{th} edition), (2003).
5. A Text Book of Organic Chemistry – R.K.Bansal, New Age International (P) Ltd. 4^{th} edition (2003).

M. Sc. SEMESTER-II

C-203: MACROMOLECULAR PHYSICAL CHEMISTRY

4 CREDITS

100 MARKS

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.Factors affecting radical polymerization and properties of the resulting polymers.
   Ionic (Catalytic) Polymerization: Kinetics of cationic and anionic polymerization.Coordination polymerization.Copolymerization and its kinetics.Evaluation of reactivityratios.
   Methods of Free Radical Polymerization: Bulk polymerization, solution polymerization, emulsion polymerization and solid phase polymerization. Problems.
3. **Polycondensation**
   Reaction route of poly functional 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.
   Methods 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.
5. **Physico-chemical Transformation Reactions**

   Types of reactions in polymer chemistry.Degradation and its classification.Cross-linking, addition and substitution reactionsReactions of functional groups.

6. **Fractionation of Polymers**

   Isolation and purification of polymers.fractionation ofpolymers. Methodspolymer fractionation: Fractional precipitation, partial dissolution or extraction method, Gradient elution method and gel permeation chromatography method.

Reference Books

1. A First Course in Polymer Chemistry, Mir Publishers, Moscow.
2. Physical Chemistry of Polymers, ATager, 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, Wiley 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.
9. Principles of Polymer Chemistry, A. Ravve, Kluwer Academic/Plenum Publisher, New York.
10. Organic Polymer Chemistry, K. J. Saundars .
11. Macromolecular Physical Chemistry, P. H. Parsania
12. Polymer Materials Science, Technology and Developments, Vol.I, SukumarMaity, AnusandhanPrakasan, Midnapore.

M. Sc. SEMESTER-II

C-204: ANALYTICAL CHEMISTRY

4 CREDITS

100 MARKS

1. **Environmental Chemistry** 35 Hours

Concept and scope of Environmental Chemistry.Terminologyand classification of environmental segments, particles, ions and radicals in the atmosphere.

Air pollution: Introduction, major sources of air pollution, air pollutants.Sources of pollutants: gaseous NOx, SOx, CO, hydrocarbons, particulates (Inorganic and Organic particulate matters).Effect of pollutants on humans, animals, materials, and vegetation.

Greenhouse effect and global warming: El Nino and La Nina phenomenon, Asian brown cloud.

Ozone layer: Creation, mechanism of depletion and its effect.

Smog: Sulphurous and photochemical smog, formation mechanism, and its control.

Analysis of air pollutants: Sampling techniques of gases and particulate, analysis of NOx, SOx, CO, H_2S, oxidants and ozone by chromatography and spectrophotometric methods. Analysis of particulates by HVAS techniques.

Water pollution: Introduction, sources of pollutants, water pollutants, classification of inorganic, organic, thermal and radioactive pollutants.

Analysis of water pollution: Determination of pH, conductivity, TDS, acidity, alkalinity, chloride, iron, sulphate, sulphide, fluoride, ammonia, nitrate, nitrite, calcium, magnesium, DO,BOD, COD, etc.

Soil pollution: Origin and nature of soil, sources of soil pollution, purpose of analysis. Methods of soil analysis:pH, moisture, total nitrogen, lime potential, total sulphur, manganese, iron, Na, K, Ca, Mg, etc.

2. **Green Chemistry** 15 Hours

Introduction, importance andtwelve principles of Green Chemistry. Designing a green synthesis using theseprinciples. Green Chemistry in day to day life.Green solvents (alternatives of organic solvents).

Ionic liquids, supercritical fluids, CO_2 and H_2O and aqueous phase organic synthesis.

Non-traditional greener alternative approaches: Green reagents, catalysis, bio-catalysis.

Applications of non-conventional energy sources:

Microwave, ultrasonic assisted synthesis, electro-synthesis and sunlight (UV) radiation assisted synthesis.

3. **Analytical Chemometrics** 10 Hours

Propagation of measurement of uncertainties, useful statistical tests: Test of significance, F- test, t-test, chisquare-test, correlation coefficient, confidence limist of mean, comparison of mean with true values. Regression analysis (least square method for linear and nonlinear plots). Statistics of sampling and detection limit evaluation.Specific study for analytical method radiation by using validation parameters: (1) accuracy, (2) precision (repeatability and reproducibility), (3) linearity

and range, (4) Limit of Detection (LOD) and Limit of quantification (LOQ),(5) selectivity/specificity, and (6) Robustness and Ruggedness.

Reference Books

1. Fundamentals of Mathematical Statistics:by S.C. Chand and V.K.Kapoor: S.Chand and Co.
2. Practical Statistics (Vol 1 and 2) by Singh, Atlantic Publishers.2003.
3. V.K.Ahluwalia, Green Chemistry: Environmentally Benign Reactions. CRC, 2008.
4. Environmental Chemistry by H.Kaur, 3rd edition PragatiPrakashan, Meerut.
5. Environmental Chemistry 7th edition by A.K.De, New Age International Publishers; New Delhi.
6. Spectroscopy 6th edition by H.Kaur, PragatiPrakashan, Meerut.
7. Environmental Chemistry by V.K.Ahluwalia Ane Books India First Edition.

M. Sc. SEMESTER-II

C-205: PRACTICALS

6 CREDITS

150 MARKS

INORGANIC CHEMISTRY

1. **Inorganic Qualitative Analysis**

Analysis of a mixture containing six radicals including one less common metal ion: W, Tl, Ti, Mo,Se, Zr, Th, Ce,V and Li.

Minimum 15 mixtures containing inorganic salts like $CuSO_4$, KBr , TiO_2 , KI, Na_2CrO_4, $CaCO_3$, $Zr(NO_3)_3$, $NaNO_3$, ZnS, Na_2SO_4, SeO_2, NaCl, K_2SO_4, $(NH_4)_2SO_4$, $(NH_4)_2MoO_4$, $BaCl_2$, $ZnCO_3$, $Al_2(SO_4)_3$, V_2O_5, ZnS, $Ni(NO_3)_2$, KNO_2, $Th(NO_3)_3$, KCl, $CdCO_3$, $CuCl_2$, $LiCO_3$, K_2SO_4, $AlPO_4$, H_3BO_3, $(NH_4)_2SO_4$, $CeSO_4$, $CdCl_2$, $Th(NO_3)_3$, $NaNO_3$, $ZnCO_3$, $AlPO_4$, $LiCO_3$, $Pb(NO_3)_2$, $NaNO_2$,$Zr(NO_3)_3$, Na_2WO_4, $MnSO_4$, $NaHSO_3$, SeO_2, K_2CrO_4, $FeSO_4$, $(NH_4)_2SO_4$, $(NH_4)_2MoO_4$, Na_3AsO_3, Na_3AsO_4, $(NH_4)_2SO_4$, K_2SO_4, $CeSO_4$, As_2O_3, NH_4Cl, $NiSO_4$, $LiCO_3$, $MgCO_3$, $NaNO_2$, $Mg_3(PO_4)_2$, V_2O_5, H_3BO_3, $SrCO_3$, $Th(NO_3)_3$, Na_3AsO_3, Na_3AsO_4, $BaCO_3$ and $LiCO_3$.

2. **Inorganic Preparation Binuclear and Mono Nuclear Metal Complexes**

Preparation of selected inorganic metal complexes and their estimation by volumetric/gravimetric/colorimetric techniques to determine the percentage purity of the complexes prepared.

a. Tetrammine cupric sulphate $[Cu(NH_3)_4]SO_4 \cdot H_2O$.
b. Tri (thiourea) cuprous sulphate $[Cu(NH_2CSNH_2)_3]_2 SO_4\ 2H_2O]$.
c. Tri (thiourea) cuprous chloride $[Cu(NH_2CSNH_2)_3]$ Cl.
d. Hexa ammine nickel(II) chloride $[Ni(NH_3)_6]Cl_2$.
e. Hexathiourea–plumbus nitrate $[Pb(NH_2CSNH_2)_6](NO_3)_2$.
f. Potassium trioxalato chromate $K_3[Cr(C_2O_4)_3]$.
g. Potassium trioxalato aluminate $K_3[Al(C_2O_4)_3]$.
h. sodium trioxalate ferrrate(III) $Na_3[Fe(C_2O_4)_3]\ 9H_2O$.
i. Hexamminecobalt(III) chloride $[Co(NH_3)_6]Cl_3$.
j. Pentathioureadicuprous nitrate $[Cu(NH_2CSNH_2)_5](NO_3)_2$.
k. Iron(III) acetylacetonate $Fe(acac)_3$ / $Fe(C_5H_7O_2)_3$

3. **Quantitative Analysis**

Estimation of the metal complexes by different techniques to determine the percentage purity quantitatively of the complexes.

a. Cu-EDTA (Volumetrically) and Cu-KCNS(Gravimetrically).
b. Ni- EDTA (Volumetrically) Ni- DMG (Gravimetrically.)
c. Co- EDTA (Volumetrically).
d. Cr- EDTA–$Pb(NO)_2$ (Volumetrically, Back Titration).
e. Al- EDTA –$ZnSO_4$ (Volumetrically, Back Titration).
f. Oxalate -$KMnO_4$(Volumetrically).

ORGANIC CHEMISTRY

1. **Multistep Preparation**
   a. m-Nitro aniline from nitrobenzene.
   b. Hydro quinone diacetate from hydroquinone.
   c. p-Methyl acetanilide from p-toluidine.
   d. p-,Bromo-aniline from aniline.
   e. 7-Hydroxycoumarine from resorcinol.
   f. Hippuric acid from glycine.
   g. Aspirin from salicylic acid
   h. Phthalamide from phthlic acid.
   i. Magneson-II (4,(4' nitro benzene azo 1)naphthol) from p-nitroaniline.
   j. Benzimdazol from o-nitroaniline.
   k. Resacetophenone from resorcinol.
2. **Qualitative Analysis of Bi-functional Compounds:**
   a. Anthranilic acid
   b. p-Aminobenzoic acid
   c. o-Chlorobenzoic acid
   d. m-Nitrobenzoic acid
   e. o/m/p-Nitroaniline
   f. Bi-phenyl amine
   g. N,N-Dimethyl aniline
   h. Resorcinol
   i. Ethyl acetoacetate
   j. P-Dichlorobenzene
   k. o/p-Cresol
   l. o/m/p-Toluidine
   m. Benzanilide
   n. Acetamide
   o. α/β-Naphthole,etc.

NOTE: Other bifunctional compounds may be asked in examination.

PHYSICAL CHEMISTRY

Conductometry

1. To determine the concentration of HCl / CH_3COOH / Oxalic acid/ HCl + CH_3COOH+ CuSO4/ Satd BA/ NH_4Cl/CH_3COONa/ mix of CH_3COONa + NH_4Cl.
2. To study the complexation of Ni^{+2} with EDTA.
3. To determine the equivalent conductance and dissociation constant of a weak electrolyte and to verify Oswald's dilution law.
4. To determine the equivalent conductance of a strong electrolyte and hence to verify the Ostwald's equation.
5. To determine the degree of hydrolysis and hydrolysis constant NH_4Cl/ CH_3COONa.

pHMetry

6. To determine the dissociation constant of benzoic/acetic / lactic acid.
7. To determine the concentration and amount of acid in a mixture of hydrochloric acid and acetic acid.
8. To determine the concentration and dissociation constants of a dibasic acid (oxalic acid).
9. To determine the dissociation constant of acetic acid (Buffer).

Potentiometry

10. To determine the normality and dissociation constant of the given acid (satd. BA).

11. To determine the normality and dissociation constants of the given dibasic acid (oxalic acid).

12. To determine the normality ofhydrochloric acid and acetic acid in the mixture.
13. To determine the standard redox potential and thermodynamic parameters of the Fe^{+2} ion.
14. To determine the concentration of KCl and the solubility product of AgCl.
15. To determine the normality of each halide in the mixture of halides.
16. To determine the standard oxidation potential of the quin hydroneelectrodel.

Spectrophotometry

17. To examine Lambert-Beer law in concentrated solution.
18. To study the rate of iodination.
19. To determine the composition of binary mixture containing potassium permanganate and potassium dichromate.

Ultrasonics

20. To determine the acoustical parameters of a given liquid.

Chemical kinetics

21. To determine the reaction velocity and reaction rate constant for the reaction between acetone and iodine.
22. To determine the heat and entropy of vaporization of a given liquid by kinetic approach.

23. To determine the kinetic parameters and temperature coefficient of reaction between $KBrO_3$ and KI.

24. To determine the kinetic parameters and the temperature coefficient of the reaction between $K_2S_2O_8$ and KI.

Thermodynamics

25. To determine the solubility and heat of solution of benzoic acid in toluene.

26. To determine the partial molar volume and the composition of unknown mixture of ethanol/methanol and water.

Partition function

27. To determine the distribution coefficient of benzoic acid between toluene and water at room temperature and hence to prove the dimerization of benzoic acid in toluene.

28. To determine the equilibrium constant for the reaction between iodide and iodine by the method of distribution.

Refractometer

29. To determine the molar refraction and refractive index of a given salt.
30. To study the variation of refractive index with composition of a given liquid and also to determine the composition of unknown mixture.

Polarimeter

31. To determine the concentration of an unknown solution of optically active compound.
32. To determine the specific and molecular rotation of cane sugar and hence intrinsic rotation.

ANALYTICAL CHEMISTRY

1. Preparation and standardization of 0.1N HCl, 0.1N H_2SO_4 and 0.1N HNO_3, against 0.1N NaOH solution as well as other strength of solutions. Find mean, standard deviation and other statistical parameters.
2. Preparation and standardization of 0.1N and 0.5N solution of NaOH and standardized against potassium hydrogen phthalate and succinic acid. Find mean, standard deviation, t-test and F-test.
3. Preparation and standardization of 0.1N or 0.1M I_2 solution and standardized against standard thiosulphate solution and other standardization solutions.
4. To determine the amount of iodine in iodized salt.
5. To determine the amount of vitamin-C (ascorbic acid) in a given sample.
6. To determine the percentage of reducing sugars in Honey sample.
7. To determine the saponification value of an oil or fat sample.
8. To determine the percentage of tannin in tea leaves.
9. To determine the percentage of calcium gluconate in the given commercial sample by complexometric titration.
10. To determine the amount of aspirin in a given sample.
11. To determine the iodine value of an oil or fat.
12. To estimate the amines using bromate-bromides solution (Bromination) method.
13. To estimate the calcium and magnesium in the given mixture solution of both by EDTA complexometric method. (50ml of mixture solution of Ca^{+2} and Mg^{+2} (25ml Ca^{+2} solution from $CaCO_3$ 10gm/L and 25ml Mg^{+2} solution ($MgCO_3$ 8.4 gm/L) use minimum quantity of dil. HCl (1ml) for Ca^{+2} and Mg^{+2} solution).
14. To determine chloride and bromide ion by precipitation titration method.
15. To determine barium gravimetrically and copper by volumetrically in a given mixture.
16. To determine the total protein content and solid content in sample of milk. (Formaldehyde method).
17. To determine the percentage of phthalic anhydride and maleic anhydride and find mean, and standard deviation.
18. To determine amount of iron (III) in solution by photometric titration (static) with EDTA.
19. To determine the amount of Cu^{+2} using DMG by spectrophotometric method.
20. To determine available chlorine in bleaching materials.

M. Sc. SEMESTER-II

C-206: VIVA VOCE

2 CREDITS

50 MARKS

Based on theory C-201 to C-204 and practicals

M. Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-301: ADVANCE CHROMATOGRAPHIC TECHNIQUES

4 CREDITS

100 MARKS

1. Introduction, revision of various chromatographic techniques and terminologies.
2. Principle, theory, instrumentation and applications of GC, HPLC, UPLC and super critical fluid chromatographic techniques.
3. **Ion Chromatography:** Principle, theory, instrumentation and applications.
4. **Exclusion Chromatography:**

   Theory and principle of size exclusion chromatography, experimental techniques for gel filtration chromatography(GFC) and gel-permeation chromatography(GPC).Column materials, factors governing column efficiency, methodology and applications.

5. **Hyphenated techniques:** Principle, theory, instrumentation and applications of GC-MS, LC-MS, GC-IR, LC-NMR, etc.
6. **Planner chromatography:**

   Paper chromatography, thin layer chromatography, and high performance thin layer chromatography: Principle, theory, instrumentation and applications.

Reference Books

1. Chromatography by E. Heftman, 5^{th} edition, part-A and B, Elesvier Science Publisher, 1992.
2. Instrumental Methods of Analysis by B.K. Sharma, Goel Publisher, Meerut.
3. Analytical chemistry by Gary D. Christian, 6^{th} edition (1994) John Wiley and sons Inc. New York.
4. Fundamental of Analytical Chemistry 8^{th}Edn. Saunders College Pub. 2001.
5. Analytical Chemistry by H. Kaur, PragatiPrakashan, Meerut.
6. Instrumental Methods of Chemical Analysis by Chatwal and Anand.
7. Standard Methods of Chemical Analysis by F.J. Welcher.
8. Introduction to Modern Liquid Chromatography: 2^{nd} edition L.R. Snyder and J.J. Kirkland- John Wiley & Sons Inc.
9. Analytical Methods in Chemistry by Y. R. Sharma.
10. Analytical chemistry by Open learning second edi. (Vol. 1-30) Wiley India Edi.
11. B. L. Karger, L.R. Snyder and C. Howarth, An Introduction to Separation Science, 2^{nd} edition (1973), John Wiley, New York.

M. Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-302: ELECTRO ANALYTICAL TECHNIQUES

4 CREDITS

100 MARKS

1. **Polarography:** Introduction and classification of polarographic techniques. Principle, instrumentation and applications of DC polarography including stripping and cyclic voltammetry and numericals.
2. **Amperometry:** Introduction, theory and applications. Amperometric titrations.
3. **Electro Gravimetric and Coulometric Methods of Analysis:** Introduction, principle, theory, instrumentation and applications.
4. **Ion selective electrodes:** Introduction, classification, theory, types and construction of ion selective electrodes and their applications.
5. **Electrophoresis:** Introduction, principle, classification, theory, instrumentation, factors affecting and applications.
6. **Capillary Electrophoresis:** Principle, theory, instrumentation, capillary electro chromatography and applications.

Reference Books

1. Instrumental Methods of Analysis by B.K. Sharma, Goel Ppublishing House, Meerut.
2. Analytical Chemistry by Gary D. Christian, 6th edition (1994) John Wiley and Sons Inc. New York.
3. Fundamental of Analytical Chemistry 8thEdn. Saunders College Pub. 2001.
4. Analytical chemistry by H. Kaur, Pragatiprakashan, Meerut.
5. Instrumental Methods of Chemical Analysis by Chatwal and Anand.
6. Standard Methods of Chemical Analysis by F.J. Welcher.
7. Vogel's Textbook of Quantitative Chemical Analysis, 6thEdn. Pearson Education Asia.
8. Modern Electrochemistry 2B (2ndedition) by John O'M Bockris and Amolya K. N. Reddy.

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)-303: MACROMOLECULER PHYSICAL CHEMISTRY-II

4 CREDITS

100 MARKS

1. **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).
2. **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.
3. **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.
4. **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 T_g, Glass transition of copolymers, The relation between T_g and T_m. and importance of T_g, Mechanism and kinetics of polymer crystallization, Thermodynamics of melting and crystallization, Melting temperatures of polymers, Free volume and packing density of polymers. Problems.
5. **Polymer Processing**
   Types of plastics, elastomers and fibers andcompounding.Processing techniques: Calendaring, diecasting, rotational casting, film casting, compression molding, injection molding, blow molding, extrusion molding, thermo forming and foaming.
6. **Composite materials**
   Definition and classification of composites.Types of matrix and fiber materials, applications of composites, laminates and hybrid composites. Reinforcements: Metallic, polymeric and ceramic fibers. Modification of fibers, properties of fiber reinforced (natural and synthetic fibers, advantages of natural fibers over synthetic fibers, polymer matrix composites and their production by hand layup, moulding, pultrusion and filament winding.

Reference Books

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

4. Analysis and Characterization of Polymers by Ed. SukumarMaity, AnusandhanPrakashan, Midnapore.
5. Composite Materials, Production, Properties, Testing and Applications by K. Srinivasan.
6. Macromolecular Physical Chemistry by P. H. Parsania.

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C (PM) - 304: NUCLEAR AND RADIO CHEMISTRY

ELECTIVE-I

4 CREDITS

100 MARKS

1. **Brief Introduction of Radioactivity**
   Nuclear particles, types of radiation, 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.
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 surveymeters. Accelerators: Van de Graff and cyclotron.
3. **Nuclear Fission, Fusion and 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.
   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 andradiation dosimetry.
6. **Tracer**
   Selection of radioisotopes as tracer, application of radioisotopes as tracers:Analytical, physicochemical, 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 byHaissionsky – 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, III rd Edition.
3. Radio Chemistry by An. N. Nesmeyanov, Mir Publishers.
4. Nuclear Chemistry by ShipraBaluja.
5. Artificial Radioactivity – By. K. Narayana Rao and H. J. Arnikar – Tata McGraw Hill Publishing Company Ltd. New Delhi
6. Radio Chemistryby ShipraBaluja.

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

(PM)-304: ELECTROCHEMISTRY

ELECTIVE-II

4 CREDITS

100 MARKS

1. **Fundamentals of Electrochemistry**

   Classification of conductors,the mechanism of electrolysis,electrolytic dissociation theory andevidences for the ionic theory.Influence of the solvent on dissociation.Faraday's laws of electrolysis.Problems.

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. Problems.

3. **Superconductor**

   Introduction, classification of superconductors,advancement in super conductors.Applications of superconductors in various fields.

4. **Semiconductors**
   Introduction, classification and applications.
5. **The Migration of Ions**

   Transference numbers and ionic velocities, Hittorf method, moving boundary method, Transference numbers in mixtures,abnormal transference numbers. Problems.

6. **Acids and Bases**

   Definitions, types of solvents, dissociation constants of acids and bases, Determination of dissociation constants, Acidity function, effect of solvent and temperature on dissociation constant and ionic product of water.Problems.

7. **Amphoteric Electrolytes**

   Dipolar ions and evidences for their existence. Dissociation of amino acids, isoelectric points and neutralization curves of ampholytes.

8. **Polarization and Over Voltage**
   Electrolytic polarization and concentration polarization.Decomposition voltages of aqueous solutions.Metal deposition over voltage, Hydrogen over voltage,Oxygen over voltage, Influence of current density, pH and temperature on over voltage, Electrolysis of water.Problems.

Reference Books

1. An Introduction of Electrochemistry by S. Glasstone. Affiliated East West Press, New Delhi.
2. Electrochemistry by ShipraBaluja and FalguniKaria.
3. Electrochemistry by B. K. Sharma. Krishna Prakashan,Meerut.
4. Modern Electrochemistry byJO'MBockri's and A. K. N. Reddy, Vol. 2, Plenum Press, New York.,1992.
5. The Principles of Electrochemistry by Duncan A. Mac Innes Dover Publication Inc. N. Y.

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-305: PRACTICALS

6 CREDITS

150 MARKS

1. **Physico-chemical exercises**

   Viscosity, thermodynamic excess properties, solubility, phase rule..

2. **Chromatography:** Paper, TLC and Column chromatography.
3. **Polymer Synthesis**

Addition and condensation polymers: PS, PMA, PMMA, PAN, PVAc,UPE, Epoxy, PF, UF and MF resins.

4. **Characterization of Polymers:** Viscosity, molecular weight determination, epoxy equivalent, acid value, hydroxyl value, density, IR, NMR, UTM

M.Sc. SEMESTER-III

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-307: VIVA-VOCE

2CREDITS

50 MARKS

Theory based on C(PM)-301 to C(PM)-304 and practicals.

M. Sc. SEMESTER-IV

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-401: ADVANCE SPECTROSCOPIC TECHNIQUES

4 CREDITS
100 MARKS

1. **Ultraviolet Photoelectron Spectroscopy**: An overview, theory and applications of UV-spectroscopy.
2. **Electron Paramagnetic Resonance Spectroscopy**
   Introduction, theory, instrumentation, spin-spin coupling, qualitative and quantitative analysis, multiple resonance, spin labelling, metallic complexes and other uses of EPR spectroscopy.
3. **^{1}HNMR Spectroscopy:** Overview of NMR spectroscopy, spin-spin interaction and nomenclature, non 1st order to 1storder spectrum, applications of coupling constants. 2D NMR technique.Multinuclear NMR spectroscopy and its applications.

4. **^{13}C NMR spectroscopy:** Comparison between ^{1}H and ^{13}C NMR spectroscopy, factors affecting ^{13}C NMR chemical shifts and identification of various organic molecules with coupling, decoupling, off resonance, etc.
5. **Vibrational and Rotational Spectroscopy**
   a. NIR: Principle, instrumentation and applications.
   b. Raman spectroscopy: Principle, theory, instrumentation and applications.
6. **Mass spectroscopy:** Principle, theory, instrumentation, fragmentation and applications.

Reference Books

1. Understanding NMR-Spectroscopy (2nd Edition), Wiley Publisher by James Keeler.
2. Spectroscopy by H. Kaur, PragatiPrakashan
3. Text book of spectroscopy by Jyotikumar, Sonali publication.
4. Analytical Spectroscopy by James Very, Pacific Book Int.
5. NMR Spectroscopy by Harald Gunther Wiley.
6. Handbook of Instrumental Techniques for Analytical Chemistry by F. Settle Pearson Edu.
7. Introduction to Spectroscopy (3rd Edition) by Pavia LampmanKriz: Cengage.
8. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Hiamalaya Publishing House.
9. Spectroscopy of Organic Copmpounds, P.S. Kalsi, New Age International Ltd.
10. Analytical Spectroscopy by James Vergeese.
11. Organic Spectroscopy by William Kemp.
12. Spectrometric Identification of Organic Compounds. (6th Edition) by Robert M. Silverstein & Francis X. Webster, Wiley.
13. Organic Spectroscopy: Principles and Applications, 2nd Edition by Jag Mohan, Alpha Science International Ltd., Harrow U. K.

M. Sc. SEMESTER-IV

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-402:INSTRUMENTAL TECHNIQUES

4 CREDITS

100 MARKS

1. **X-ray diffractions**

   Introduction, origin of X-rays, monochromatization and diffraction methods. Crystal structure elucidation limited to cubic system. Applications of XRD and numericals.

2. **Thermal Methods Of Analysis**

Principle, theory and instrumentation of TGA, DTA and DSC.Factors affecting thermal analysis.Applications of thermal methods in various field of science.Various theories of thermal analysis for evaluation of kinetic parameters and analysis of simple and polymeric compounds.

3. **Spectropolarimetry**

   Introduction, definition of polarized light, optical activity, specific rotation, ORD, CD, Cotton effect, etc.Instrumentation and applications.

4. **Scanning Electron and Transmission Electron Microscopy**

   Introduction, principle, theory, instrumentation and applications.

5. **Automated Analysis**

   Automated system an overview.Didistinction between automatic and automated systems, merits and demerits of automation, types of automated techniques. Discrete automatic system, C, H, and N elemental analyser, multilayer thin film analytical techniques. Flow injection analysis: Principle, instrumentation and applications.

Reference Books

1. Chromatography by E. Heftman, 5th edition, part-A and B, ElsevierScience Publisher, 1992.
2. Instrumental Methods of Analysis by B.K. Sharma, Goel Publishing House, Meerut.
3. Analytical Chemistry by Gary D. Christian, 6th edition (1994) John Wiley and Sons Inc. New York.
4. Fundamental of Analytical Chemistry 8thEdn. Saunders College Pub. 2001.
5. Analytical chemistry by H. Kaur, Pragatiprakashan, Meerut.
6. Instrumental Methods of Chemical Analysis by Chatwal and Anand.
7. Standard Methods of Chemical Analysis by F.J. Welcher.

M. Sc. SEMESTER - IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)-403: CHEMISTRY OF MATERIALS-I

4 CREDITS

100 MARKS

1. **Nanomaterials**
   Introduction of nano materials, their size, fundamental science behind nanotechnology.Applications of nanomaterials.

2. **Micelles**

   Surface active agents, classification of surface active agents, micellization, micelle structure and shape, shape transition, elongated micelles, vesicles, inverted structures, micelle aggregation number, hydrophobic interaction, critical micellar

concentration(CMC), factors affecting the CMC of surfactants, counterion binding to micelles, thermodynamics of micellization, Gibbs free energy, enthalpy and entropy of micelle formation, phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

3. QSAR

Introduction, classification of QSAR parameters:hydrophobic, electronic, theoretical and steric.Advantages and disadvantages of QSAR.

4. Ultrasonics

Introduction, applications and determination of thermodynamicparameters.Effect of concentration, temperature, nature of solvents and solutes on acoustical properties.

5. Fuel cells

General chemistry of fuel cells, hydrogen-oxygen fuel cell, hydrocarbon-oxygen fuel cell, efficiency and advantages of fuel cells.

6. Solar cells

Solar energy, conversion of solar energy into other forms of energy, solar technology, photo catalytic cells andsolar photovoltaic cells.Advantages of photo voltaics and applications of photovoltaic systems, PV street lighting system, other applications of solar energy, solar desalination, advantages of solar energy, environmental implications of solar energy.

Reference Books

1. Nanotechnology by M. Ratner and D. Ratner, Pearson.
2. Electrochemistry by B. K. Sharma, Goel Publishing House.
3. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania.
4. Surface active agents by M. J. Rosen.

M. Sc. SEMESTER - IV

PHYSICAL AND MATERIALS CHEMISTRY

C(PM)-404: REACTION DYNAMICS AND MECHANISMS

ELECTIVE-I

4 CREDITS

100 MARKS

6. **Fast Reactions**
   Introduction, methods of studying fast reactions: Flow methods, flash photolysis, relaxation methods.
7. **Theory of Reaction Rates**
   Collision and absolute reaction rate theory.Thermodynamical formulation of reactionrate.
8. **Reaction Mechanism**
   Reaction between NO_2 and F_2, NO_2 and CO at low temperature, NO and O_2 , H_2 and I_2 , hypochlorite and iodide,acetone and iodine, CO and Cl_2, ammonium cyanate and urea. decomposition of ozone, Acid catalyzed hydrolysis of methyl acetate. Thermal decomposition of nitrogen pentoxide.
4. **Chain Reactions**
   Definition, characteristics of chain reactions, mechanism of chain reactions, kinetics of chain reactions.Decomposition of ozone and nitrogen pentoxide, thermal reaction between hydrogen and bromine, photochemical reactions between hydrogen and bromine;**h**ydrogen and chlorine, decomposition reaction of ethane (first order), acetaldehyde (one half and three half order) and butane (three half order).

5. **Acid-Base Catalysis**
   Types of acid-base catalysis, Mechanism of acid-base catalysis, catalytic coefficients.
6. **Photochemical Reactions**
   Laws of photochemistry, photolytic and photosensitized reactions,chemical actinometers.
7. **Reactions in Solution:** Transition state theory for liquid solutions, influence of ionicstrength of solution and nature of solvent on reaction rates,

Reference Books

1. Basic reaction Kinetics and Mechanisms by H.E. Avery, Macmillan
2. Chemical Kinetics byGurdeep Raj, Krishna Prakashan, Meerut
3. Chemical Kinetics by K. J. Laidler, MaGraw Hill New York.

M. Sc. SEMESTER - IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM) - 404: CHEMISTRY OF MATERIALS-II

ELECTIVE-II

4 CREDITS

100 MARKS

1. **Phase Transfer Catalysts**
   Definition, principle, types, examples, applications, scope, benefits and barriers of commercial phase-transfer catalysis applications.
2. **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.
3. **High Performance Thermoplastics**
   Polyimides and copolymers, polyether sulfones, polyether ketones, aromatic polyamides and other polymers, application of highperformance polymers.
4. **Mechanical andOptical Properties**
   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, tear resistance, abrasion resistance, hardness,transparent, opaque and translucent materials, color, gloss, haze and transparency.
5. **Paints**
   Introduction, classification of paints, pigments, classification of pigments, particles, organic and inorganic pigments, toxicity of pigments.
6. **Water BorneCoatings**
   Polymer emulsions, formation of emulsions, surfactants, vinyl emulsion paints: materials and manufacture. Acrylic emulsions and paints, water soluble binders.

Reference Books

1. Physical Chemistry by P. C. Rakshit.
2. Physical Chemistry by Danial Alberty, Mc Graw-Hill.
3. Text-book of Polymer Science, F. W. Billmeyer, Willey Interscience.
4. Outlines of Paint Technology by W. M. Morgans, CBS Publishers and Distributors.
5. Phase Transfer Catalysis by Charles M. Starks, Charles L. Liotta and Marc
6. Halpern. Springer International Edition
7. Physical Chemistry of Macromolecules, D. D. Deshpande, IIT, Bombay
8. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma and M. S. Pathania.
9. Liquid Crystals and Plastic Crystals by W. Gray and P. A. Windsor, Vol. 1.

M. Sc. SEMESTER - IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)–405: PRACTICALS/DISSERTATION

6 CREDITS

150 MARKS

1. Kinetic study by polarimetry and conductometry,
2. Conductometry: Mixture of mono and biprotic acids, very weak acid and very weak base, relative acid strength, amount of aspirin tablet, dissociation constant of copper sulphate.
3. Potentiometry: Iodide- permanganate, K_{sp} of AgCl, activity coefficient and transport number determination, thermodynamic parameter determination of zinc-copper cell and equilibrium constant of silver-ammonia complex.
4. pHmetry: Mixture of mono and biprotic acids, amount of aspirin tablet,, mixture of carbonate and bicarbonate, solubility and dissociation constant of salicylic acid, Hammet constant of substituted benzoic acids.
5. Spectrophtometry:Indicator constants, paracetamol in a tablet, complexometric titrations and molecular compositions of complexes.
6. Ultrasonics. Determination of excess acoustical parameters of various binary mixtures.
7. Polarographic and amperometric experiments by various methods.

M. Sc. SEMESTER - IV

PHYSICAL AND MATERIALS CHEMISTRY

C (PM)- 406: VIVA-VOCE

2 CREDITS

50 MARKS

Theory based on C(PM)-301 to C(PM)-304 and practicals

M. Sc. SEMESTER-III

PHARMA-ANALYTICAL CHEMISTRY

C(PA)-301: ADVANCE CHROMATOGRAPHIC TECHNIQUES

4 CREDITS

100 MARKS

7. Introduction, revision of various chromatographic techniques and terminologies.
8. Principle, theory, instrumentation and applications of GC, HPLC, UPLC and super critical fluid chromatographic techniques.
9. **Ion Chromatography:** Principle, theory, instrumentation and applications.
10. **Exclusion Chromatography:**

    Theory and principle of size exclusion chromatography, experimental techniques for gel filtration chromatography(GFC) and gel-permeation chromatography(GPC).Column materials, factors governing column efficiency, methodology and applications.

11. **Hyphenated techniques:** Principle, theory, instrumentation and applications of GC-MS, LC-MS, GC-IR, LC-NMR, etc.
12. **Planner chromatography:**

    Paper chromatography, thin layer chromatography, and high performance thin layer chromatography: Principle, theory, instrumentation and applications.

Reference Books:

12. Chromatography by E. Heftman, 5^{th} edition, part-A and B, ElesvierScience Publisher, 1992.
13. Instrumental Methods of Analysis by B.K. Sharma, Goel Publisher, Meerut.
14. Analytical chemistry by Gary D. Christian, 6^{th}edition (1994) John Wiley and sons Inc. New York.
15. Fundamental of Analytical Chemistry 8^{th}Edn. Saunders College Pub. 2001.
16. Analytical Chemistry by H. Kaur, PragatiPrakashan, Meerut.
17. Instrumental Methods of Chemical Analysis by Chatwal and Anand.
18. Standard Methods of Chemical Analysis by F.J. Welcher.
19. Introduction to Modern Liquid Chromatography: 2^{nd} edition L.R. Snyder and J.J. Kirkland- John Wiley & Sons Inc.
20. Analytical Methods in Chemistry by Y.R. Sharma.
21. Analytical chemistry by Open learning second edi. (Vol. 1-30) Wiley India Edi.
22. B. L. Karger, L.R. Snyder and C. Howarth, An Introduction to Separation Science, 2^{nd} edition (1973), John Wiley, New York.

M. Sc. SEMESTER-III

PHARMA-ANALYTICAL CHEMISTRY

C(PA)-302: ELECTRO ANALYTICAL TECHNIQUES

4 CREDITS

100 MARKS

7. **Polarography**

   Introduction and classification of polarographic techniques.Principle, instrumentation and applications of DC polarography including stripping and cyclic voltammetry and numericals.

8. **Amperometry**

   Introduction, theory and applications.Amperometric titrations.

9. **Electro Gravimetric and Coulometric Methods of Analysis**

   Introduction, principle, theory, instrumentation and applications.

10. **Ion selective electrodes**

    Introduction, classification, theory, types and construction of ion selective electrodes and their applications.

11. **Electrophoresis**

    Introduction, principle, classification, theory, instrumentation, factors affecting and applications.

12. **Capillary Electrophoresis**

    Principle, theory, instrumentation, capillary electro chromatography and applications.

Reference Books

1. Instrumental Methods of Analysis by B. K. Sharma, Goel Ppublishing House, Meerut.
2. Analytical Chemistry by Gary D. Christian, 6th edition (1994) John Wiley and Sons Inc. New York.
3. Fundamental of Analytical Chemistry 8thEdn. Saunders College Pub. 2001.
4. Analytical chemistry by H. Kaur, Pragatiprakashan, Meerut.
5. Instrumental Methods of Chemical Analysis by Chatwal and Anand.
6. Standard Methods of Chemical Analysis by F.J. Welcher.
7. Vogel's Textbook of Quantitative Chemical Analysis, 6thEdn. Pearson Education Asia.

8. Modern Electrochemistry 2B (2nd edition) by John O'M Bockris and Amolya K. N. Reddy.

M. Sc. SEMESTER-III

PHARMA-ANALYTICAL CHEMISTRY

303: ADAVANNCES IN ENVIRNOMENTAL CHEMISTRY

4 CREDITS

100 MARKS

1. **Types of Water Pollution**

   Introduction, ground water, surface water, river water and marine pollution.

2. **Water Pollutants and their effect**

   Inorganic and toxic metals and their detrimental effect.Organic pollutants, eutrophication, pesticide pollutants.

3. **Industrial Pollution and treatment options**

   Effluents from some typical industries, sources, characteristics and their effect, textiles, paper and pulp, fertilizer, dairy, drug, electroplating, leather industries. Tanning and drug, general methods of treatment and treatment option.

4. Treatment and purification of water.
5. Domestic effluent treatment and control of water pollution.
6. Solid waste treatment and disposal methods.
7. Control of soil pollution
8. Environmental toxicology.
9. Air pollution control methods.
10. Radioactive pollution and disposal of radioactive waste.
11. Carbon credit and EIA study.

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 GeethaSwaminathan.
4. Atmospheric Pollu8tion By Black. W. (McGrow Hill Company) New York. 67
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.
15. Green chemistry (V.K. Ahluwalia)
16. Perspective in Enviromentalstidies (A. Kaushik & C.P. Kaushik)
17. Vogels qualitative Inorganic Analysis (Seventh Edition by G. svehla)
18. Air pollution & Water Pollution.

M.Sc. SEMESTER-III

PHARMA-ANALYTICAL CHEMISTRY

304: SELECTED TOPICS IN ANALYTICAL CHEMISTRY

ELECTIVE-I

4 CREDITS

100 MARKS

1. **Natural Product Analysis**

   Introduction, sources, classification, isolation techniques qualitative and quantitative analysis of phytochemicals.Characterization and elucidation of structure by various instrumental techniques.

2. **Pharmaceutical Analysis**

   Pharmacopoeias at glance, limit test for impurities, introduction to drugs, classification, contamination and drug product analysis.

3. **Fertilizer Analysis**

   Sampling, sample preparation, nitrogen, phosphorous, and potassium analysis in fertilizers.

4. **Pesticide Analysis**

   Introduction, classification, DDT, endosulphan, malathion, dichlorovos, etc.

5. **Cement Analysis**

   Introduction, loss on ignition, insoluble residue, R_2O_3 and other elements of cement, air and dust pollution treatment plant, atmoshpheric dispersion of pollutants in cement industries.

6. **Cosmetic Analysis**

   Composition of creams and lotions, determination of water, propylene glycol, non-volatile matter and ash determination, qualitative and quantitative analysis of borates, carbonates, sulphates, phosphate, titanium and zinc oxide. Analysis of face powder, deodorants and antiperspirants.

Reference Books

1. Treatise on Analytical Chemistry vol. I&II by I. M. Kolthoff.
2. Encyclopaedia of industrial chemical analysis vol. 1to20 (John Wiley Publishers)
3. Cosmetics by W. D. Poucher (three volumes)
4. Pharmacopeia of India vol. I and II.
5. Practical Pharmaceutical Chemistry IIIrd Edition Vol.I by A. H. Beckett and J. B. Sterlake.
6. Practical Pharmaceutical Analysis by AshutoshKar.
7. Official Method of Analysis 11th edition (1970), W. Horwitz (editor), Association of Official Analytical chemists, Washington DC.
8. Vogel's textbook of quantitative inorganic analysis, L. Borrt et al. ELBS.
9. Chemistry of natural products by V. K. Ahluwalia, Lalita S. Kumar.

M. Sc. SEMESTER-III

PHARMA-ANALYTICAL CHEMISTRY

C(PA)-304: PATENT LAWS ANS CASE STUDIES
ELECTIVE-II

4 CREDITS
100 MARKS

1. **Patent Laws:** Indian and international.
2. IPRs and other related laws.
3. Patents search tools and their usages.
4. Selected topics of chemo and bio informatics tools and their applications.
5. Agreements, confidential, nondisclosure agreements.

Reference Book

1. Patents for future by N. B. Zaveri, Vakils, Feffer and Simons Ltd. Mumbai (1st edition 2001)

M. Sc. SEMESTER-III

PHARMA-ANALYTICAL CHEMISTRY

C(PA)-305: PRACTICALS

6 CREDITS
150 MARKS

1. To determine the % purity of a given sample of isoniazid.
2. To determine the amount of benzyl penicillin in the given sample.
3. To determine the amount of paracetamol in the given sample by colorimetric method.
4. To determine the amount of salicylic acid by colorimetric method.
5. To determine the amount of acetyl salicylic acid in the aspirin tablet.
6. To determine the amount of ascorbic acid in the given sample.
7. To determine the amount of cephalexin.
8. To determine the concentration of the given sample of adrenaline tartrate using spectrophotometric method.
9. To determine the amount of KI in KIO_3.
10. To determine the amount of $KBrO_3$ in the given commercial sample.
11. To determine the iron (Fe) content in the given sample.
12. To determine the composition of Fe (III)- EDTA/ Fe (III)-Oxalate complex form in acidic medium by Job's method using SSA as an oxaillary ligand.
13. To determine the amount of copper in the given sample by spectrophotometric method.
14. To determine the amount $KMnO_4$ and $K_2Cr_2O_7$ present in the given sample by column chromatography.
15. To determine the sulphate amount in the given water sample.
16. To determine the amount of free chlorine in the given sample of bleaching liquid.
17. To determine the amount of sulphites in the given sample.
18. To determine the amount of sodium nitrite ($NaNO_2$) in the given commercial sample.
19. To determine aluminium using by complexometric titration method.
20. To determine R_f values of the amino acids in a given mixture by circular paper chromatography.
21. To determine R_f values amino acids in a given mixture by ascending chromatography.
22. To determine $R_f$values of the metal ions in a given mixture by circular paper chromatography.
23. To determine $R_f$values of metal ions in a given mixture by ascending paper chromatography.
24. Qualitative and quantitative analysis by gas chromatographic technique.
25. Qualitative and quantitative analysis by HPLC method.
26. Separation of metal ions by ion exchange chromatography.
27. Estimation of COD in a given water sample.
28. Other relevant experiments based on theory.

M. Sc. SEMESTER-III

PHARMA-ANALYTICAL CHEMISTRY

C(PA)-306: VIVA VOCE

2 CREDITS
50 MARKS

Theory based on C(PA)-301 to C(PA)-304 and practicals

M. Sc. SEMESTER-IV

PHARMA-ANALYTICAL CHEMISTRY

C(PA)-401: ADVANCE SPECTROSCOPIC TECHNIQUES

4 CREDITS
100 MARKS

7. **Ultraviolet Photoelectron Spectroscopy**: An overview, theory and applications of UV-spectroscopy.
8. **Electron Paramagnetic Resonance Spectroscopy:** Introduction, theory, instrumentation, spin-spin coupling, qualitative and quantitative analysis, multiple resonance, spin labelling, metallic complexes and other uses of EPR spectroscopy.
9. **^{1}HNMR Spectroscopy:** Overview of NMR spectroscopy, spin-spin interaction and nomenclature, non 1st order to 1st order spectrum, applications of coupling constants. 2D NMR technique. Multinuclear NMR spectroscopy and its applications.
10. **^{13}C NMR spectroscopy:** Comparison between ^{1}H and ^{13}C NMR spectroscopy, factors affecting ^{13}C NMR chemical shifts and identification of various organic molecules with coupling, decoupling, off resonance, etc.
11. **Vibrational and Rotational Spectroscopy**
    c. NIR: Principle, instrumentation and applications.
    d. Raman spectroscopy: Principle, theory, instrumentation and applications.
12. **Mass spectroscopy:** Principle, theory, instrumentation, fragmentation and applications.

Reference Books

14. Understanding NMR-Spectroscopy (2ndEdition), Wiley Publisher by James Keeler.
15. Spectroscopy by H. Kaur, PragatiPrakashan
16. Text book of spectroscopy by Jyotikumar, Sonali publication.
17. Analytical Spectroscopy by James Very, Pacific Book Int.
18. NMR Spectroscopy by Harald Gunther Wiley.
19. Handbook of Instrumental Techniques for Analytical Chemistry by F. Settle Pearson Edu.
20. Introduction to Spectroscopy (3rd Edition) by Pavia LampmanKriz: Cengage.
21. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Hiamalaya Publishing House.
22. Spectroscopy of Organic Copmpounds, P.S. Kalsi, New Age International Ltd.
23. Analytical Spectroscopy by James Vergeese.
24. Organic Spectroscopy by William Kemp.
25. Spectrometric Identification of Organic Compounds. (6th Edition) by Robert M. Silverstein & Francis X. Webster, Wiley.

26. Organic Spectroscopy: Principles and Applications, 2nd Edition by Jag Mohan, Alpha Science International Ltd., Harrow U. K.

M. Sc. SEMESTER-IV

PHARMA-ANALYTICAL CHEMISTRY

C(PA)-402: INSTRUMENTAL TECHNIQUES

4 CREDITS

100 MARKS

6. **X-ray Diffractions**

   Introduction, origin of X-rays, monochromatization and diffraction methods. Crystal structure elucidation limited to cubic system. Applications of XRD and numericals.

7. **Thermal Methods Of Analysis**

   Principle, theory and instrumentation of TGA, DTA and DSC.Factors affecting thermal analysis.Applications of thermal methods in various field of science.Various theories of thermal analysis for evaluation of kinetic parameters and analysis of simple and polymeric compounds.

8. **Spectropolarimetry**

   Introduction, definition of polarized light, optical activity, specific rotation, ORD, CD, Cotton effect, etc.Instrumentation and applications.

9. **Scanning Electron and Transmission Electron Microscopy**

   Introduction, principle, theory, instrumentation and applications.

10. **Automated Analysis**

    Automated system an overview.Didistinction between automatic and automated systems, merits and demerits of automation, types of automated techniques. Discrete automatic system, C, H, and N elemental analyser, multilayer thin film analytical techniques. Flow injection analysis: Principle, instrumentation and applications.

Reference Books

1. Chromatography by E. Heftman, 5^{th} edition, part-A and B, Elsevier Science Publisher, 1992.
2. Instrumental Methods of Analysis by B. K. Sharma, Goel Publishing House, Meerut.
3. Analytical Chemistry by Gary D. Christian, 6^{th} edition (1994) John Wiley and Sons Inc. New York.
4. Fundamental of Analytical Chemistry 8^{th}Edn. Saunders College Pub. 2001.
5. Analytical chemistry by H. Kaur, Pragatiprakashan, Meerut.
6. Instrumental Methods of Chemical Analysis by Chatwal and Anand.
7. Standard Methods of Chemical Analysis by F.J. Welcher.

M. Sc. SEMESTER-IV

PHARMA ANALYTICAL CHEMISTRY

C (PA)-403: PHARMA REGULATORY AFFAIRES

4 Credits

100 Marks

1. Introduction of regulatory affairs.
2. Standard operating procedures and documentation.
3. ICH guidelines.
4. GMP, GLP, C-GMP and other practices.
5. Calibration, validation and quantifications.
6. Analytical method validation protocols.
7. Selected topics on updates regulation aspects.

Reference Books

1. Guidelines on GMP/GLP BY S. Lyer.
2. US pharmacopeia and its Revised books.
3. Indian Pharmacopoeia(JP).
4. British Pharmacopoeia(BP).
5. Japanese Pharmacopoeia(JP).
6. Analytical method validation and instrumental performance verification(by chung chow chan, Y.C. Lee ana Lam).
7. Quality assurance in Analytical Chemistry (by B. W. Wenclawiak, M. Koch ,E. Hadjicostas).
8. Development & validation of analytical methods.(by Christopher Riley, ThomsRasanske).
9. SOP guidelines(by D. H. Shah).
10. Regulation of clinical trials (by Rakesh Kumar Rishi).
11. ICH guidelines (QQ1A, Q1B, Q1C,Q1D, Q1E, Q1F, Q2A, Q2A, Q3A(R), Q3B(R), Q3C, Q3C(M), Q4 Q4A, Q4B, Q5A, Q5B,Q5C,Q5D, Q5E, Q6, Q6A,Q6A,Q7,Q7A, Q8,Q9, Q10,).
12. Laboratory QS,QA, Standardization, Accreditation(by Pamposhkumar& V.P.S. Tomar).

M.Sc. SEMESTER-IV

PHARMA-ANALYTICAL CHEMISTRY

404: APPLIED ANALYTICAL CHEMISTRY

ELECTIVE-I

1. Solvent Extraction Method in Analysis: Principle, classification of extraction system, mechanisms of extraction, theory and applications solid phase extraction and applications.
2. **Food Analysis**

   Food additives, food preservatives, milk and milk products, honey, beverages, jam, catch up, etc.Tocopherol and other food product analysis.

3. **Clinical Analysis**

   Biological significance, assay of enzymes, vitamins and clinical chemical analysis.

4. **Green Analytical Chemistry**

   Introduction, principle and applications.

5. **Process analytical chemistry**

   Introduction, theory and applications.

6. **Analysis of Minerals, Ores and Alloys**

   Dolomite, bauxite, limestone, hematite, pyrolusites, gypsum and uranium ores, steel, Cu-Ni alloy, solder, bronze, brass, tenoallous of silicon, chromium, titanium, etc.

Reference Books

1. Analytical chemistry of Food by Ceiwyns James Blackie Academic and Professional Chapman and Hill Publisher, 1st Edn. Madras.
2. Chemical analysis of food by Pearson.
3. Practical Biochemistry in clinical medicine by R.L. Nath, Academic Publisher 2nd Edn. (1990)
4. Introduction to Food Science and Technology of Food Science and Technology series by G. F. Stewart and M. A. Amerine, Academic Press.
5. Handbook of Industrial Chemistry by Davis Berner.
6. Solvent Extraction in Analytical Chemistry by G. H. Morrison and H. Freiter John Wiley New York 1958.
7. Basic Concept of Analytical Chemistry by S.M. Khopkar.
8. Quantitative Inorganic Analysis by A. I. Vogel 5th edition.
9. Encyclopaedia of Industrial Methods of Chemical Analysis by F. D. Snil.

M.Sc. SEMESTES-IV

PHARMA-ANALYTICAL CHEMISTRY

404: SELECTED TOPICS IN ANALYTICAL CHEMISTRY

ELECTIVE-II

4 CREDITS

100 MARKS

1. **Analysis of Paints and Pigments**
   Preliminary inspection of sample. Test on the total coating. Separation of pigments, binder and thinner of latex paints.Separation of pigments, binder and thinner of solvent type coating.Modification of binder.Identification and analysis of thinner.
2. **Analysis of Coal and Coke**
   Types, composition of sample, proximate and ultimate analysis calorific value by bomb calorimetry.
3. **Analysis of Gaseous Fuels**
   Composition of fuel gases, collection of gas and analysis of fuel gases (coal gas, producer gas, water gas and flue gas).
4. **Analysis of Explosives**
   General methods, heat of explosion, hygroscopicity, moisture by Karl Fischer titration, qualitative tests of explosives, qualitative analysis of explosive mixture dynamites. Blasting caps and electric detonators, primers, liquid propellants and solid propellants.
5. **Glass and Glass-Ceramics**
   Introduction, composition, method of analysis sampling and sample preparation, composition analysis preliminary testing, decomposition, chemical methods for the individual constituents of Si, B, Pb, Zn, Al, Cl, Ca, Mg, Ti.
6. **Body Fluid Analysis**
   Composition and detection of abnormal level of certain constituents leading to diagnosis of diseases. Sample collection and preservation of physiological fluids, analytical methods to the constituents of physiological fluids (blood, urine and serum). Blood estimation of glucose, cholesterol, urea, haemoglobin and bilirubin.Urine-urea, uric acid, creatinine, calcium, phosphate, sodium, potassium and chloride.
7. **Forensic Analysis**
   Special features of forensic analysis, sampling, sample storage, sample dissolution, classification of poisons, lethal dose, significance of LD-50 and LC-50. General discussion of poisons with special reference to mode of action of cyanide, organophosphate and snake venom.Estimation of poisonous material such as lead, mercury and arsenic ion biological sample.
   Introduction to Forensic Science
   Profile of a forensic laboratory, forensic scientist role and quality control, crime scene investigation, collation and preserving physical evidences and evidentiary documentation, future prospects of forensic analysis.

8. Real case Analysis

Liquor analysis, trap-case analysis, petroleum product analysis, fire and debris analysis, injuries, firearm wounds, asphyxia and stress analysis (only analytical identification).

Reference Books

1. Handbook of Industrial Chemistry by Davis Berner.
2. Quantitative Inorganic Analysis by A. I. Vogel. 5th edition.
3. Encyclopaedia of Industrial Methods of Chemical Analysis by F. D. Snil.
4. Textbook of Forensic Pharmacy by B. M. Mithal 9th edition 1993, National Centre Calcutta.
5. Forensic Pharmacy by B. S. Kuchekar and A. M. KhadatareNiraliPrakashan.

M. Sc. SEMESTES-IV

PHARMA-ANALYTICAL CHEMISTRY

405: PRACTICALS/ DISSERTATION

6 CREDITS

150 MARKS

1. To determine the active ingredient of a given sample of dichlorovos.
2. To determine the active content of phosphamidon in the given sample.
3. To determine the active content of endosulphan in a given sample.
4. Determination of nitrite (NO_2^-) in the given sample.
5. Determine the percentage of tin (Sn) and lead (Pb) in the given sample of solder wire.
6. To determine calcium and calcium carbonate in Ca-ore.
7. To estimate copper and tin in the given sample of bronze.
8. To determine sulphite (SO_3^-) in sulphurous acid (H_2SO_3) by back titration.
9. To determine copper, nickel and zinc composition in the given sample of germen silver alloy.
10. To analyse the given dolomite ore sample for its various elements.
11. To determine iron in ore.
12. To determine the available phosphorous in the soil.
13. To determine copper and zinc content in brass.
14. To determine of barium by preparing barium thiosulphate monohydrate.
15. To determine the lead by volumetric titration.
16. To determine zinc as ammonium phosphate or pyrophosphate.
17. To determination of Mg as a 8-hydroxy phenolate.
18. To determine the H_2O_2 in the given commercial sample.
19. To determine amount of organic carbon in soil.
20. Solvent extraction of organic/metal ion and their quantitative analysis.
21. Flame photometric determination of Na, K, Li and Ca.
22. Any other relevant experiment may be added.

M. Sc. SEMESTES-IV

PHARMA-ANALYTICAL CHEMISTRY

406: VIVA VOCE

2 CREDITS

50 MARKS

Theory based on C(PA)-401 to C(PA)-404 and practicals.

M. Sc. SEMESTER-III

ORGANIC PHARMACEUTICAL CHEMISTRY

C(OP)-301: ADVANCE CHROMATOGRAPHIC TECHNIQUES

4 CREDITS
100 MARKS

13. Introduction, revision of various chromatographic techniques and terminologies.
14. Principle, theory, instrumentation and applications of GC, HPLC, UPLC and super critical fluid chromatographic techniques.
15. **Ion Chromatography:** Principle, theory, instrumentation and applications.
16. **Exclusion Chromatography:**
    Theory and principle of size exclusion chromatography, experimental techniques for gel filtration chromatography (GFC) and gel-permeation chromatography(GPC). Column materials, factors governing column efficiency, methodology and applications.

17. **Hyphenated techniques:** Principle, theory, instrumentation and applications of GC-MS, LC-MS, GC-IR, LC-NMR, etc.
18. **Planner chromatography:**
    Paper chromatography, thin layer chromatography, and high performance thin layer chromatography: Principle, theory, instrumentation and applications.

Reference Books

23. Chromatography by E. Heftman, 5th edition, part-A and B, Elesvier Science Publisher, 1992.
24. Instrumental Methods of Analysis by B. K. Sharma, Goel Publisher, Meerut.
25. Analytical chemistry by Gary D. Christian, 6th edition (1994) John Wiley and sons Inc. New York.
26. Fundamental of Analytical Chemistry 8thEdn. Saunders College Pub. 2001.
27. Analytical Chemistry by H. Kaur, PragatiPrakashan, Meerut.
28. Instrumental Methods of Chemical Analysis by Chatwal and Anand.
29. Standard Methods of Chemical Analysis by F. J. Welcher.
30. Introduction to Modern Liquid Chromatography: 2nd edition L. R. Snyder and J. J. Kirkland- John Wiley & Sons Inc.
31. Analytical Methods in Chemistry by Y. R. Sharma.
32. Analytical chemistry by Open learning second edi. (Vol. 1-30) Wiley India Edi.
33. B. L. Karger, L. R. Snyder and C. Howarth, An Introduction to Separation Science, 2nd edition (1973), John Wiley, New York.

M. Sc. SEMESTER-III
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-302: ORGANIC SYNTHESIS-A DISCONNECTION APPROACH
4 CREDITS
100 MARKS

1. Disconnection fundamentals, explanation of synthons, synthetic equivalents considering various examples, concept and design of synthesis for molecules, criteria for good disconnection.
2. Explanation of one group disconnection and two group disconnection considering various examples.
3. Disconnections considering use of Diels-Alder reaction concept and its use in synthesizing organic molecules.
4. Reversal of polarity meaning, explanation (Unpolung) various examples in which polarity of carbon is reversed.
5. Protection and deprotection of various functional groups, various reagents for and examples.
6. Ring synthesis: three and four membered cyclic compounds.
7. Disconnection of acyclic and cyclic heterocompounds, synthesis of ethers, amines, nitrogen and oxygen containing five and six membered heterocyclic compounds.
8. Illogical two disconnection and synthesis of 2-hydroxy carbonyl compounds, 1,2-diols,1,4-diols and 1,6-carbonyl compounds.

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 and J. M. Coxon.
4. Advanced Organic Chemistry Part B – F. A. Carey and 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 : HETEROCYCLIC CHEMISTRY

4 CREDITS
100 MARKS

1. **Nomenclature of Heterocyclic Compounds**

   Introduction, Hanzch-Widman nomenclature for monocyclic, fused and bridged heterocycles.

2. **Three and four membered heterocycles**

   Preparation and properties of aziridine, azirine, oxiran, thiirane.
   Preparation and properties of diazirine and oxaziridine.
   Preparation and properties of azetidine, oxetane, thietane.

3. **Five-membered Heterocycles**

   Preparation and properties of pyrazole, imidazole, oxazole, thiazole.

   Preparation of isoxazole, oxazole, isothiazole, isothiazole.

   Preparation and properties of indole, benzofuran, thianaphthene.

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

   Preparation and properties of triazole and tetrazole.

4. **Six-membered Heterocycles**

   Preparation and properties of pyridine, pyran, pyrimidine, pyridazine and pyrazine.

   Preparation of 2-pyrones and 4-pyrones.

   Preparation and properties of quinoline, isoquinoline, acridine,phenanthridine, quinazoline, quinoxaline and cinnoline.

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

5. **Seven and Eight Membered Heterocycle**

   Synthesis of azepine, thiepine, diazepine.

   Synthesis of azocine, 1,4-diazocine,1,4-dioxocin,1,4-dithicine.

Reference Books

1. Heterocyclic Chemistry-R.K. Bansal.
2. An introduction to the Chemistry of Heterocyclic Compounds - R.H.Acheson.
3. Chemistry of Heterocyclic compounds-J.J. Trivedi
4. Heterocyclic Chemistry-R.R. Gupta, M.Kumar and V. Gupta, Springer.
5. The Chemistry of Heterocycles - T. Eicherand 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.
9.The Essence of Heterocyclic Chemistry, New Age International Publications,2013.

M.Sc. SEMESTER-III
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-304 : CHEMISTRTY OF NATURAL PRODUCTS
ELECTIVE-I

4 CREDITS
100 MARKS

1. **Alkaloids**
   Introduction and classification, Chemistry of atropine, coniine, and reserpine.Synthesis of morphine, colchinine, strychnine, sceletium A_4.
2. **Vitamins**
   Introduction and Chemistry of Vitamin A, E and K. Synthesis of riboflavin, pyridoxine vitamin C, niacin, pantothenic acid, folic acid,vitamin-H.
3. **Nucleic acid**
   Structure of nucleoside, nucleotide, and protein.
4. **Terpenoids**
   Introduction, classification, Chemistry of eudesmol, zingiberene and α-pinene.Synthesisof farnesol, santonine and longifolene.
5. **Steroids and Hormones**
   Constitution of cholesterol (no synthesis), Chemistry of progesterone and testosterone. Synthesis of hormones:Hexosterol and stilbosterol, ACTH.
6. **Prostaglandins**

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. StereoselectiveSynthesis: A Practical Approach - M. Nogradi.
4. Chemistry, Biological and Pharmacological 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.
6. Chemistry of Natural Products. By S. V. Bhat, B. A. Nagasampagi and M. Sivakumar,Springer-Berlin Heidelberg (2005).
7. Organic Chemistry of Natural Products by O.P. Agarwal, Goel Publishing House, Meerut(1997).

M. Sc. SEMESTER-III
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-304: SYNTHETIC DYES AND PIGMENTS

ELECTIVE-II

4 CREDITS
100 MARKS

1. **Color and Chemical Constitution**
   Introduction of dyes and pigments, prerequisites for a dye. Nomenclature of dyesintermediates, nomenclature of dyes.Bathochromic and hypsochromic effects.Colour, relation between colour and chemical constitution: Witt's theory, Armstrong's theory, Nietzki's theory, Valence bond theory, Molecular orbital theory. Classification of dyes based on chemical constitution and method of applications and examples.
2. **Natural Pigments and Porphyrins Derivatives**
   General structures, synthesis and spectral properties.Structural determination of haemoglobin, chlorophyll and bilirubin.Synthesis of cryptopyrrole, phytopyrrole, opsopyrrole and haemopyrrole and their carboxylic acid derivatives.
3. **General Introduction**
   Diazotization, mechanism and different methods of diazotization and laws of coupling, General introduction, classification and synthesis of monoazo dyes, bisazo dyes and azoic dyes. Evaluation of dyes.
   Synthesis of the following dyes: Disperse Red 13, Acid Blue 92, Mordant Black 11, Acid Black 1, Acid Blue 113, Direct Blue 15, Direct Violet 1, Direct Red 28, Naphthol AS-BR, Fast Orange GGD.
4. **Heterocyclic Dyes**
   Pyrazolone dyes, cyanine dyes, dyes containing azine, oxazine and thiazine ring systems. Thiazole dyes.
   Pigments:Different classes of organic pigments and synthesis. Synthesis of basic Yellow 11, Basic Orange 21, Safranine B, Rosinduline GG, Sirius Supra Blue FFRL, Brilliant Alizarin Blue 3R, Sirius Supra Yellow RT, Acid Yellow 19, Copper Phthalocyanine, Sirius Supra Light Green FFGL.

Reference Books

1. The Chemistry of Synthetic Dyes, Vol. I to VII by Venkataraman, Academic Press, New York.
2. Chemistry of Synthetic Dyes & Pigments by Lubs.
3. Dyes and their intermediates by E. N. Abrahart.
4. Handbook of Synthetic Dyes and Pigments, Vol. I & II by K. M. Shah.
5. Industrial Dyes by Klans Hunger, Germany by Wiley-VCH

M. Sc. SEMESTER-III
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-305: PRACTICALS

6 CREDITS
150 MARKS

1. Multicomponent reactions
2. Fries reaction
3. Friedel-Craft reaction
4. Mannich reaction
5. Beckmann reaction
6. Fischer indole synthesis
7. Hoffmann Degradation
8. Benzil-benzilic acid reaction
9. Ullmann reaction (Nascent Copper preparation and use)
10. Cyclocondensation reaction
11. Formylation reaction
12. Pechmann condensation

M. Sc. SEMESTER-III
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-306: VIVA VOCE

2 CREDITS
50 MARKS

Theory based on C(OP)-3-1 to C(OP)-304 and practicals

M. Sc. SEMESTER-IV

ORGANIC PHARMACEUTICAL CHEMISTRY

C(OP)-401: ADVANCE SPECTROSCOPIC TECHNIQUES

4 CREDITS
100 MARKS

13. **Ultraviolet Photoelectron Spectroscopy**: An overview, theory and applications of UV-spectroscopy.
14. **Electron Paramagnetic Resonance Spectroscopy:** Introduction, theory, instrumentation, spin-spin coupling, qualitative and quantitative analysis, multiple resonance, spin labelling, metallic complexes and other uses of EPR spectroscopy.
15. **^{1}HNMR Spectroscopy:** Overview of NMR spectroscopy, spin-spin interaction and nomenclature, non 1st order to 1storder spectrum, applications of coupling constants. 2D NMR technique.Multinuclear NMR spectroscopy and its applications.
16. **^{13}C NMR spectroscopy:** Comparison between ^{1}H and ^{13}C NMR spectroscopy, factors affecting ^{13}C NMR chemical shifts and identification of various organic molecules with coupling, decoupling, off resonance, etc.
17. **Vibrational and Rotational Spectroscopy**
    e. NIR: Principle, instrumentation and applications.
    f. Raman spectroscopy: Principle, theory, instrumentation and applications.
18. **Mass spectroscopy:** Principle, theory, instrumentation, fragmentation and applications.

Reference Books

27. Understanding NMR-Spectroscopy (2ndEdition), Wiley Publisher by James Keeler.
28. Spectroscopy by H. Kaur, PragatiPrakashan
29. Text book of spectroscopy by Jyotikumar, Sonali publication.
30. Analytical Spectroscopy by James Very, Pacific Book Int.
31. NMR Spectroscopy by Harald Gunther Wiley.
32. Handbook of Instrumental Techniques for Analytical Chemistry by F. Settle Pearson Edu.
33. Introduction to Spectroscopy (3rdEdition) by Pavia LampmanKriz: Cengage.
34. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Hiamalaya Publishing House.
35. Spectroscopy of Organic Copmpounds, P.S. Kalsi, New Age International Ltd.
36. Analytical Spectroscopy by James Vergeese.
37. Organic Spectroscopy by William Kemp.
38. Spectrometric Identification of Organic Compounds. (6th Edition) by Robert M. Silverstein & Francis X. Webster, Wiley.
39. Organic Spectroscopy: Principles and Applications, 2ndEdition by Jag Mohan, Alpha Science International Ltd., Harrow U. K.

M. Sc. SEMESTER-IV
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-402: CHEMISTRY OF SYNTHETIC DRUGS

4 CREDITS
100 MARKS

1. General introduction, nomenclature and classification of drugs.
2. **Cardiovascular drugs**
   Antiarrhythmic agent, antihypertensive, vasodilators (peripheral and coronary), coagulants and anticoagulants, antithrombotic and antiplatelet drugs.
3. **Central Nervous system:**
   Anaesthetic (local & general), analgesics, antipyretics, (steroidal and nonsteroidal anti-inflammatory drugs), sedative and hypnotic tranquilizers (major and minor), antiepileptics, anticonvulsants, antidepressants and antimaniacs. Drugs used in movement disorder, antiemetics ,CNS stimulants and activators.
4. **Musculoskeletal Disordor Drugs**:
   NSAIDS, antiarthritic drugs, neuromuscular drugs, muscle relaxants, topical analgesics.
5. **Respiratory System Drugs**:
   Antitussives, expectorants and mucolytics, respiratory stimulants, and antiasthematics.
6. **Gastrointestinal Tract Drugs:**
   Antacids, antiulcer, anti-spasmodics, anti-diarrheals, laxatives and lubricants.
7. **Genito urinary system Drugs**:
   Urinary infectives, diuretics and anti-diuretics, analgsics , spermicidal, contraceptives
8. **Allergy & immunology**
   Antiallergic and antihistamin, immuno-suppressants.
9. **Hormones**
   Anebolic and androgenic steroids, conticosteroids, oestrogen, progeslogers and contracoptrus, thyroids and antithyroid drugs, antidiabetic and hyper glycemics, fertiity agents, antiobesity drugs, hypolipidaemic agents.
10. **Antiinfections and Antiinfestation**
    Anticancer introduction to chemotherapeutic agents
    Antimalarials, antiprotogoals, antileprosy, antitubercular, antifungal, antianaerobicsanthelminticsand antiinfestive drugs and antiviral.
    Antibiotics and Antibacterials
    Pencillins, cophelosphorins, fluroquinolones, aminoglycosides, macrolides and other antibiotics, chloramphenicol, tetracycline, oxazolidinediones, and sulfonamides.

M.Sc. SEMESTER-IV
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-403: STEREOCHEMISTRY

4 CREDITS
100 MARKS

1. **Fundamental of Stereochemistry**
   Important terminology of stereochemistry andnomenclature.
   Chiral properties of Organic compounds: ORD, CD and rules for optical properties.Chemical and stereo chemical aspects of DNA, andenzymes.
2. **Conformational Analysis**
   Acyclic, cyclic, fused and bridged cyclic ring system.Dynamicstereochemistry, conformation and reactivity.
3. **Diastereosilectivity**
   Stereospecific and stereo selective reactions, prochirality, Crame's rule,Newman projection and Felkin-Anh model.Stereo selective and stereo regulator polymerization.Stereo chemistry of fused ring and bridge ring and spirans.
4. **Determination of Stereochemistry by Spectroscopic Methods**
   Dihedral angle and coupling constant.3j Coupling and Karplus equation and its modification.Geminal coupling in six-membered, five-membered and four-membered ring, Nuclear over houser effect, etc.Geometrical isomer and coupling constants.

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Reference Books

1. Organic Chemistry - I.L. Finar.
2. Stereochemistry - J.P. Trivedi
3. Stereochemistry of Organic Compounds by- D. Nasipuri,2nd Edition, New Age International(P) Ltd.(1994).
4. Stereochemistry of Organic Compounds - P.S. Kalsi.
5. StereoselectiveSynthesis : A Practical Approach, - M. Nogradi, VCH.
6. Organic Chemistry, By, J. Clayden,N. Greeves, S.Warren and P.Worthers, Oxford, University Press, (2001).
7. Stereochemistry of Carbon CompoundsBy E.L. Eliel,Tata McGrawn-Hill Pub. Co. Ltd.(1962).

M. Sc. SEMESTER-IV
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-404:ADVANCED STEREO CHEMISTRY

ELECTIVE-I

4 CREDITS
100 MARKS

1. **Isomerism of Organic Compounds**
   General introduction and classification of isomerism, entiomerism, measurement of optical activity, elements of symmetry and chirality of molecule, asymmetric and dissymmetric molecules.
2. **Aliphatic Nucleophilic Substitution**
   Introduction of aliphatic nucleophilic substitution reaction.SN^2reaction mechanism and evidence.SN^1reaction, nucleophilic substitution of allylicsystems.$SN^1$and SN^2reactions.Rearrangement in allylic systems.Nucleophilic displacements at allylic halides/tosylates.Nucleophilic substitution at the benzylic position.Nucleophilic substitution of vinylic and aryl halides. The SNimechanism,mixed SN1and SN2 reactions.Ambidentnucleophiles,Regioselectivity, set mechanisms, neighboring group participation-Anchimericassistance and others.
3. **Stereo Chemistry of Fused ring, bridge ring and Spirans**
   Introduction, trans-fused ring system, cis-fused ring system, spirocyclic ring system.Reactions with cyclic transition states.
4. **Stereo Selective and Stereo Regulator Polymerization.**
5. **Stereo Chemistry of N, S, P, As and B compounds.**

Reference Books

1. Organic Chemistry by I.L Finar.
2. Stereochemistry by J.P.Trivedi.
3. Stereochemistry by D.Nasipuri.
4. Stereochemistry of Organic Compounds by P.S.Kalsi (7^{th} edition).
5. Stereochemistry of Organic Compounds byE.L.Elieil and S.H.Wilen(1994).
6. Principle of Asymmetric Synthesis by J.Aube and R.E.Gawely.
7. Stereochemistry by Dacid G. Morris (2001).
8. StereoselectiveSynthesis: A Practical Apporch by M.Nogardi, VCH.
9. Organic Chemistry Clayden, Graves, Warren, Wothers Edition 2001 Oxford University.

M. Sc. SEMESTER-IV
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-404:ADVANCED MEDICINAL CHEMISTRY

ELECTIVE-II

4 CREDITS
100 MARKS

1. Introduction and Important terminology
2. **Drug Design**
   Fundamentals, techniques, concept of lead identification and lead modification SAR. Factors affecting biological activity. Resonance, inductive effect, Isosterism, bioisosterism and spatial consideration.

3. Pharmacokinetics
   ADME, prodrugs and polymorphism.

4. **Pharmacodynamics**
   Fundamentals, treatment of diseases by enzymes stimulation and inhibition, LDSO, MIC and MEC, etc.Theories of drug activity relationship.

5. Patents and IPR in drug discovery and development.
6. **Combinatorial Chemistry**
   Fundamentals methods, preparation study of targeted or focused libraries.

7. Recent updates in drug discovery (New Drugs).

Reference Books

1. Introducion to Medicinal Chemistry, AGringuage, Wiley-VCH.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F. Dorge.
3. An Introduction of Drug Design, S,S. Pandey and J.R. Dimoock, New Age International
4. Burgers Medicinal and Drug Discovery, Sixth Edition, Ed. M. E. Wolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill
6. The Organic Chemistry of Drug Design Action, R. B. Silverman, Academic Press.
7. Strategies for Organic Drug synthesis and Design, D. Ladnicer, John Wiley
8. Pharmaceutical Substances, Kleemann, Vol-I and 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. Erck Index, Thirteen edition, Merck and 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. Satqskar, Bhandarkar, Popular Prakashan.
15. Bio Pharmaceutics and Pharmakinatics by Bhramankar, VallabhPrakashan.

M. Sc. SEMESTER-IV

ORGANIC-PHARMACEUTICAL CHEMISTRY

C(OP)-405:PRACTICALS/DISSERTATION

6 CREDITS
150 MARKS

1. Multistep preparations with TLC monitoring of following

    a. Reduction
    b. Partial Reduction
    c. Oxidation
    d. Nitration
    e. Diazotization
    f. Sulphonation
    g. Methylation
    h. Etherification
    i. Use of PTC in organic synthesis
    j. New reagents

2. Drug Analysis
3. Spectral analysis of synthesized compounds

M. Sc. SEMESTER-IV
ORGANIC-PHARMACEUTICAL CHEMISTRY
C(OP)-406:VIVA VOCE

2 CREDITS
50 MARKS

Theory based on C(OP)-401 to C(OP)-404 and practicals

M. Sc. SEMESTER-III

INORGANIC CHEMISTRY

C(I)-301: ADVANCE CHROMATOGRAPHIC TECHNIQUES

4 CREDITS

100 MARKS

1. Introduction, revision of various chromatographic techniques and terminologies.
2. Principle, theory, instrumentation and applications of GC, HPLC, UPLC and super critical fluid chromatographic techniques.
3. **Ion Chromatography:** Principle, theory, instrumentation and applications.
4. **Exclusion Chromatography:**

   Theory and principle of size exclusion chromatography, experimental techniques for gel filtration chromatography (GFC) and gel-permeation chromatography(GPC). Column materials, factors governing column efficiency, methodology and applications.

5. **Hyphenated techniques:** Principle, theory, instrumentation and applications of GC-MS, LC-MS, GC-IR, LC-NMR, etc.
6. **Planner chromatography:**

   Paper chromatography, thin layer chromatography, and high performance thin layer chromatography: Principle, theory, instrumentation and applications.

Reference Books:

1. Chromatography by E. Heftman, 5^{th} edition, part-A and B, Elesvier Science Publisher, 1992.
2. Instrumental Methods of Analysis by B. K. Sharma, Goel Publisher, Meerut.
3. Analytical chemistry by Gary D. Christian, 6^{th} edition (1994) John Wiley and sons Inc. New York.
4. Fundamental of Analytical Chemistry 8^{th}Edn. Saunders College Pub. 2001.
5. Analytical Chemistry by H. Kaur, PragatiPrakashan, Meerut.
6. Instrumental Methods of Chemical Analysis by Chatwal and Anand.
7. Standard Methods of Chemical Analysis by F. J. Welcher.
8. Introduction to Modern Liquid Chromatography: 2^{nd} edition L. R. Snyder and J. J. Kirkland- John Wiley & Sons Inc.
9. Analytical Methods in Chemistry by Y. R. Sharma.
10. Analytical chemistry by Open learning second edi. (Vol. 1-30) Wiley India Edi.
11. B. L. Karger, L. R. Snyder and C. Howarth, An Introduction to Separation Science, 2^{nd} edition (1973), John Wiley, New York.

M. Sc. SEMESTER-III

INORGANIC CHEMISTRY

C(I)-302: MOLECULAR SYMMETRY AND GROUP THEORY

4 CREDITS

100 MARKS

1. Molecular Symmetry

Concept of Symmetry in Molecules

Symmetry elements and symmetry operations.

Group Theory

Molecular Point Groups: Definitions of group, subgroups, relation between orders of a finite group and its subgroup. Conjugacy relation and classes.Point symmetry group.**Matrix Methods in Symmetry:** 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.

IR and Raman Spectroscopy of Molecules: Application of group theory to Vibrational spectroscopy, symmetry and shapes of AB_2, AB_3, AB_4, AB_5, and AB_6. Applications of resonance to Raman and IR spectroscopy.

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 of the energy of various terms in weak field approximation: $^3A_{2g}$, $^3T_{2g}$ and $^3T_{1g}$ derived from $^3F(d^2)$ and ^1E_g and $^1T_{2g}$ derived from ^1D in an Oh field. **Strong Field Approximation:** Determining multiplicities by the method of descending 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. Introduction to Ligand Field, B.N.Figgis, Inc. New York.
3. Coordination Compounds, S. F. A. Kettle, ELBS.

4. Introduction to Ligand Field Theory, Bell Hausen, McGraw Hill.
5. Group Theory and Its Application to Chemistry, K. V. Raman, Tata McGraw Hill.

M. Sc. SEMESTER-III

INORGANIC CHEMISTRY

C(I)-303: ADVANCE BIOINORGANIC CHEMISTRY

4 CREDITS

100 MARKS

1. Metal ion Transport and Storage

Storage and transport of alkali and alkaline earth metals, ionophores, Na/K (sodium/potassium) pump, calcium pump. Scheme for (Ca^{2+}, Mg^{2+})-ATPase.

Storage and Transport of Iron

Ferritin and transferrin.Transport and storage of iron in plants, storage of iron in microbes.

2. Metalloenzymes

Mechanism of enzyme action, role of metal ions in catalysis.Kinetics of enzyme catalysis. The chemistry of vitamin B_{12}: Adenosylcobalmin and cynocobalmin (Vitamin -B_{12}), absorption, transport and metabolic function of vitamin B_{12}.

Nitrogen Fixation and Iron-sulphur Proteins: Nitrogen cycle and its fixation, iron-sulphur, 1Fe-S, 2Fe-2S, 4fe-4S proteins.

3. **Redox Metalloenzymes**

Cytochromes electron carriers, classification of cytochromes, cytochromes *c*, cytochromes *b*, cytochromes P-450.

4. Photosynthesis

Photoredox and non-protein metallobiomolecules: Chlorophyll, photosynthesis, light reaction, dark reaction: The Calvin cycle.

5. Coordination Compounds in Medicine

Metals and its Complexes as Therapeutic Agents: General remarks, anticancer drugs (platinum complexes) antiarthritis drugs (gold, copper and their complexes).

Reference Books

1. The Inorganic Chemistry of Biological Processes, M. N. Hughes, John Wiley & Sons.
2. Bioinorganic Chemistry, G. R. Chatwal and A. K. Bhagi, Himalaya Publishing House.
3. Advance Inorganic Chemistry, Cotton & Wilkinson, Weily Elsevier.

4. Principle of Bioinorganic Chemistry, S. J. Lippard and J. M. Berg, Uni. Science Books.

5. Inorganic Biochemistry Vols. I and II ed., G. L. Eichhorn, Elsevier.

M. Sc. SEMESTER-III

INORGANIC CHEMISTRY

C(I)-304: ORGANOMETALLIC COMPOUNDS AND CATALYSIS

(ELECTIVE-I)

4 CREDITS

100 MARKS

1. Organometallic Compounds

Introduction and nature of bonding in organometallic compounds of transition metals. π -bonded organ metallic compounds. Introduction and classification of π-bonded organometallic compounds of transition metals. Preparative methods, typical reactions and applications of η4-cyclobutadyne complexes, η5-cyclpentadynyl d-block metal complexes, fluxional organometallic compounds.

2. Catalysis

Homogeneous and heterogeneous catalysis involving metal complexes and organometallic compounds.Hydrogenation and hydroformylation reactions.Oxidative addition, reductive elimination, insertion and des-insertion reactions.

Metal complexes in enantioselective synthesis

Asymmetric hydrogenation and oxidation of alkenes, catalyst characterization, kinetics and application of these reactions. Catalyst development and mechanistic aspects of Zeigler – Natta catalysis, Fischer–Tropsch synthesis, water–gas shift reaction, Wacker process, monsanto process. Phase transfer and micellar catalysis. Principles of Green Chemistry and role of catalysis – concept of atom economy, E factors and atom efficiency, typical examples of atom economic reactions and atom un-economic reactions, some specific examples of chemical routes developed using catalysts.

Reference Books

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

M. Sc. SEMESTER-III

INORGANIC CHEMISTRY

C(I)-304: SELECTED TOPICS IN INORGANIC CHEMISTRY

(ELECTIVE-II)

4 CREDITS

100 MARKS

1. Inorganic Chemistry of Chains, Rings and Cages

Chains: Catenation, heterocatenation, zeolites, inseralation chemistry, one-dimensional conductors.

Rings: Borazines, phosphazenes (synthesis, bonding and reaction). Phosphazene polymers and homocyclic inorganic systems.

Cage compounds having phosphorus oxygen, nitrogen and sulphur (structure and bonding). Borane cages, boranes, $B_{12}H_{12}$ and other boranes derived from $B_{12}H_{12}$, structure relationship of closo, nido, archano and hypo boranes, carboranes, metallacarboranes, structure prediction of heterocarboranes.

2. Inorganic Chemistry of Biological system

Introduction, energy sources for life, non-photosynthetic processes, metalloporphyrins, cytochromes, iron porphyrins biomolecules. Structure and function of hemoglobin, Function of chlorophyll, structure and function of hemoglobin. Other iron-porphyrin biomolecules, peroxides and catalases, cytochrome P450 enzymes, other natural oxygen carriers, hemerythrins, electro transfer, respiration and photosynthesis; ferridoxins, and subredonim carboxypeptidase, carbonic anhydrase, metallathioneins. Blue copper proteins, superoxide dismutase hemocyanines photosynthesis, chlorophyll and photosynthetic reaction center.

3. Enzymes

Structure and function, inhibition and poisoning Vitamin B12 and B12 coenzymes metallothioneins, nitrogen fixation, in-vitro and in vivo nitrogen fixation, bio-inorganic chemistry of Mo and W, nitrogenases: other elements V, Cr, Ni (essential and trace elements in biological systems). Correnoid dependent enzymetic reaction, Vitamin B12 model compounds.

4. **Organometallic CompoundS in Pharmaceuticals**: Organometallic compounds as radiopharmaceuticals, tracers, ionphorse and sensors

Reference Books

1. J. E. Huheey, E. A. Keiter and R. L. Kieter, Inorganic Chemistry Principles of Structure and Reactivity, 4th Edition, Haper Collins.

2. B. Douglas, D. McDaniel and J. Alexzander, Concepts and Model of Inorganic Chemistry, 3rd Edition, John Wiley and Sons.
3. F.A.Cotton and G. Wilkinson, Advanced Inorganic Chemistry: A Comprehensive Text,

   5th Edition, John Wiely.

4. Ch, Elschenbroich and A. Salzer, Organimetallics, A Concise Introduction, Second Edition, Wiley-VCH.
5. D.F.Shriver and P.W. Atkins, Inorganic Chemistry, 3rd Edition Oxford University, Press.
6. J.A.Cowan, Inorganic Biochemistry, 2nd Edition, Wiley – VCH.
7. G.Wulfsberg, Inorganic Chemistry, University Science Books.

M. Sc. SEMESTER-III

INORGANIC CHEMISTRY

C(I)-305: PRACTICALS

6 CREDITS

150 MARKS

1. **Ore and Alloy Analysis**

   a. Dolomite
   b. Magnesite
   c. Calcite
   d. Brass
   e. Bronze
   f. Steel
   g. German Silver
   h. Steel
   i. Hematite

2. **Spectrophotometric Determination**

   Determination of composition and stability constant by various methods:

   a. Job's method of continuous variations.
   b. Mole-ratio method.
   c. Slope-ratio method.

3. **Water Analysis**

   Identification and determination of some cations and anions like

   a. Chloride
   b. Sulphate
   c. 3.Nitrate
   b. Carbonate
   c. Bicarbonate
   d. Calciam
   e. Magnesium
   f. COD
   g. Total hardness
   h. pH measurement
   i. Cconductivity measurement

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, Willy.
5. Fundamental of Analytical Chemistry, Skoog and West, Holt,Rinehart And Winston Inc.
6. Environmental Chemistry, A. K. De , Wiley Eastern.

M. Sc. SEMESTER-III

INORGANIC CHEMISTRY

C(I)-306:VIVA VOCE

2 CREDITS

50 MARKS

Based on theory (C-101 to C104) and practicals

M. Sc. SEMESTER-IV

INORGANIC CHEMISTRY

C(I)-401: ADVANCE SPECTROSCOPIC TECHNIQUES

4 CREDITS
100 MARKS

19. **Ultraviolet Photoelectron Spectroscopy**: An overview, theory and applications of UV-spectroscopy.
20. **Electron Paramagnetic Resonance Spectroscopy:** Introduction, theory, instrumentation, spin-spin coupling, qualitative and quantitative analysis, multiple resonance, spin labelling, metallic complexes and other uses of EPR spectroscopy.
21. **^{1}HNMR Spectroscopy:** Overview of NMR spectroscopy, spin-spin interaction and nomenclature, non 1st order to 1storder spectrum, applications of coupling constants. 2D NMR technique.Multinuclear NMR spectroscopy and its applications.
22. **^{13}C NMR spectroscopy:** Comparison between ^{1}H and ^{13}C NMR spectroscopy, factors affecting ^{13}C NMR chemical shifts and identification of various organic molecules with coupling, decoupling, off resonance, etc.
23. **Vibrational and Rotational Spectroscopy**
    g. NIR: Principle, instrumentation and applications.
    h. Raman spectroscopy: Principle, theory, instrumentation and applications.
24. **Mass spectroscopy:** Principle, theory, instrumentation, fragmentation and applications.

Reference Books

40. Understanding NMR-Spectroscopy (2ndEdition), Wiley Publisher by James Keeler.
41. Spectroscopy by H. Kaur, PragatiPrakashan
42. Text book of spectroscopy by Jyotikumar, Sonali publication.
43. Analytical Spectroscopy by James Very, Pacific Book Int.
44. NMR Spectroscopy by Harald Gunther Wiley.
45. Handbook of Instrumental Techniques for Analytical Chemistry by F. Settle Pearson Edu.
46. Introduction to Spectroscopy (3rdEdition) by Pavia LampmanKriz: Cengage.
47. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Hiamalaya Publishing House.
48. Spectroscopy of Organic Copmpounds, P.S. Kalsi, New Age International Ltd.
49. Analytical Spectroscopy by James Vergeese.
50. Organic Spectroscopy by William Kemp.
51. Spectrometric Identification of Organic Compounds. (6th Edition) by Robert M. Silverstein & Francis X. Webster, Wiley.
52. Organic Spectroscopy: Principles and Applications, 2ndEdition by Jag Mohan, Alpha Science International Ltd., Harrow U. K.

M. Sc. SEMESTER-IV

INORGANIC CHEMISTRY

C(I)-402: INORGANIC SPECTROSCOPY

4 CREDITS
100 MARKS

1. Nuclear-Quadrupole Resonance

Introduction, origin of transition and experimental techniques. Towne's and Dailey's formula, structural information from NQR illustrated by suitable examples.

2. Nuclear Magnetic Resonance

NMR studies of nuclei such as ^{19}F ,^{11}B and ^{31}P applications in inorganic complexes and shift reagents.

3. Electron Spin Resonance

Interaction between electron and spin and magnetic field, ESR technique, relaxation process and line width in ESR transition, hyperfine structure in ESR, zero field splitting, Kramer's degeneracy. Determination of 'g' and factors affecting it. Isotropic and anisotropic 'g' values, measurement techniques and applications of ESR measurements.

4. Photoelectron Spectroscopy

Basic principles, experimental method, ionisation process and Koopman's Theorem.Photoelectric spectra and their interpretation for simple molecules.Ultraviolate photoelectron spectra of atoms, Ultraviolate photoelectron spectra of molecules.Basic idea of Auger electron spectroscopy.

Reference Books

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

M. Sc. SEMESTER-IV

INORGANIC CHEMISTRY

C(I)-403: BONDING IN COMPLEXES

4 CREDITS
100 MARKS

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 planar arrangement of ligands around metal ion.Transformation of these potential from Cartesian to spherical harmonics.

2. **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 planar systems.

   Simple applications of CFSE.

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. 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.

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 and R. G. Pearson, Wiley New York.

M. Sc. SEMESTER-IV

INORGANIC CHEMISTRY

C(I)-404:COORDINATION CHEMISTRY

ELECTIVE-I

4 CREDITS
100 MARKS

1. **Reaction Mechanism of Transition Metal Complexes**

Substitution reaction of octahedral complexes: The nature of substitution reaction, Theoretical approach to substitution mechanism. Nucleophilic reactivity and nature of central atom.Kinetic application of crystal field theory. Substitution reaction of Co(III) complexes, replacement of co-ordinated water. Acid catalysis.

2. **Stereochemical changes in Octahedral Complexes**

Molecular rearrangement in complexes.Reactions of geometrical and optical isomers.Isomerization and racemization of octahedral complex.Ligand stereospecificity.

3. **Substitution Reaction of Square-Planar Complexes**

Trans effect and its theories. Mechanism of substitution reaction of Platinum (II) complexes.

4. **Oxidation-Reduction Reaction**

Outer sphere mechanism, inner sphere mechanism, and two electron transfer. Application to synthesis of coordination compounds.

5. **Complex Equilibria**

Introduction, computation of stability constant from equilibrium data.Basic principle, Mathematical functions and their interrelationships.

6. **Method of Computing Stability Constant**

Method based on half integral n values, correction method, graphical method and numerical method.. Experimental determination of composition and stability: Spectroscopic methods, methods of continuous variations, pH-metric Irving-Rossotti method.

Reference Books

1. Coordination Chemistry, D. Benerjia, Tata McGraw Hill.
2. Mechanism of Inorganic Reactions, F.Basolo and R. G. Pearson, Wiley New York.
3. Determination of Stability constants, Rossotti and Rassotti.
4. The Mechanisms of Reactions at Transition Metal Sites, Richard A.. Henderson, Oxford
5. Inorganic Reaction Mechanism, J.O. Edwards, Benjamin.

6. Chemistry of Complex Equilibria, T. M. Beck.
7. Chemistry of Metal Chelate Compounds, Martell and Calvin, John Wiley & Sons.

M. Sc. SEMESTER-IV

INORGANIC CHEMISTRY

C(I)-404: CATALYSIS

ELECTIVE-II

4 CREDITS
100 MARKS

1. Application of Organometallic Complex to Catalysis

a. **Fundamental processes in reaction of organo-transition metal complex**
Ligand coordination and dissociation, oxidative addition/reductive elimination including cyclometallation reaction.Insertion/Extrision, reaction of coordination ligands.

b. **Characteristics of transition metal complexes catalyst**
Mild condition and high selectivity homogeneous and heterogeneous catalysis. Polymerization and oligomerization of olefins and dienes.

c. **Synthesis using carbon monoxide**
Hydroformylation reaction, carboxylation of olefins, carbonylation of methanol, synthesis of oxalates, reaction, of synthesis gas.

d. **Oxidation of reaction**
Oxidation of olefins by Wacker process, acetoxlation of olefins, synthesis of arcylates and related derivatives, olefins epoxidation, olefin metathesis.

2. Organic Synthesis Using Transition Metal Complexes

a. Hydrogenation and related reactions, basic concept of olefin hydrogenation, asymmetric hydrogenation, hydro-silyation, hydrocyanation, isomerisation of olefins.
b. C-C bond formation: C-C coupling combing oxidation addition, alkylation and reductive elimination, C-C coupling utilizing oxidative addition combined with CO insertion, combination, of olefin insertion, hydrogen transfer and oxidative addition of organic halides.
c. Synthesis utilizing nucleophilic attack on coordinated ligands: reaction of coordinated olefins, synthesis and reactivity of coordinated allyl ligands, synthesis using C-H bond activation, synthesis utilizing oxidation addition and decarbonylate synthesis utilizing inseration and alkyl transfer, cyclopropanation reaction.
d. Electrophilic attack on the coordinated ligands, electrophilic cleavage of M-C organocobalt complex.
e. Stoichiometric reactions utilizing transition metal complexes: organocopper, organocobalt complexes.

Reference Books

1. F.A.Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley and sons.
2. J.E.Huheey, Inorganic Chemistry, Harper International.
3. M.N. Greenwood and A. Earnshaw, chemistry of the Elements, Pergramon Press.
4. Ch, Elschenbroich A. Salzer, Organometallic; A concise Introduction Chemistry: VCH.
5. D.F.Shriver, Inorganic Chemistry, Oxford Press

M. Sc. SEMESTER-IV

INORGANIC CHEMISTRY

C(I)-405:PRACTICALS/DISSERTATION

6 CREDITS
150 MARKS

1. **Inorganic Qualitative Analysis**
   Analysis of a mixture containing Eight radicals including one less common metal ions: W, Tl, Ti, Mo, Se, Zr, Th, Ce, V, Li.
   Minimum 15 mixtures containing inorganic salts like $CuSO_4$, KBr , TiO_2 , KI, Na_2CrO_4, $CaCO_3$, $Zr(NO_3)_3$, $NaNO_3$, ZnS, Na_2SO_4, SeO_2, NaCl, K_2SO_4 , $(NH_4)_2SO_4$, $(NH_4)_2MoO_4$, $BaCl_2$, $ZnCO_3$, $Al_2(SO_4)_3$, V_2O_5, ZnS, $Ni(NO_3)_2$, KNO_2, $Th(NO_3)_3$, KCl, $CdCO_3$, $CuCl_2$, $LiCO_3$, K_2SO_4, $AlPO_4$, H_3BO_3, $(NH_4)_2SO_4$, $CeSO_4$, $CdCl_2$, $Th(NO_3)_3$, $NaNO_3$, $ZnCO_3$, $AlPO_4$, $LiCO_3$, $Pb(NO_3)_2$, $NaNO_2$, $Zr(NO_3)_3$, Na_2WO_4, $MnSO_4$, $NaHSO_3$, SeO_2, K_2CrO_4, $FeSO_4$, $(NH_4)_2SO_4$, $(NH_4)_2MoO_4$, Na_3AsO_3, Na_3AsO_4, $(NH_4)_2SO_4$, K_2SO_4, $CeSO_4$, As_2O_3, NH_4Cl, $NiSO_4$, $LiCO_3$, $MgCO_3$, $NaNO_2$, $Mg_3(PO_4)_2$, V_2O_5, H_3BO_3, $SrCO_3$, $Th(NO_3)_3$, Na_3AsO_3, Na_3AsO_4, $BaCO_3$, $LiCO_3$.
2. **Preparations and Characterization of Inorganic Compounds**

   Preparation of selected inorganic compounds, their estimation and characterization by usual methods.

   a. Cu (α – Benzoin oxime)

   b. Ni $(DMG)_2$

   c. Fe (Cupfferon)

   d. Prussian Blue-$Fe_4[Fe(CN)_6]_3$

3. Chromatographic Separation

a. Paper Chromatography-circular and ascending

1. Zn^{++}, Mn^{++} and Co^{++}
2. Ag^{++}, Hg^{++} and Pb^{++}
3. Ni^{++}, Cu^{++}, and Co^{++}

b. Column Chromatography- Ion exchange

1. Zn^{++} and Mg^{++}
2. Co^{++} and Ni^{++}
3. Cl^- and Br^-
4. Zn^{++} and Cd^{++}

c. Thin-layer chromatography –

1. Fe^{++} and Al^{++}

2. Cu^{++} and Ni^{++}

4. **Flame Photometric Determination**
    1. Sodium and potassium when present together,
    2. Lithium/ Calcium
5. **pH metry**

    Determination of stability constant of complexes by pH-metry method

    1. Cu(II)- salicylaldehyde
    2. Ni(II) – salicylaldehyde

Reference Books

1. Inorganic Reaction Mechanism, J. O. Edwards, Benjamin.
2. Mechanism of Inorganic Reactions, F. Basolo and R. G. Pearson, Wiley New York.
3. Fundamental of Analytical Chemistry, Skoog and West, Holt, Rinehart and Winston Inc.
4. Text Book of Quantitative Inorganic Analysis, Vogel's, ELBS.

M. Sc. SEMESTER-IV

INORGANIC CHEMISTRY

C(I)-405: VIVA VOCE

2 CREDITS
50 MARKS

Theory based on C(I)-402 to C(I)-404 and practicals