

**M. Sc. SEMESTER: I - II  
CHEMISTRY**

**SYLLABUS**

**Effective from June 2010**



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

**DEPARTMENT OF CHEMISTRY**  
**SAURASHTRA UNIVERSITY, RAJKOT**  
**NEW SYLLBAS EFFECTIVE FROM JUNE-2010**  
**(CBCS)**

**M. Sc. SEMESTER-I**

<b>Subject Code</b>	<b>Title of the Course</b>	<b>Course Credits</b>	<b>No. of Hrs. / Week</b>	<b>Internal Examn. Marks</b>	<b>Sem. Examn. Marks</b>	<b>Total Marks</b>	<b>Examn. Hrs.</b>
C-101	Inorganic Chemistry	3	3	30	70	100	3
C-102	Organic Chemistry	3	3	30	70	100	3
C-103	Physical Chemistry	3	3	30	70	100	3
C-104	Analytical Chemistry	3	3	30	70	100	3
C-105	Practicals	15	15	-	-	100	14
		<b>27</b>	<b>27</b>	<b>120</b>	<b>480</b>	<b>500</b>	<b>-</b>

**M. Sc. SEMESTER-II**

<b>Subject Code</b>	<b>Title of the Course</b>	<b>Course Credits</b>	<b>No. of Hrs. / Week</b>	<b>Internal Examn. Marks</b>	<b>Sem. Examn. Marks</b>	<b>Total Marks</b>	<b>Examn. Hrs.</b>
C-201	Inorganic Chemistry	3	3	30	70	100	3
C-202	Organic Chemistry	3	3	30	70	100	3
C-203	Macromolecular Physical Chemistry-I	3	3	30	70	100	3
C-204	Analytical Chemistry	3	3	30	70	100	3
C-205	Practicals	15	15	-	-	100	14
		<b>27</b>	<b>27</b>	<b>120</b>	<b>480</b>	<b>500</b>	<b>-</b>

## M.Sc. SEMESTER-I

### C-101: INORGANIC CHEMISTRY

3 Credits  
100 Marks  
60Hrs.

#### UNIT-1 &2:

30Hrs.

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<sub>2</sub>O, NH<sub>3</sub> and CH<sub>4</sub>. Huckel  $\pi$ -electro theory and its applications to Ethylene, Butadiene and Benzene. Idea of Self-consistent field method.
2. **Magneto chemistry:** Definition of Magnetic Properties, Types of magnetic bodies, Diamagnetism and Pascal's Constant, Russell-Saunders or LS Coupling, Multiple width Large compared to kT, Multiple width small compared to kT, Stereo chemical applications of Magnetic Properties of the First Transition Series, Lanthanides and actinides, Determination of magnetic susceptibility by Gouy's Method, Derivation of Van Vleck formula for Susceptibility.

#### UNIT-3:

12Hrs

3. **Fundamentals of Mössbauer spectroscopy:** Introduction of Mössbauer Spectroscopy, Principle and evaluation of Mössbauer effect. Recoil energy, Doppler effect. Experimental techniques. Isomer Shift, Quadrupole splitting. Applications.

#### UNIT-4:

9Hrs

4. **Uses of Inorganic reagents in inorganic analysis :** General discussion and uses of some inorganic reagents: Potassium Bromate (KBrO<sub>3</sub>), Potassium Iodate(KIO<sub>3</sub>), Ammonium Vanadate (NH<sub>4</sub>VO<sub>3</sub>), Ceric Suphate [Ce(SO<sub>4</sub>)<sub>2</sub>], Ethylenediamine Tetra Acetic Acid (EDTA)

**UNIT-5:****9Hrs**

- 5. Uses of Organic reagents in inorganic analysis:** Cupferron, DMG, dithiozone, aluminon, oxine, dithiooxamide, a-benzoinoxime, a-nitro-(3-naphthol, a-nitrosoj3-naphthol, diphenyl carbazone, diphenyl carbazide, anthranilic acid, tannin, pyragallol, benzidine. salicylaloxime, o-phenanthroline

**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 Magnetochemistry, 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 Colelge.
8. Introduction to Magnetochemistry, Alan Earnshaw, Academic Press.

## M. Sc. SEMESTER-I

### C-102: ORGANIC CHEMISTRY

3 Credits  
100 Marks  
60 Hrs

#### UNIT-1: 12 Hrs

- 1. Reaction path way and effect of structure on reactivity:**  
Homolytic and Heterolytic fission, different types of arrow notation, Electrophile and Nucleophile, Linear free energy relationships (LFER), the Hammett equation- substituent and reaction constants, the Taft treatment of polar and steric effects in aliphatic compounds.

#### UNIT-2 & 3: 20Hrs

- 2. Organic Reactions like:** (I)  
**Nucleophilic C-C bond formation**  
1. Aldol condensation, 2. Horner-Wordworth-Emmons reaction, 3. Mukaiyama reaction, 4. Wittig reaction.

##### (II) Electrocyclic C-C bond formation

1. Nazarov cyclization, 2. Prins reaction, 3. Reaction of allyl palladium complexes, 4. Vilsmeier- Haack reaction, 5. Noyori reaction, 6. Reaction of allyl silane, 7. Stille coupling

##### (III) Miscellaneous reaction

1. Barbier-Wieland, 2. Barton, 3. Birch, 4. Bouveault, 5. ChiChi Babin 6. Clemmensen, 7. Elbs-persulphate, 8. Darzen, 9. Hantzsch, 10. Hofmann-Löffler Freytag, 11. Hydroboration, 12. Grubb's reaction, 13. Knoevenagel, 14. Leukart, 15. Michael addition, 16. McMurry olefination, 17. Mitsunobu reaction, 18. Oppenauer, 19. Passerini reaction, 20. Perkin, 21. Reformatsky, 22. Robinson annulation, 23. Rosenmund, 24. Shapiro, 25. Sharpless asymmetric epoxidation, 26. Stobbe, 27. Stork enamine, 28. Suzuki coupling, 29. Ugi reaction, 30. Vilsmeier-hack,,31. Wolff Kishner, 32. Wittig.

#### UNIT-4: 16 Hrs

- 3. Rearrangements:**  
General mechanistic consideration—nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements: Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Curtius, Schmidt, Baeyer-villiger.

**4. Important Reagents:**

Sodium cyanoborohydride, BBN, IBX, Dess martin periodinane, Ceric ammonium nitrate, Lithium diisopropylamide, Dicyclohexylcarbodiimide, Trimethylsilyl iodide, Peterson's synthesis, Lithium dimethylcuprate, Woodward and Prevost hydroxylation, Wilkinson's catalyst, Phase transfer catalyst, Crown ethers and Merrifield resin.

**Reference books**

1. Advanced Organic Chemistry, Part B – F. A. Carey & R. J. Sundberg, Plenum Press (2007).
2. Organic Chemistry by G. Marc. Loudon, Oxford University Press (2002).
3. Organic Reaction Mechanism (II edition) – V.K. Ahluwalia, R.K. Parasar.
4. Reaction Mechanism and Reagents in Organic Chemistry – Gurdeep R. Chatwal.
5. Organic Chemistry by Morrission and Boyd, prentice hall of India pvt ltd (6<sup>th</sup> edition), (2003)
6. Organic Chemistry – I.L.Finar 6<sup>th</sup> edition (low price), Pearson Education (2003).
7. A Text Book of Organic Chemistry – R.K.Bansal, New Age International (P) ltd. 4<sup>th</sup> edition (2003).
8. Advanced Organic Chemistry (IV edition) – Jerry March.
9. Reaction Mechanism and Problems in Organic Chemistry – P. Chattopadhyay, Asian Book Pvt Ltd, New Delhi (2003).
10. Reactive Intermediates in Organic Chemistry – J.P. Trivedi, University granth Nirman Board.
11. Organic Chemistry by T.W. Graham solimn, Craig B. Fryble, low price 8<sup>th</sup> edition, John Wiley & Sons, inc.
12. Organic Chemistry by V.K.Ahluwalia, Madhuri Goyal, Narosa Publishing House, (2000).
13. Organic Synthesis (2<sup>nd</sup> edition) by M.B. Smith, Mcgraw-Hill, Inc. (2001).
14. Some Modern Methods of Organic synthesis (4<sup>th</sup> edition), W.Carruthers, Cambridge University Press (2004).
15. Comprehensive Organic Synthesis, Vols 1-9, B.M. Frost & I Fleming. Pergamon (1991).
16. Organic Cehmsitry – Structure and Reactivity by Seyhan Ege, A.I.T.B.S. Publishers and Distributors. 3<sup>rd</sup> edition (1998).
17. Organic Synthesis – Strategy and Control by Paul Wyatt & Stuart Warren, John Wiley & Sons, (2007).
18. Principles of Organic Synthesis by R.O.C Norman, J.M. Coxon, CRC Press, (3<sup>rd</sup> edition) (2009).
19. Organic Chemistry by J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press (2000).
20. Organic Chemistry by J. Mcmurry, Asian Books Pvt. Ltd., 5<sup>th</sup> edition (2001).

## M.Sc. SEMESTER-I

### C-103: PHYSICAL CHEMISTRY

3 Credits  
100 Marks  
60 Hrs

#### UNIT-1:

12 Hrs

- 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.

#### UNIT-2:

10 Hrs

- 2. Fugacity and Activity:** Definition of fugacity and its determination by graphical, equation of state, approximate and generalized methods. Variation of fugacity with temperature and pressure. Fugacity of solids and liquids. Mixture of ideal gases and real gases. Activities and Activity coefficients in liquid solution. Problems.

#### UNIT-3:

10Hrs

- 3. The Debye-Huckel Theory:** Ionic interactions in solutions. Electrical potential of ionic atmosphere. Electrical free energy and activity coefficients. Mean ionic activity coefficients (D-H limiting law). Applications of D-H theory: quantitative and qualitative, solubility in presence of added electrolyte and osmotic coefficient. The D-H theory in more concentrated solutions. D-H theory and equilibrium constant. Problems.

#### UNIT-4:

10 Hrs

- 4. The properties of solutions:** Ideal solutions: Properties, the Duhem Margules equation, vapor pressure curves. Composition of liquid and vapor in equilibrium influence of temperature on gas solubility and solid-liquid equilibria. Non ideal solutions: Deviation from ideal behavior, vapor pressure curves, Liquid and vapor compositions. General equations for liquid mixtures. Partially miscible liquids.

**Dilute solutions:** Henry's law. Determination of molecular weight by freezing and boiling point methods. Problems.

**UNIT-5:****18 Hrs**

- 5. Free energy and Chemical reactions:** Chemical equilibrium and the equilibrium constant: Equilibrium in homogeneous gaseous systems. Homogeneous reactions in liquid solutions. Homogeneous reactions in dilute solutions. Chemical equilibria in heterogeneous systems. Free energy change in chemical reactions: The reaction isotherm, standard free energy of reaction, the direction of chemical change. Variation of equilibrium constant with pressure and temperature. Influence of temperature on heterogeneous reactions. Integration of the Van't Hoff equation. Variation of standard free energy with temperature. Simultaneous equilibria. Formation of standard free energies and entropy changes and their applications. Problems.
- 6. Applications of electrode potentials and thermodynamics of ions in solutions:** Calculations of equilibrium constants and solubility products from standard potentials. Dissociation pressures. The dissociation constants of water and weak acids. Free energies of formation of ions. Standard entropies of ions and applications. Standard heats of formation of ions. Examples.

**Reference Books**

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



## M. Sc. SEMESTER-I

### C-104: ANALYTICAL CHEMISTRY

3 Credits  
100 Marks  
60 Hrs

#### UNIT-1 & 2:

**30 Hrs**

##### **1. Introduction:**

What is analytical chemistry? The role of analytical chemistry, Classification of analytical methods: classical and instrumental. An internal role for chemical analysis.

##### **2. Fundamentals of quantitative chemical analysis**

- 1) Types and applications of chemical analysis.
- 2) Sampling.
- 3) Classical and instrumental techniques.
- 4) Factors affecting the analytical methods.
- 5) Law of mass action
- 6) Factors affecting chemical reactions in solution
- 7) Electrolytic dissociation
- 8) Solubility product
- 9) Common ion effect
- 10) Theory and factors affecting to precipitation, redox, complexometric and neutralization techniques
- 11) Various concentration units
- 12) Preparation, standardization of solutions, reagents, primary and secondary standards.

#### UNIT-3:

**10 Hrs**

##### **3. Food analysis:**

Moisture, ash, crude, protein, fat, crude-fiber, carbohydrate, Ca, K, Na and  $\text{PO}_4$ , Oil and fat.

##### **4. Flamephotometry:**

5. Principle, theory, instrumentation, sample handling and applications.

**UNIT-4:**

**10 Hrs**

**6. Fluorimetry and Phosphorimetry:**

Principles, theory, instrumentation, sample handling and applications.

**UNIT-5:**

**10 Hrs**

**7. Turbidimetry and Nephelometry:**

principles, theory, instrumentation, sample handling and applications.

**Reference Books:**

1. Fundamentals of analytical chemistry. D. A. Skoog, D. M. West, F. J. Holler and Crouch.
2. Analytical Chemistry.- G. D. Christian.
3. Quantitative Analysis.. R. A. wDay Jr. And A. L. Underwood.
4. Analytical Chemistry. Principles – J. K. Kennedy and W. B. Saunders.
5. Instrumental Methods of Chemical Analysis.B. K. Sharma.
6. Food Analysis. S. N. Mahindru.
7. Vogel's Textbook of quantitative Inorganic Analysis – L. Barrt et. al. ELBS.

## M.Sc. SEMESTER-I

### C-105: PRACTICALS

15 Credits  
100 Marks

#### 1. Organic Chemistry:

(i) Organic preparation: Two stage preparation (10).

(ii) Organic spotting (15): Multifunctional compounds.

#### 2. Inorganic Chemistry:

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

2 **Preparation and estimation of metal complexes:** Preparation of selected inorganic metal complexes (15) and their estimation by usual volumetric/gravimetric/colorimetric techniques to determine the percentage purity of the complexes prepared:

#### 3. Physical Chemistry:

##### (i) Instrumental exercises:

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

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

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

(d) **Ultrasonics:** Acoustical parameters of liquids.

(e) **Refractometry:** Binary mixtures and solids.

(f) **Polarimetry:** Optically active compounds.

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

##### (ii) Physicochemical exercises:

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

(b) **Partition coefficient:** Dimerization of acids, I-I<sub>2</sub> system, Cu<sup>2+</sup> - NH<sub>3</sub> complexes.

(c) **Thermodynamics:** Heat of solution, partial molar volume, etc.

(d) **Steam distillation:** Molecular weight determination.

#### **4. Analytical Chemistry:**

1. **Practicals based on food analysis:** Honey, oil, tea-leaves, turmeric powder, etc.
2. **Drug analysis:** aspirin, Benzyl benzoate, etc.
3. **Volumetric and gravimetric exercises:** Ester, peroxides, other ions, etc.
4. **Industrial products:** Estimation for purity and assay.

## M. Sc. SEMESTER-II

### C-201: INORGANIC CHEMISTRY

3 Credits  
100 Marks  
60 Hrs  
**18 Hrs**

#### UNIT-1 & 2:

- 1. Organometallic Compounds:** Introduction and Nature of bonding in organometallic compounds of transition metals.  $\sigma$ -bonded organometallic compounds: Introduction, Classification and synthesis of  $\sigma$ -bonded organotransition metal compounds, general characteristics, chemical reactions, bonding and structure.  $\pi$ -bonded organometallic compounds: Introduction and Classification of  $\pi$ -bonded organometallic compounds (a)  $\eta^2$ -alkene complexes: Preparative methods, physical properties, chemical properties, bonding of structure. (b)  $\eta^3$  allyl (or enyl) complexes preparation, physical of chemical properties.

#### UNIT-3:

**15 Hrs**

- 2. Fundamentals 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-hemoglobin and myoglobin, Physiology of blood.

#### UNIT-4:

**15 Hrs**

- 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 following: 1. Zinc and Magnesium, 2. Chloride and bromide, 3. Cobalt and Nickel, 4. Cadmium and Zinc

**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 And Bhagi, 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

3 Credits  
100 Marks  
60 Hrs  
12 Hrs

#### UNIT-1:

##### 1. Photochemical Reactions:

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

##### 2. Determination of Reaction Mechanism :

Classification, rate constant and life times of reactive energy state – determination of rate constant of reactions Effects of light intensity on the rate of photochemical reactions. Types of photochemical reaction – photo-dissociation, gas phase photolysis.

##### 3. Photochemistry of Alkenes:

Intramolecular reaction of the olefinic-bond –geometrical isomerism, cyclisation reactions, rearrangement of 1,4- and 1, -dienes.

#### UNIT-2:

12 Hrs

##### 4. Photochemistry of Carbonyl Compound :

Intramolecular reaction of the Carbonyl Compound-saturated, cyclic and acyclic,  $\beta,\gamma$ -unsaturated and  $\alpha,\beta$ -unsaturated compounds, Cyclohexadienones. Intramolecular cycloaddition reaction- dimerisation and oxetane formation.

##### 5. Photochemistry of Aromatic Compounds:

Isomerisations, addition and substitutions reactions.

##### 6. Miscellaneous Photochemical Reactions:

Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photo degradation of polymers. Photochemistry of vision.

#### UNIT-3 & 4:

24 Hrs

##### 7. Pericyclic Reaction

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3 – butadiene, 1,3,5–hexatriene and allyl system. Classification of pericyclic reactions. Woodward–Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reaction – conrotatory and disrotatory motions,  $4n$  and  $4n+2$  and allyl systems.  $2+2$  Cycloadditions – antarafacial and suprafacial additions.

**UNIT-5:****12 Hrs****8. Aromaticity**

Nonbenzene aromatic compounds, azulenes, Tropolener ( $4n+2$ ), Huckel's rule and its applications.

**Reference books**

1. Organic Chemistry by G. Marc. Loudon, Oxford University Press (2002).
2. Organic Reaction Mechanism (II edition) – V.K. Ahluwalia, R.K. Parasar.
3. Reaction Mechanism and Reagents in Organic Chemistry – Gurdeep R. Chatwal.
4. Organic Chemistry – I.L.Finar 6<sup>th</sup> edition (low price), Pearson Education (2003).
5. A Text Book of Organic Chemistry – R.K.Bansal, New Age International (P) Ltd. 4<sup>th</sup> edition (2003).
6. Advanced Organic Chemistry (IV edition) – Jerry March.
7. Principles of Organic Synthesis by R.O.C Norman, J.M. Coxon, CRC Press, (3<sup>rd</sup> edition) (2009).
8. Organic Chemistry by J. Clayden, N. Greeves, S. Warren, P. Wothers, Oxford University Press (2000).



## M. Sc. SEMESTER-II

### C-203: MACROMOLECULAR PHYSICAL CHEMISTRY-I

3 Credits

100 Marks

60 Hrs

#### UNIT-1: 10 Hrs

- 1. Basic concept of polymer chemistry:** Classification of polymers. Types of polymer chains. Stereo regular polymers. Polymer nomenclature. Functionality and polymerization concept. Synthesis of monomers.

#### UNIT-2: 16 Hrs

- 2. Chain polymerization:** Free radical polymerization: Methods of initiating free radical polymerization. Chain transfer reactions. Kinetics of free radical polymerization and chain transfer reactions. Factor affecting radical polymerization and properties of the resulting polymer.  
Ionic (Catalytic) polymerization: Kinetics of cationic and anionic polymerization. Coordination polymerization. Molecular weight distribution. Copolymerization and its kinetics. Evaluation of reactivity ratios.

Methods of free radical polymerization: Bulk polymerization, solution polymerization, emulsion polymerization and solid phase polymerization. Poly-recombination. Problems.

#### UNIT-3: 16 Hrs

- 3. Polycondensation:** Reaction route of polyfunctional compounds. Kinetics of polycondensation reaction. Molecular weight control in polycondensation. Nonlinear polycondensation. Statistics of linear polycondensation. Effect of monomer concentration and temperature on direction of polycondensation reaction. Polycondensation equilibrium and molecular weight of polymer. Factors affecting the rate of polycondensation and molecular weight of the polymer. Method of polycondensation: Melt, interfacial, solution and solid phase polycondensation. Problems.

#### UNIT-4: 6 Hrs

- 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.

**UNIT-5:****12 Hrs**

5. Thermodynamics of liquid mixtures and polymer solutions. Polymer dissolution, solubility parameter and simple liquid mixtures. Types of solutions. Polymer solutions. Solvent activity. Noncombinatorial free energy. Examples.
6. Physico-chemical degradation reactions. Cross-linking and reactions, of functional groups.

**Reference Books**

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

## M.Sc. SEMESTER-II

### C-204: ANALYTICAL CHEMISTRY

3 Credits  
100 Marks  
60 Hrs

#### UNIT-1 & 2: 30 Hrs

##### 1. Introduction to Environmental Chemistry:

Definitions of air pollution, energy balance between earth-atmospheric systems, particulates types classifications, organic particulates, particulate collection techniques, importance of particulates, photolytic cycle, photochemical smog chemistry. Principles of water analysis their parameters, sampling and preservation techniques. Definitions of important terms.

#### UNIT-3 & 4: 20 Hrs

##### 2. Electrometric Analysis

- a. Types of error
- b. Accuracy and precision
- c. Data processing
- d. Confidence limit and interval
- e. Test of significance
- f. t-test and F-test
- g. Rejection of data
- h. Control charts
- i. Least square analysis
- j. Problems

#### UNIT-5: 10 Hrs

##### 3. Green Chemistry approach

Introduction, current trends of synthesis and techniques of green approach .

### Reference Books:

1. Environmental Chemistry. A. K. De.
2. An Introduction to air pollution. R. K. Trivedi and P. K. Goel.
3. Principles of Environmental Chemistry. H. Kolhandaraman and Geetha Swaminathan.
4. Atmospheric Pollution. Black W. (McGraw Hill Company) New York.
5. A Textbook of Environmental Chemistry and Pollution Control. S. S. Dara (S. Chanda & Co.) New Delhi.
6. Ecology of Polluted water and Toxicology. K. D. Mishra.
7. Environmental Guidelines and Standards in Indian. P. K. Goel & K. P. Sharma.
8. Enzyme Biotechnology. G. Tripathi.
9. Industry, Environment and Pollution. Arvind Kumar and P. K. Goel.
10. Manual on water & waste water analysis. NEERI
11. Water Pollution. Dr. V. P. Kudesia.
12. Basic concepts of Environmental Chemistry. Des W. Connel.
13. Manual on Water and Wastewater analysis. Dr. B. B. Sundarsan.
14. Liquid waste of Industry: Theories Practices and Treatment. Nelson L. Nemerow.
15. Statistics in Chemistry. P. H. Parsanaia
16. W. Horwitz, Official Methods of Analysis, 11<sup>th</sup> edition (1970), Association of Official Analytical Chemists, Washington DC.

## M.Sc. SEMESTER-II

### C-205: PRACTICALS

15 Credits  
100 Marks

#### 1. Organic Chemistry:

(i) Organic preparation: Two stage preparation (10).

(ii) Organic spotting (15): Multifunctional compounds.

#### 2. Inorganic Chemistry:

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

**Preparation and estimation of metal complexes:** Preparation of selected inorganic metal complexes (15) and their estimation by usual Volumetric /Gravimetric /Colorimetric techniques to determine the percentage purity of the complexes prepared:

#### 3. Physical Chemistry:

##### (i) Instrumental exercises:

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

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

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

(d) **Ultrasonics:** Acoustical parameters of liquids.

(e) **Refractometry:** Binary mixtures and solids.

(f) **Polarimetry:** Optically active compounds.

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

**(ii) Physicochemical exercises:**

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

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

**(c) Thermodynamics:** Heat of solution, partial molar volume, etc.

**(d) Steam distillation:** Molecular weight determination.

**4. Analytical Chemistry:**

3. **Practicals based on food analysis:** Honey, oil, tea-leaves, turmeric powder, etc.

4. **Drug analysis:** aspirin, Benzyl benzoate, etc.

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

6. **Industrial products:** Estimation for purity and assay.