# SYLLABUS

MANONMANIAM SUNDARANAR UNIVERISTY, TIRUNELVELI-12

**PG - COURSES – AFFILIATED COLLEGES**

Course Structure for

# M.Sc. CHEMISTRY

(Choice Based Credit System)

(with effect from the academic year 2021- 2022 onwards)

| **Semester-I** | | | | |
|---|---|---|---|---|
| **Part** | **Subject Status** | **Subject Title** | **Subject Code** | **Credit** |
| III | Core - 1 | Aromaticity and Organic Reaction Mechanism | ZCHM11 | 4 |
| | Core - 2 | Fundamentals of Inorganic Chemistry, Nuclear Chemistry and Inorganic Polymers | ZCHM12 | 4 |
| | Core - 3 | Quantum Mechanics and Spectroscopy – I | ZCHM13 | 4 |
| | Elective – I | Green Chemistry – Techniques and Applications | ZCHE11 | 4 |
| | Core - 4 Practical - 1 | Organic Chemistry Practical – I | ZCHL11 | 2 |
| | Core – 5 Practical - 2 | Inorganic Chemistry Practical – I | ZCHL12 | 2 |
| | Core -6 Practical - 3 | Physical Chemistry Practical – I | ZCHL13 | 2 |

# AROMATICITY AND ORGANIC REACTION MECHANISM

**Objectives:**

- To understand the concept of aromaticity, Novel ring systems and organic reaction mechanism determination.
- To study about reactive intermediates involved in organic reactions.
- To understand Aliphatic and Aromatic Nucleophilic substitution reaction, Elimination and Addition reaction mechanisms.

**UNIT I –**

**AROMATICITY AND NOVEL RING SYSTEM**

Aromaticity: Benzenoid and non–benzenoid aromatic compounds – sextet theory – MO theory – Delocalisation and resonance - Huckel's rule – Aromatic – antiaromatic –

homoaromatic and non–aromatic compounds - Musulin – Frost diagram - NMR and aromaticity - Annulenes and hetero annulenes – Azulene and sydnones - Fullerenes - Alternant and non – alternant Hydrocarbons.

**Novel ring system**: Nomenclature of bicyclic and tricyclic systems – structure and synthesis of Adamantane – Congressane.

**UNIT II**

**DETERMINATION OF ORGANIC REACTION MECHANISM**

**Reaction mechanism**: Energy diagram of simple Organic reactions – Transition state and intermediate - Kinetic and Thermodynamic requirements of reactions – Hammond Postulate and microscopic reversibility.

**Methods:** Kinetic and Thermodynamic control of product formation. Kinetic methods of determination: Rate law – Primary and secondary isotope effect. Non-Kinetic methods of determination: Testing and Trapping of intermediates, Isotopic labeling, Cross–over experiment, Product analysis and stereo chemical evidence.

**LFER:** Hammett equation – Physical significance of □□and □ – Applications and Limitations – Taft equation. Yukawa Tsuno equation, Swain-Lupton equation, Grunwald–Winstein equation.

**UNIT III**

**REACTIVE INTERMEDIATES**

**Carbenes**: Generation, stability, structure and reactivity of carbenes – Simmons Smith cyclopropanation, Wolff rearrangement of acyl carbenes and their synthetic applications.

**Nitrenes:** Generation, stability, reaction of nitrenes - Mechanism of rearranegements through Nitrene intermediate: Schmidt, Hoffmann, Beckmann rearrangements.

**Free radicals**: Formation, structure, stability and reactivity - Fenton, Kolbe, Hofmann-Loffler, Barton – McCombie, Giese reactions and Barton-decarboxylation.

**UNIT IV**

**ALIPHATIC NUCLEOPHILIC SUBSTITUTION AND ELIMINATION REACTIONS**

Aliphatic nucleophilic substitution: Mechanism of $S_N1$, $S_N2$, $S_Ni$, $S_N1'$, $S_N2'$ and $S_Ni'$ reactions – Stereochemical aspects of these reactions - Effect of substrate, nucleophile, leaving group and solvent on the rate of substitution - Ambident nucleophile – NGP.

**Elimination reaction**: $E_1$, $E_2$ and $E_1CB$ mechanisms - Stereochemical aspects of these reactions - Factors influencing elimination reactions - Hofmann and Satyzeff rules - Pyrolytic elimination - Chugaev and cope reactions - competition between substitution and elimination reactions.

**UNIT V**

**AROMATIC NUCLEOPHILIC SUBSTITUTION REACTION AND ADDITION TO MULTIPLE BONDS**

Aromatic nucleophilic substitution reaction: Unimolecular, Bimolecular and Benzyne mechanisms - Reactivity, effect of substrate, leaving group and attacking nucleophile -typical reaction as oxygen and sulphur as nucleophile - Bucherer and Rosenmund reaction - Smiles rearrangement - Ortho-lithiation reaction and its application.

Catalytic hydrogenation - Birch reduction - Dieckmann condensation - Mannich reaction - Wittig reaction - Sharpless asymmetric epoxidation - Michael addition (1,2 and 1,4) - Addition of dialkyl groups to triple bonds. Addition of hydrides – $LiAlH_4$ and $NaBH_4$.

**PRESCRIBED BOOKS**

1. R.T. Morrison, and R.N. Boyd, Organic Chemistry, 7th edn, Pearson Education, 2010.
2. J. Mc Murry, Fundamentals of Organic Chemistry, 7th edn, Cengage Learning India Edition, 2013.
3. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, 6th edn, Pearson Education, 2003.
4. I.L. Finar, Organic Chemistry, Vol I, 6th edn, Pearson Education, 2002.
5. M.B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 7th edn, Wiley, 2015.
6. S.M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Trinity Press, 2014.
7. John McMurry, Fundamentals of Organic Chemistry, Fifth edition, Thomson-Brooks/Cole, 2003.
8. Raj K. Bansal, Organic Reaction mechanisms, Tata Mc Graw Hill, Third Editon, 2007.

**REFERENCE BOOKS**

1. Jerry March, Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Fourth edition, John Wiley & Sons (Asia) Pvt. Ltd. 2003.
2. S.H. Pine, Organic Chemistry, Fifth edition, Tata McGraw Hill Education, 2006.
3. T.W. Graham Solomons, C.B. Fryhle and S.A. Snyder, Organic Chemistry, 12th edn, Wiley, 2016.
4. J. Clayden, N. Greeves and S. Warren, Organic Chemistry, Second edition, Oxford University Press, 2014.
5. H. Togo, Advanced Free Radical Reactions for Organic Synthesis, Elsevier, 2004.
6. F.A. Carey and J. Sundberg , Advanced Organic Chemistry, Part A: Structure and Mechanisms, Fifth edition, Springer, 2007.
7. F.A. Carey and J. Sundberg, Advanced Organic Chemistry, Part B: Reaction and Synthesis, Fifth edition, Springer, 2007.

# FUNDAMENTALS OF INORGANIC CHEMISTRY, NUCLEAR CHEMISTRY AND INORGANIC POLYMERS

**Objectives:**

- To understand different type of bonds and to study different theories of bonding.
- To understand the acid-base concept, reactions in non-aqueous medium and to study applications of redox potential in inorganic systems.
- To introduce nuclear chemistry and to study the applications of radio isotopes.
- To understand structures and bonding in inorganic polymers and metal clusters.

## UNIT I
## CHEMICAL PERIODICITY, CHEMICAL FORCES AND REDOX POTENTIAL

Cause of Periodicity; Atomic radius: Covalent radius; Vander Waals' radii; Ionic radii; Ionization Potential; Electron affinity and electronegativity (Their variation in the periodic table and factors affecting them). Anomalous ionization potential and electron affinities; Applications of electronegativity, Group - electronegativity, Electronegativity equilization.

**Slater Rules**: Statement, applications and limitations.

Chemical Forces: Ion – dipole forces, dipole – dipole interactions, induced dipole interactions, instantaneous dipole – induced dipole interactions, Repulsive forces, H – bonding and its types – Effect of chemical forces on melting point, boiling point and solubility.

**Redox potential**: Factors affecting Redox potential - Applications of redox potentials: Latimer diagram.

## UNIT II –
## CHEMICAL BONDING

**Valence Bond theory**: Lewis structure – Concepts and VB theory of $H_2$ molecule - Stereochemistry of hybrid orbitals – Calculation of s and p characters of equivalence and nonequivalence of hybrid orbitals - VSEPR theory.

**M.O. theory** – Linear combination of Atomic orbitals ( s – s, s – p, d – p, p – p and d –d overlapping) - s , p, d and quadruple bond. – M.O. diagrams of hetero nuclear diatomic molecules (CO, NO, HF) and triatomic molecules ($BeH_2$, $H_2O$, $CO_2$) – Walsh diagrams – Structure and hybridization - Bents rule and apicophilicity.

**Ionic Bond**: Lattice energy – Consequences- Born-Lande equation, Born Haber cycle and numerical problems involving it for the calculation of electron affinity or lattice energy – Kapustinskii equation.

## UNIT III
## ACID BASE CONCEPTS AND NON-AQUEOUS SOLVENTS

**Acid Base concepts**: Lewis, Solvent systems, Lux Flood and Usanovich Acid – Base concepts. Group characteristics of Lewis acids – Reactions of Lewis acids Relative strength of Acids and Bases, Steric effect, Proton sponges, Solvation effects and Acid Base anomalies.

**HSAB:** Classification of Hard and Soft acids and bases – Pearson's concept – Acid – base strength and Hardness and Softness – Symbiosis – Theoretical basis of Hardness and Softness – Electronegativity and Hardness and Softness – Applications of HSAB.

**Non-aqueous solvents**: Classification of protic and aprotic solvents – General

characteristics of solvents - Self ionization and leveling effect. Reactions in non-aqueous solvents - acid-base reactions, complex formation, solvolysis, solvation, Metatheses - Reactions in liquid $NH_3$, $SO_2$, $H_2SO_4$ - Molten salts.

**UNIT IV**

**NUCLEAR CHEMISTRY**

**Atomic nuclei**: Nuclear shell structure – nuclear reactions : types, Q-value, threshold energy, cross sections and excitation functions. Direct nuclear reactions – transmutation reactions: stripping and pick-up – high energy reactions : neutron evaporation and spallation – heavy ion reactions – photonuclear reactions. Nuclear fusion and stellar energy – nuclear fission : mass distribution of fission products – fission energy – fission neutrons – theory of nuclear fission – spontaneous fission. Waste disposal and atomic power project in India.

**Radio isotopes**: Preparation - Analytical applications: radio chromatography, neutron activation analysis, neutron absorptiometry and radiometric titrations.

**UNIT V**

**INORGANIC POLYMERS AND METAL CLUSTERS**

**Inorganic polymers**: General characteristics, degree of polymerization, catenation and heterocatenation - property correlation - Polyacids - structures of isopoly and heteropoly anions - Polymeric sulphur nitride - Borazines - Phosphazenes - Phosphazene polymers - Boranes and carboranes - Structure and bonding in boranes - Wade'srule.

**Structure and Bonding of Inorganic Metal clusters**: Dinuclear Clusters: Cu(II) carboxylate, Chromium(II) acetate, $Mo_2Cl_8^{4-}$ and $Re_2Cl_8^{2-}$ - Trinuclear Clusters: $Re_3Cl_9$ - Tetranuclear Clusters: $W_4(OR)_{12}$, $W_4(OR)_{16}$, $Mo_4Cl_{12}^{4-}$ - Hexanuclear Clusters: $[Nb_6Cl_{12}]^{2+}$, $[Os_6(CO)_{18}]^{2-}$ and $[Mo_6Cl_8]Cl_4$– Capping rule – poly atomic Zintl ions.

**PRESCRIBED BOOKS**


1. James E. Huheey, Ellen A. Keiter, Richard L. Keiter and O.K. Medhi, Inorganic chemistry: principles of Structure and Reactivity, 4th Edition, Pearson Education India, 2006.
2. J.D. Lee, Concise Inorganic Chemistry, Wiley, 5th Edition, 2014.
3. Wahid.U.Malik , G.D.Tuli and R.D.Madhan , Selected Topics in Inorganic Chemistry , S.Chand& Company Ltd , New Delhi, 2009.
4. P.Atkins , T.Overton , J.Rourke , M.Weller and F.Armstrong , Inorganic Chemistry , 5th edition , Oxford University press, 2010.
5. C.E.Housecraft and A.G.Sharpe , Inorganic Chemistry , 4th edition , Pearson, 2012.
6. Samuel Glasstone, Source Book of Atomic Energy, 3rd edition, East West Pvt. Ltd., 1979.
7. H.J. Arnikar, Essentials of Nuclear Chemistry, Wiley Eastern Ltd., 4th Edition, 2000.


**REFERENCE BOOKS**


1. F. Albert Cotton, Geoffrey Wilkinson, Carlos A. Marilo and Manfred Bochman, Advanced Inorganic Chemistry, Wiley Interscience Publication, 6th Edition, 1999.
2. N.N. Greenwood and Earnshaw, Chemistry of the Elements, Pergamon Press, 2nd Edition, 1997.
3. B.E. Douglas, D.H. McDaniel and J.J. Alexander, Concepts and Models of Inorganic Chemistry, John Wiley and Sons Ltd. 3rd Edition, 2010.
4. K.F. Purcell and J.C. Kotz, Advanced Inorganic Chemistry, Cengage Learning, 2012.
5. W.l.Jolly ,Modern Inorganic Chemistry , 2nd Edition , McGraw-Hill ,1991.
6. J.E.Mark , R.West&H.R.Allcock , Inorganic Polymers , Academic Press ,1992.

7. G. Friedlander, J.W. Kennedy, E.S. Macies and Julian Malcolm, Nuclear and Radiation Chemistry, Wiley Interscience publication, 1981.
8. Gregory Choppin, Jan-OlovLiljenzin, Jan Rydberg and Christian Ekberg, Radiochemistry and Nuclear Chemistry, Academic Press, 4th Edition, 2013.

# QUANTUM MECHANICS AND SPECTROSCOPY – I

**Objectives:**

- To have a good foundation in understanding the physical and mathematical aspects of quantum mechanics that leads to classical thermodynamics.
- To become familiar with the required mathematics for solving quantum mechanical problems.
- To understand and appreciate the quantum mechanical approach to the atomic and molecular electronic structure.
- To know quantization of energy and the interaction of electromagnetic radiation with matter.
- To learn the fundamentals of molecular spectroscopy.
- To know the application of spectroscopy to study the structure of molecules.

**UNIT I**

**MATHEMATICS FOR QUANTUM MECHANICS (QM) AND QM POSTULATES**

Coordinate systems, Complex numbers - Functions (odd & even, orthogonality and normalization) - Operators: Linear, Differential, and Hermitian and Hamiltonian operators - Quantum mechanical treatment of angular momentum - simultaneous measurement of several properties. Statement of Heisenberg Uncertainty Principle by using the evaluation of commutator of [x, $p_x$] and their significance. Eigen functions and eigen values - Failure of Classical Mechanics and the need for QM - Postulates of QM - The time-dependent and time - independent Schrodinger wave equations.

**UNIT II –**

**SOME QM MODELS AND THEIR APPLICATIONS**

Particle in a box (1D & 3D), degeneracy and its application to linear conjugated molecular systems. Bohr's correspondence principle. QM tunneling, Rigid Rotor: wave equation and solution calculation of rotational constants and bond length - Harmonic Oscillator: wave equation and solution, anharmonicity force constant and its significance. The Hydrogen atom and H-like ions: Solution to H and H-like wave equation, radial and angular functions, quantum numbers n, l and m and their importance. Radial distribution functions and H-like orbitals and their representation.

**UNIT III**

**APPLICATION OF QM TO MULTI-ELECTRON ATOMS**

Approximation Methods: Need for approximation methods - The electron spin, Pauli exclusion principle and Slater determinant for He atom. The variation method - trial variation function and variational integral (examples of variational calculations from particle in a box and Helium atom). Molecular QM and Chemical Bonding - Hydrogen molecule ion - the use oflinear variation function, the LCAO method - Hydrogen molecule: Molecular orbital theory and Heitler-London treatment. Electronic structure of conjugated systems: Huckel method applied to ethylene, allyl system, 1,3-butadiene and benzene.

**UNIT IV**

**INTRODUCTION TO SPECTROSCOPY AND ROTATIONAL SPECTROSCOPY**

**Electromagnetic radiation**: quantization of energy, rotational, vibrational, and electronic energy levels and transitions in molecules; regions and representation of spectra. Resolution and intensity of spectral transition: signal-to-noise ratio, width of spectral lines -

collision broadening, Doppler broadening, Heisenberg uncertainty principle; intensity of spectral lines-selection rules and transition probability, transit ion moment integral, Einstein absorption and emission coefficients, Boltzmann distribution.

**Diatomic molecules as rigid rotors**: Rotational energy levels, intensity of spectral lines, selection rules, effect of isotopic substitution. Diatomic molecules as non-rigid rotors: rotational transitions, centrifugal distortion constant; rotational spectra of linear and symmetric top polyatomic molecules.

**UNIT V**

**VIBRATIONAL SPECTROSCOPY**

**Vibrating diatomic molecule**: Energy of diatomic molecules as simple harmonic oscillator- energy levels, vibrational transitions, selection rules; anharmonic oscillator energy levels, selection rules, vibrational transitions.Diatomic vibrating rotator: Born-Oppenheimer approximation, vibration-rotation spectra, selection rules, P, Q, R branches. Vibrations of polyatomic molecules: symmetry and fundamental vibrations, normal modes of vibration, overtones, combination, difference bands; influence of rotations on the spectra of polyatomic molecules-parallel and perpendicular vibrations in linear and symmetric top molecules.

**Raman Effect**: Rayleigh and Raman scattering, Stokes' and anti-Stokes' radiation, molecular polarizability, Raman selection rules.Raman spectra: rotational Raman spectra-linear molecules, symmetric top and spherical top molecules; vibrational Raman spectra-symmetry and Raman active vibrations, rule of mutual exclusion; rotation-vibration Raman spectra of diatomic molecules.Applications of IR and Raman spectroscopy: skeletal and group vibrations, fingerprinting and absorption frequencies of functional groups for inorganic and organic compounds.

**PRESCRIBED BOOKS**

1. A. K. Chandra, Introductory Quantum Chemistry; 4th Edition, Tata McGraw Hill, 2001.
2. R.K. Prasad, Quantum Chemistry through problems and Solutions, New Age International Publishers, New Delhi., 1997.
3. R.P. Rastogi and V.K. Srivastava, An Introduction to Quantum Mechanics of Chemical Systems, Oxford & IBH Publishing Co., NewDelhi, 1986.
4. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy; 4th Edition, McGraw Hill Education, 2016.
5. K.V. Raman, R. Gopalan and P.S. Raghavan, Molecular Spectroscopy, Thomson and Vijay Nicole, Singapore, 2004.

**REFERENCE BOOKS**

1. W. J. Moore, Physical Chemistry, 5th edition, Orient Longman, 1976.
2. P. Atkins, J.D. Paula and J. Keeler, Physical Chemistry, 11th Edition, Oxford University press, 2018.
3. D.A. McQuarrie and J.D. Simon, Physical Chemistry: A Molecular Approach, Viva Books Private Limited, New Delhi, 2020.
4. D.A. McQuarie, Quantum Chemistry, Viva Books, 2016.
5. R.L. Flurry, Symmetry Groups: Theory and Chemical Applications, Prentice Hall, 1980.
6. Ira N. Levine, Quantum Chemistry, 7th edition, Pearson, 2013.
7. Ira N. Levine, Molecular Spectroscopy, John Wiley & Sons, New York, 1975.
8. K. Nakamoto, Infrared and Raman Spectra of Inorganic and coordination Compounds, Part B: 5th ed., John Wiley & Sons Inc., New York, 1997.
9. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill, 1962.

# ELECTIVE - I
# GREEN CHEMISTRY – TECHNIQUES AND APPLICATIONS

**Objectives:**

- To understand the basic principles of Green chemistry and Green techniques.
- To study Green catalysis and Green solvents.
- To learn Renewable energy sources, their working principle and applications.

## UNIT I
## BASIC PRINCIPLES OF GREEN CHEMISTRY

Green chemistry principles – Waste minimization and atom economy – atom economic reactions and calculations – Reduction of non-renewable raw materials usage – considerations in protecting group and catalysts need – process intensification – Reduction of energy requirements – alternative energy sources and energy efficient improvements – Reduction of risk and hazards – Inherently safer design and alternative solvents. Green metrics – selected metrics used: Effective Mass Yield – E factor – Reaction Mass Efficiency – Mass Intensity and Mass Productivity.

## UNIT II
## GREEN CATALYSIS

Introduction to green catalysis – heterogeneous catalysis – applications of zeolites, silica, alumina, clay, polymers, cyclodextrin and solid supported catalysts in green chemical reactions. Bio-catalysis - role of enzymes in catalytic oxidation, catalytic reduction, catalytic hydrolysis and catalytic carbon-carbon formation reactions. Green aspects – microbial production of ethanol. Phase-transfer catalysis and its advantage –applications of crown ethers in oxidation, substitution, elimination and esterification reactions.

## UNIT III
## GREEN SOLVENTS

Role of solvents in synthesis – Application of green solvents –Super critical fluids – super critical carbon dioxide and super critical water. Aqueous phase reactions – Diels Alder reaction, Wurtz reaction, Claisen rearrangement, Aldol condensation, Knoevenagel reaction, Michel reaction. Ionic liquids - properties of ionic liquids -applications of ionic liquids as catalysts and solvents. An introduction to tunable and switchable solvent systems.

## UNIT IV
## GREEN TECHNIQUES AND ALTERNATIVE ENERGY SOURCES

Photochemical reactions – photo reduction reactions, photochemical ring closure of dienes. Green techniques using microwaves – merits and demerits of microwave techniques – mechanism of microwave heating – effects of solvents in microwave assisted synthesis – microwave assisted reactions - Hoffman elimination, Heck reaction, Suzuki reaction, Microwave solvent free reactions – Deacetylation, saponification of esters. Sonochemistry – basics of sonochemistry – ultrasound assisted reactions – Friedal-Crafts reaction, Simmons-Smith reaction, Cannizzaro reaction, Strecker synthesis and Reformatsky reaction.

**UNIT V–**
**RENEWABLE ENERGY RESOURCES**

Introduction to renewable energy sources - types of renewable energy sources - Solar cells: basic principles, types and their applications - Fuel cells - basic principles, types and their applications – working principle and applications of Biofuel cells - brief introduction about hydroelectric, biomass, wind power and geothermal power and their applications and limitations - energy from some other natural sources.

**PRESCRIBED BOOKS**

1. Mike Lancaster, Green Chemistry: An Introductory Text, RSC, 2002.
2. Editors -James Clark and Duncan MacQuarrie, Handbook of green chemistry and technology, Blackwell Science, 2002.
3. Edited by – Paul T. Anastas, Green Processes Vol 7: Green Synthesis, Wiley – VCH, 2012.
4. V.K Ahluwalia and M. Kidwai, New Trends in Green Chemistry, Anamaya Publishers, 2004.

**REFERENCE BOOKS**

1. Roger Arthur Sheldon, Isabel Arends and Ulf Hanefeld, Green Chemistry and Catalysis, Wiley – VCH, 2007.
2. John Twidell and Tony Weir, Renewable Energy Resources, Routledge Third Edition, 2015.
3. Francesca M. Kerton, Alternative Solvents for Green Chemistry, RSC Publishing, 2009.
4. Edited by Suresh C. Ameta and Rakshit Ameta, Green Chemistry: Fundamentals and Applications, Apple Academic Press, 2013
5. Gadi Rothenberg, Catalysis: Concepts and Green Applications, Wiley-VCH, 2008.

# CORE 4
# ORGANIC CHEMISTRY PRACTICAL - I

**Objectives**:

- To introduce the students to have hands on experience to perform various reactions.
- The students can Separate and characterize the two component mixtures.

1. Qualitative analysis of Organic mixture (atleast six two component mixtures)
   - Separation of organic mixtures
   - Elemental analysis
   - Functional group(s) identification
   - Preparation of derivatives
   - Physical properties determination (melting point and boiling point) for both components and their derivatives.
   - Analysis may be performed in micro (or) macro scale depending upon the conditions of the laboratory.
2. For Class Work Only:
   1. Separation of Caffeine from Tea / Coffee.
   2. Separation of green, blue, red inks by TLC method.

**PRESCRIBED BOOKS**

1. A.I. Vogel, Elementary Practical Organic Chemistry: Small Scale Preparations, Qualitative Organic Analysis, Quantitative Organic Analysis, Pearson Education, 2011.
2. K. Bansal Raj, Laboratory Manual of Organic Chemistry, New Age International, 2009.
3. V. Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, 2004.

**REFERENCES BOOKS**

1. R.G. Engel, D.L. Pavia, G.M. Lampman and G.S. Kriz, A Microscale approach to Organic Laboratory, 5th edition, Paperback – International Edition, 2012.
2. P.B. Cranwell, L.M. Harwood, and C. J. Moody, Experimental Organic Chemistry, 3rd edn, Wiley-Blackwell, 2017.
3. J. Leonard, B. Lygo and G. Procter, Advanced Practical Organic Chemistry, 3rd edn, CRC Press, 2013.

# INORGANIC CHEMISTRY PRACTICAL - I

**Objectives:**

- To learn the principles and methods of qualitative analysis of familiar and less familiar cations present in a mixture.
- To identify the methodology to analyze qualitatively a metal ion in the presence of another metal ion.

**Qualitative Analysis:**

Qualitative analysis of mixture containing two familiar and two less familiar cations: Pb, Cu, Bi, Cd, Zn, Co, Ni, Mn, Ca, Ba, Sr, W, Se, Te, Mo, Ce, Zr, V, Ti, and Li.

**Course work**

Th & U (Course Work)

**PRESCRIBED BOOKS**

1. V.V. Ramanujan, Inorganic Semi-micro Qualitative Analysis, 3rd Edition, National Publishing Company, Chennai, 1990.

**REFERENCE BOOKS**

1. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edition, Pearson Education India, 2008.

# PHYSICAL CHEMISTRY PRACTICAL - I

**Objectives:**

- To learn the Principles of Conductometric Titrations.
- To understand the Principles of Thermometry.

I. ConductometricTitrations

a. (a). Standard: NH4Cl Link: NaOH Estimation: HCl and CH3COOH in a mixture
b. (b) Standard: NH4Cl Link: NaOH Estimation: NH4Cl and HCl in a mixture
c. (c) Acid-Base and PrecipitationTitration
    (i) Standard: Pb(NO3)2 Link:Na2CO3 Estimation: HNO3 + Pb(NO3)2
    (ii) Standard: CuSO4 Link: NaOH Estimation: H2SO4 + CuSO4
d. Determination of Solubility Product

Conductometry - Solubility product of sparingly soluble silver salts(AgCl,AgBr andAgI).

**II. Thermometry**

Determination of Solution enthalpy of

(i) Oxalic acid - water
(ii) Ammonium oxalate - water
(iii) Ammonium chloride - water
(iv) Naphthalene - toluene

**PRESCRIBED BOOKS**

1. J. B.Yadav, Advanced Practical Physical chemistry, 20th Edn., GOEL publishing House, Krishna Pakashan Media Ltd., 2001.
2. J.N. Gurtur and R.Kapoor, Advanced Experimental chemistry, Vol.I. Chand & Co., Ltd., NewDelhi, 1987.
3. B.C. Kosla, Senior Practical Physical Chemistry, Simla Printers, New Delhi, 1987.
4. Saroj Kumar and Naba Kumar, Physical Chemistry Practical, New Central Book Agency, 2012.

**REFERENCE BOOKS**

1. Findlay's Practical Physical Chemistry, Revised and edited by B.P. Levitt 9th Edn., Longman, London, 1985.
2. W.J. Popiel, Laboratory Manual of Physical Chemistry, ELBS, London, 1970.
3. G.W. Garland, J.W. Nibler and D.P. Shoemaker, Experiments in Physical Chemistry, 8th Edn. McGraw Hill, 2009.