Deccan Education Society's

FERGUSSON COLLEGE, PUNE

(AUTONOMOUS)

SYLLABUS UNDER AUTONOMY

FIRST YEAR B.Sc. CHEMISTRY

SEMESTER – I

Academic Year 2016-2017

AIMS AND OBJECTIVES:

1. F.Y. B. Sc. Chemistry syllabus has been framed as per UGC/BCUD directives.
2. The content of the syllabus have been framed as per UGC norms.
3. The students are expected to understand the fundamentals, principles, mathematical concepts and recent developments in the subject area.
4. The practical course is in relevance to the theory courses to improve the understanding of the concepts.
5. It would help in development of practical skills of the students.
6. It is expected to inspire and boost interest of the students towards chemistry as the main subject.
7. It would enable to develop interdisciplinary approach of the subjects for students opting for specialization in other subjects at latter stages of graduation.

COURSE STRUCTURE:

Term / Semester	Name of the Paper	Title of Paper	Credit	No. of Lectures / Practicals
First Term / Semester I	Theory Paper - 1	CHE1101 : Physical & Inorganic Chemistry - I	2	36
	Theory Paper - 2	CHE1102 : Organic & Inorganic Chemistry - I	2	36
	Practical Paper - 1	CHE1103 : Chemistry Practical - I	2	10
Second Term / Semester II	Theory Paper - 3	CHE1201 : Physical & Inorganic Chemistry - II	2	36
	Theory Paper - 4	CHE1202 : Organic & Inorganic Chemistry - II	2	36
	Practical Paper - 2	CHE1203 : Chemistry Practical - II	2	10

First Term - Semester I

CHE1101: Physical and Inorganic Chemistry - I:

[Credit 2, 36L]

1. **Chemical Mathematics**
   (6 L)
   1. Logarithm - Rules of logarithm, Characteristic and mantissa, Change of sign and base, Problems based on pH and pOH.

   2. Graphical representation of equations-Rules for drawing graph co-ordinates etc., Equation of straight line, slope and intercept, plotting the graph from the data of chemical properties and problems.

   3. Derivative - Rules of differentiation and partial differentiation, Algebraic, logarithmic and exponential functions and problems.

   4. Integration- Rules of integration, Algebraic and exponential functions and problems.

Aims and objectives:

After studying this chapter, students should be able to

1. Define logarithm.
2. State all rules of logarithms.
3. Convert negative mantissa into positive (i.e. convert natural to logarithm and logarithm to natural)
4. Calculate pH and pOH.
5. Plot the given data on graph paper.
6. Identify the co-ordinates of any points on a graph.
7. Plot the graph and find slope and intercept.
8. Express the equation of the straight line or convert and first order rate constant (K) in the form of straight line.
9. Select a proper scale and plot a graph when chemical data are given and find the slope and intercept.
10. State the rules of derivative.
11. Solve the problems based on differentiation of a function with power, addition subtraction, logarithmic function etc.
12. State rules of integration.
13. Problems based on: integration related to chemical data.

2. **Gaseous State**
   (12 L)

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal gas behaviour.

van der Waals equation of state, its derivation .van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms

Aims and Objectives:

Students should learn:

1. Fundamental assumption of kinetic theory of gases
2. Derivation of kinetic gas equation.
3. Explain the collision between molecules using collision cross section, collision frequency, mean free path
4. Explain the Brownian motion
5. Maxwell Boltzmann distribution of molecular speed: Molecular velocity, average root mean square and most probable velocities
6. Equipartition of energy: average value of individual components
7. Equipartition of energy and quantization(rotational, translational and vibrational degree)
8. Explain ideal and non-ideal behaviour of gas on the basis of PV against P
9. Deviation of gases from ideal behaviour
10. Explain compressibility factor (z), variation of compressibility factor with pressure for different gases (like H_2, N_2, CH_4 and CO_2)
11. Causes of behaviour of ideal gas
12. Derivation of van der Waals equation
13. Explain the virial coefficient Boyle's temperature
14. Isotherm of real gases and compare these isotherm with the van der Waals isotherm

3. Liquid State
(6 L)

Qualitative treatment of the structure of the liquid state, radial distribution function, physical properties of liquids, vapour pressure, surface tension and coefficient of viscosity and their determination.

Effect of addition of various solutes on the surface tension and viscosity, explanation of cleansing action of detergents, temperature variation of viscosity of liquids and comparison with that of gases. qualitative discussion of structure of water.

Aims and Objectives:

Students should learn:

1. Explain radial distribution function (RDFs)
2. Compare the RDFs of liquids , solids and gases
3. Role of RDFs in structure of liquids
4. Measurable physical properties of liquid such as vapour pressure, surface tension and viscosity (Ostwald viscometer) and their experimental determination by one method each.
5. Effect of addition of solutes on the surface tension and viscosity
6. Cleansing action of detergents
7. Variation of viscosity of liquids with temperatures.

4. Atomic Structure
(12 L)

Rutherford model, Electromagnetic spectrum, Bohr's theory, its limitations and atomic spectrum of hydrogen atom.

Wave mechanics: de Broglie equation, Heisenberg's uncertainty Principle and its significance, Schrödinger's wave equation(derivation not required), significance of ψ and ψ^2, quantum numbers and their significance, normalized and orthogonal wave, functions, sign of wave functions.

Radial and angular wave functions for hydrogen atom, radial and angular distribution curves, shapes of *s*, *p*, *d* and *f* orbitals.

Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, variation of orbital energy with atomic number.

Aims & Objective:

Students should learn:

1. Concept of atoms, Rutherford's model of atom and its drawbacks
2. Wave nature of radiation and electromagnetic spectrum
3. Bohr's theory of atomic model – main postulates, usefulness and limitations
4. Appearance of large number of lines in the spectrum of hydrogen atom
5. Important features of Quantum Mechanical Model of atom – dual nature of matter and radiation, de Broglie concept, Heisenberg's uncertainty Principle and its significance
6. Related problems on position, momentum or velocity uncertainty
7. Time independent Schrödinger's wave equation and meaning of various terms in it
8. Significance of ψ and ψ^2, Radial and angular parts of the hydogenic wavefunctions (concept of atomic orbitals), variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation)
9. Quantum numbers – principal quantum number, azimuthal quantum number, magnetic quantum number and spin quantum number with their significance
10. Shapes of *s*, *p*, *d* orbital
11. Rules for filling electrons in various orbitals – Aufbau's principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity

References:

1. Principles of Physical Chemistry by Maron and Prutton
2. Castellan, G. W. Physical Chemistry 4th Ed. Narosa, 2004.
3. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP, 200).
4. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson, 2013.
5. Essentials of physical chemistry Bhal, Tuli and S. Chand.
6. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
7. Douglas, B.E. 7 McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
8. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
9. Rodger G. E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

CHE1102: Organic and Inorganic Chemistry - I:

[Credit – 2, No. of Lectures – 36]

1. Basics of Organic Chemistry
(8 L)

Organic Compounds: Classification and nomenclature, hybridization, shapes of molecules, influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyper conjugation and their applications, dipole moment, organic acids and bases, their relative strength.

Homolytic and heterolytic fission with suitable examples. curly arrow rules, formal charges; electrophiles and nucleophiles nucleophlicity and basicity, types, shape and their relative stability of carbocations, carbanions, free radicals and carbenes.

Introduction to types of organic reactions and their mechanism, addition, elimination and substitution reactions.

Aims and objectives:

Students should learn:

Introduction of basic concepts of the organic chemistry.

2. Introduction to Functional Groups Analysis
(5 L)

Functional groups, chemical analysis of functional groups, aldehyde, ketone, carboxylic acids, alkyl halide, aryl halide, nitro, amide, amine, anilide, ester, hydrocarbons.

Aims and objectives:

Students should learn:

To get acquainted with functional groups in organic chemistry.

3. **Stereochemistry**
(10 L)
Fischer Projection, Newmann and Sawhorse Projection formulae and their inter conversions, Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Aims and objectives:

Students should learn:

To develop imagination for the 3D structure of organic molecules.

4. **Optical Isomerism:** Optical activity, specific rotation, chirality/asymmetry, enantiomers, molecules with two or more chiral-centres, distereoisomers, meso structures, racemic mixture and resolution, relative and absolute configuration, D/L and R/S designations

Aims and objectives:

Students should learn:

To know about chirality of the carbon, optical isomerism and its nomenclature.

5. **Recent trends in Chemistry**
[1 L]
Introduction to Premier Indian research Institutes in Chemistry, Shantiswaroop Bhatnagar Awardees in last 5 years in Chemistry.

Aims and objectives:

Students should learn:

To know recent developments in the field of chemistry and to inculcate the interest of the students towards organic chemistry in particular.

6. **Periodicity of Elements**
[12 L]
s, *p*, *d*, *f* block elements, the long form of periodic table, detailed discussion of the following properties of the elements, with reference to *s* and *p*-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(b) Atomic radii (van der Waals)
(c) Ionic and crystal radii.
(d) Covalent radii (octahedral and tetrahedral)
(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.
(f) Electron gain enthalpy, trends of electron gain enthalpy.
(g) Electro-negativity, Pauling's/ electro-negativity scales.

Aims and objectives:

Students should learn:

1. Skeleton of long form of periodic table
2. Block, group, modern periodic law and periodicity
3. Classification of elements as main group, transition, and inner transition elements
4. Name, symbol, electronic configuration (including some exceptional electronic configuration), trends and properties
5. Periodicity in the following properties in details:
   a. Atomic and ionic size;
   b. Electron gain enthalpy – definition and trends in the periodic table
   c. Ionization enthalpy – definition, trends and factors governing ionization enthalpy and variation in the periodic table
   d. Effective nuclear charge (Slater rule), shielding or screening effect; some numerical problems
   e. Electronegativity – definition, trend, Pauling electro-negativity scale.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
8. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
9. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
10. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications,1962.
11. Rodger G. E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

CHE1103: Chemistry Practical - I:

[Credit – 2, Minimum No. of Practicals – 10]

A. Physical Chemistry Practicals:

1. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
2. To determine the gas constant R in different units by eudiometer method.
3. Sketch the polar plots of s and p orbitals.
4. Plot the graph of following functions using excel (a) exponential (b) logarithmic function (c) linear functions

B. Organic Chemistry

1. Techniques:
   A) Purification of organic compounds by crystallization using the following solvents:
   (a) Water (b) Alcohol (c) Alcohol-Water
   B) Purification of organic compounds by sublimation.
2. Qualitative analysis / characterization of organic compounds containing only C, H, (O) elements (no element test).

C. Inorganic Chemistry Practicals

1. Semi-micro Inorganic Qualitative Analysis of a sample containing two cations and two anions.
2. Estimation of carbonate and hydroxide present together in mixture.
3. Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
4. Determination of the amount of Mg(II) present in the given solution complexometrically.

References:

1. Khosla, B.D.; Garg, V. C. and Gulati Senior practical physical chemistry, R. Chand & Co.: New Delhi (2011)
2. Garland, C. W.; Nibler, J.W. and shoemaker, D. P Experiments in physical chemistry 8 th Ed. McGraw-Hill: New work (2003)
3. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education, 2009.
5. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson, 2012

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SYLLABUS UNDER AUTONOMY

FIRST YEAR B.Sc. CHEMISTRY

SEMESTER – II

Academic Year 2016-2017

Second Term - Semester II

CHE1201: Physical and Inorganic Chemistry - II:

[Credit – 2, No. of Lectures – 36]

1. **Solid State**
   (12 L)
   Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations.
   Qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.

   Aims and Objectives
   Students should learn:
   1. Explain the structural difference between solid and liquid
   2. Law of crystallography: Law of constancy of interfacial angles, law of rational indices, Miller indices
   3. Symmetry in crystal systems: plane of symmetry, axis of symmetry, centre of symmetry
   4. Elements of symmetry and symmetry operations
   5. Explain the point group and space group
   6. Seven crystal systems and their properties
   7. The structure of crystals ; 14 Bravais or space lattice
   8. Lau method of X ray analysis
   9. Bragg's law and Bragg's method of crystal analysis(detail), X ray analysis of sodium chloride
   10. Bragg's X-ray spectrometer
   11. Powder method of X-ray analysis
   12. Analysis powder diffraction of NaCl, CsCl, and KCl

2. **Ionic Equilibrium**
   (12 L)
   Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Dissociation constants of mono-, di-and triprotic acids (exact treatment).

   Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

   Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

Aims and Objectives

Students should learn:

1. Classification of electrolytes, conjugate acid base , strengths of acid and bases
2. Explain the degree of ionization , factor affecting on ionization, Kw
3. Dissociation constants of mono-, di-and triprotic acids
4. Buffer solution, properties of Bufffers
5. Derivation of Henderson's equation and its application
6. Explain Buffer capacity
7. Role of Buffer in analytical chemistry
8. Application of Buffers in Physiological process in human body
9. Solubility, solubility product
10. Explain role of indicators, theory of acid-base indicator, choice of best indicator for titration
11. Know neutralization curves for various acid base titration(Calculation of pH at the various stages of titration)
12. Multistage equilibria in polyelectrolyte systems: Titrations of poly functional acids and bases

3. Chemical Bonding
(12 L)

1. **Ionic bond:** General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation. Born-Haber cycle and its application, Solvation energy.

2. **Covalent bond:** Lewis structure, Valence Bond theory (Heitler-London approach). Energetic of hybridization, equivalent and non-equivalent hybrid orbitals. Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths, Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization, Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

3. **Metallic Bond:** Qualitative idea of valence bond and band theories.

4. **Weak Chemical Forces:** van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, on melting and boiling points.

5. **Coordinate bond:** A qualitative approach.

Aims and Objectives:

Student should understand:

1. Definition of chemical bond, different types of bonds – ionic, covalent, coordinate and metallic (qualitative idea) attainment of stable configuration, fundamental concepts of theories of bonding
2. Definition of Ionic bond and its formation, factors affecting the formation of ionic

bond

3. Born-Haber cycle (calculation of lattice energy), and general characteristic of ionic compounds, solvation energy
4. Definition of Covalent bond and its formation, Lewis representation of simple molecules, characteristics of covalent compounds, concept of formal charge
5. Concept of hybridization: Definition, need of hybridization, steps involved in hybridization, types of hybridization involving s, p, & d orbitals Applications of hybridization geometries of molecules like i) BeH_2 ii) BF_3 iii) $[MnCl_4]^{2-}$ iv) $[Ni(CN)_4]^{2-}$ v) $Fe(CO)_5$ vi) $[Cr(H_2O)_6]^{2+}$ vii) IF_7
6. Concept of different types valence shell electron pairs and their contribution in bonding, VSEPR
7. Basic understanding of geometry and effect of lone pairs with examples

a. i) ClF_3 ii) Cl_2O iii) BrF_5 iii) $TeCl_4$ iv) XeO_3

8. Fajan's rules and consequences of polarization

References:

1. Principles of Physical Chemistry by Maron and Prutton
2. Castellan, G. W. Physical Chemistry 4th Ed. Narosa, 2004.
3. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP, 200).
4. Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson, 2013.
5. Fundamentals of Analytical Chemistry, Skoog, West and Haller
6. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
7. Douglas, B. E. & McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
8. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications,1962.
9. Rodger G. E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

CHE1202: Organic and Inorganic Chemistry - II:

[Credit – 2, No. of Lectures – 36]

1. Chemistry of Aliphatic Hydrocarbons (14 L)

(a) **Carbon-Carbon Sigma Bonds:**
Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation-relative reactivity and selectivity.

(b) **Carbon-Carbon pi Bonds:**
Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

(c) **Reactions of Alkenes:**
Electrophilic additions their mechanisms (Markownikoff/Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation,ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and,

Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene.

(d) **Reactions of Alkynes:**
Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

2. Aromatic Hydrocarbons
(8 L)
Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

3. Recent Trends in Chemistry
(2 L)
Introduction to research journals in chemistry, Nobel Prize winners in Chemistry in last five years.

4. Molecular Orbital Theory
(5 L)
Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given).

5. Oxidation-Reduction
(7 L)
Oxidizing and Reducing agents, Oxidation number, Rules to assign oxidation number. Balancing redox reactions by ion-electron method. Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class.

References:

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
6. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.

8. Douglas, B.E. & McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
9. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
10. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications,1962.
11. Rodger G. E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

CHE1203: Chemistry Practical - II:

[Credit – 2, Minimum No. of Practicals – 10]

A. **Physical Chemistry Practicals:**
   1. Determination of dissociation constant of a weak acid by pH metry.
   2. To determine the rate constant (or to study kinetics) of acid catalyzed ester hydrolysis.
   3. Interpretation of powder diffraction pattern of 1:1 salts.
   4. To determine the heat solution of potassium nitrate in water.

B. **Organic Chemistry**
   1. Qualitative analysis / characterization of organic compounds containing C, H, (O), N, S, halogen elements. (Element tests to be done)
   2. Chromatography
      Separation of a mixture of o-and p-nitrophenol or o-and p-nitroaniline by thin layer chromatography (TLC).

C. **Inorganic Chemistry Practicals**
   1. Semi-micro Inorganic Qualitative Analysis of a sample containing two cations and two anions.
   2. Determination of acetic acid in vinegar by titrimetric method.
   3. Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.
   4. Determination of % composition of ZnO and $ZnCO_3$ in the given mixture gravimetrically.

References:

1. Khosla, B. D.; Garg, V. C. and Gulati Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J.W. and Shoemaker, D. P. Experiments in Physical Chemistry, 8th Ed. McGraw-Hill: New York (2003).
3. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education,2009.
5. Furniss, B. S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).