FYBSc Sem I

Course I: Fundamentals of physical and analytical chemistry

Course Learning Outcomes:

After the successful completion of the Course, the learner will be able to:

1. Understand the concept of thermochemistry and ionic equilibrium.

2. Analyze the types of qualitative and quantitative analysis and differences between them.

3. Apply the core concepts of common ion effect and solubility products in semi-micro inorganic separation, complexation and oxidation number.

4. Apply the concept of equivalent weight of acid, base, salt, reducing agent and oxidizing agent, mole, mole fraction, molarity, molality, normality, ppm and ppb for solving the numerical based on it.

Module I: Thermochemistry and ionic equilibrium [15L]

1.1 Thermochemistry

Recapitulation of important terms of thermodynamics, state functions, internal energy, enthalpy, work, heat, first law of thermodynamics and maximum work. **[2L]**

Important principles and definitions of thermochemistry, concept of standard state and standard enthalpies of formations, applications of Hess's law, integral and differential enthalpies of solution and dilution, Kirchhoff's equation, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, variation of enthalpy of a reaction with temperature (Numerical expected). **[5L]**

1.2 Ionic equilibrium

1.2.1 Electrolytes and nonelectrolytes: Electrolytes and non-electrolytes, types of electrolytes (weak and strong), dissociation, degree of dissociation, factors affecting degree of dissociation, Oswald's dilution law, dissociation constants of acids and bases, relative strength of acid and bases, ionic product of water, concept of acid and base: Arrhenius theory, Bronsted-Lowery theory, Lewis theory, pH scale. **[4L]**

1.2.2 Buffers: Types of buffers, buffer capacity, mechanism of buffer action, Henderson Hasselbach equation and its significance (Numericals expected). **[2L]**

1.2.3 Concept of salt: Types of salts, solubility, solubility products and its applications, common ion effect and its applications. **[2L]**

References:

1. Puri, Sharma and Pathania, Principles of Physical Chemistry, 44th Edn., Vishal Publishing Co.

2. Arun Bahl, J.D. Tuli, Essentials of Physical Chemistry, S. Chand Publishing Co.

3. Samuel Glasstone, Textbook of Physical Chemistry

4. Paul S Monk ,Physical Chemistry- Understanding Our Chemical World, John Wiley & Sons Ltd. (2008)

Module II: Introduction to analytical methods and concept of quality [15L]

1.1 Analytical methods: Types of analytical methods (depending on sample size, sample information, sample properties), classification (classical and instrumentation), process of analysis, qualitative & quantitative analysis - types, examples, applications. **[4L]**

1.2 Qualitative analysis and mole concept

1.2.1 Qualitative analysis: Theory of elemental analysis of organic compounds, theoretical concepts in semi-micro analysis of inorganic mixture (common ion effect, solubility product, complexation and oxidation number). Standard solution-primary and secondary standards, preparation of standard solutions, standardization, calibration of glasswares. **[4L]**

1.2.2 Mole concept: Methods of expressing concentrations of solutions, molarity, formality, normality, mole fraction, molality, ppm, ppb, ppt, milli equivalents, millimoles, dilution of solutions. **[4L]**

1.3 Concept of quality: General idea, quality control and quality assurance, important quality parameters like accuracy, precision, range, limit of detection and limit of quantification, concept of errors. **[3L]**

References:

1. A I Vogel. Inorganic quantitative analysis, 6th edition.
2. Skoog, Fundamentals of Analytical Chemistry 9th edition.
3. Gary Christian, Analytical Chemistry 6th edition.

Course II: Fundamentals of organic and inorganic chemistry

Course Learning Outcomes:

After the successful completion of the Course, the learner will be able to:

1. Apply IUPAC nomenclature to aliphatic and aromatic compounds.

2. Relate the fundamentals of organic chemistry with stability, reactivity and structure of organic compounds.

3. Understand the various theories of chemical bonding and apply them for predicting the structures of the molecules.

Module I: IUPAC nomenclature of organic compounds and introduction to organic chemistry [15L]

1.1 IUPAC nomenclature of organic compounds [8L]

1.1.1: Types of organic compounds. Nomenclature of aliphatic compounds (mono functional).

1.1.2: Priority rules.

1.1.3: Nomenclature of bifunctional compounds.

1.1.4: Nomenclature of benzene derivatives, mono, di and polysubstituted derivatives.

1.2 Introduction to organic chemistry [7L]

1.2.1: Cleavage of bonds: homolysis and heterolysis.

1.2.2: Reactive intermediates: carbocations, carbanions and free radical's generations and its reactivity.

1.2.3: Structure, shape and reactivity of organic molecules: nucleophiles and electrophiles.

1.2.4: Physical effects, electronic displacements: inductive effect, electromeric effect, resonance and hyperconjugation.

1.2.5: Types of organic reactions based on mechanism - substitution, addition, elimination and rearrangement.

References:

1. Organic Chemistry, Morrison Boyd & Bhattacharjee, edition 7th, 2012-Pearson India

2. A Logical Approach to Modern Organic Chemistry, Jagdamba Singh, Pragati Prakashan

Module II: Chemical bonding [15L]

2.1 Chemical bond, Octet rule, ionic bond, formation of ionic bond, energy changes in the formation of ionic bond, characteristics of ionic compound, lattice energy, solvation energy, Born-Haber cycle, Born Lande's equation and Kapustinskii equation. **[4L]**

2.2 Covalent bond, formation of covalent bond, energy changes in the formation of covalent bond, characteristics of covalent compound, electron dot structure, Valence bond theory (VBT): postulates of valence bond theory, sigma and pi bonds, coordinate covalent bond. **[3L]**

2.3 Hybridization- concept of hybridization, types of hybridization - sp, sp^2, sp^3 with respect to inorganic molecules like $BeCl_2$, BF_3, $SiCl_4$ and organic molecules like ethane, ethene and ethyne. Valence shell electron pair repulsion (VSEPR)- postulates of VSEPR theory, shape of chemical species on the basis of VSEPR theory - NH_3, ClF_3, BrF_5, PCl_3, ICl_2^- and TeF_5^-. **[8L]**

References:

1. Fundamental concepts of Inorganic Chemistry, Asim K Das, Volume 2, 2nd edition.

2. Principles of Inorganic Chemistry, Puri, Sharma and Kalia, 6th edition.

3. Selected topics in Inorganic Chemistry, Malik, Tuli, Madan, S. Chand Publications, Revised edition.

4. A Textbook of inorganic chemistry, Anilkumar De.

FYBSc Sem I – Practical

Course Learning Outcomes: The practical is intended to

1. Apply the importance of calibration of volumetric apparatus.
2. Estimate the solution by volumetric analysis.
3. Evaluate the elemental analysis of organic compounds.

Course I: Calibration of apparatus and volumetric estimation

1. Calibration of pipettes and standard flasks.
2. Standardization of NaOH by titrating it with succinic acid solution.
3. Standardization of $KMnO_4$ by titrating it with oxalic acid solution.
4. Estimation of sodium carbonate & sodium bicarbonate present in a mixture.
5. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ solution.

Course II: Organic spotting

Identification of organic compounds (minimum 7).

References:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

3.Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

FYBSc Sem II

Course I: Fundamentals of physical and analytical chemistry

Course Learning Outcomes:

After the successful completion of the Course, the learner will be able to

1. Understand the gaseous and liquid states of matter, behaviour of real gases, van der Waals equation, Joule Thomson effect and Linde's experiment for liquefaction of gases.

2. Analyse the critical conditions for liquefaction of real gases.

3. Apply the concept of surface tension and viscosity measurements for solving different numerical based on it.

4. Understand the classical method of chemical analysis such as volumetric and gravimetric analysis, its basic principle and techniques with suitable examples.

Module I: Gaseous and liquid states [15L]

1.1 Gaseous state: Behaviour of real gases: deviations from ideal gas behaviour, Boyle temperature, compressibility factor (Z) and its variation with pressure for different gases, causes of deviation from ideal behaviour, volume correction and pressure correction, van der Waals equation- derivation and application in explaining real gas behaviour. **[5L]**

1.2 Liquefaction of gases: Effect of temperature on liquefaction of gases-Andrews isotherms, importance of critical constants, relation between critical constants and van der Waals constants, Joule Thomson effect and inversion temperature, Linde's experiment for liquefaction of gases. **[5L]**

1.3 Liquid state: Introduction, surface tension: determination of surface tension by drop number method using Stalagmometer, types of surfactants and micelle formation, applications of surface-active agents in treatment of oil spills and detergent action, viscosity: introduction, coefficient of viscosity, determination of coefficient of viscosity by Ostwald viscometer, applications of viscosity measurement- viscosity of motor oils, lubricants (Numerical on surface tension and viscosity measurements are expected). **[5L]**

References:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).

Module II: Volumetric and gravimetric analysis [15L]

2.1 Volumetry:

2.1.1 Acid-base titration: Theory, types and examples, classical and instrumental methods, pH-metry and titration curves for i) strong acid v/s strong base ii) weak acid v/s strong base iii) weak base v/s strong acid iv) weak acid v/s weak base (Numericals expected). **[6 L]**

2.1.2 Redox titrations: Theory, examples of oxidising and reducing agents, examples of different redox titrations systems, titration curves for redox titration of i) Fe^{2+} against Cr^{6+} ii) Fe^{2+} against Ce^{4+} (Numericals expected). Types of indicators, theory of acid-base and redox indicators. **[6 L]**

2.2 Gravimetry – Types of gravimetric analysis (direct and indirect analysis), basic principle and steps involved in direct gravimetric analysis, factors affecting precipitation and mechanism of precipitation. **[3 L]**

References:

1. A I Vogel. Inorganic quantitative analysis, 6th edition.
2. Skoog, Fundamentals of Analytical Chemistry 9th edition.
3. Gary Christian, Analytical Chemistry 6th edition.

Course II: Fundamentals of organic and inorganic chemistry

Course Learning Outcomes:

After the successful completion of the Course, the learner will be able to

1. Illustrate the methods of preparation, properties and reactions of aliphatic hydrocarbons and haloalkanes.

2. Compare the trends in the periodic table and properties of the elements.

Module I: Chemistry of hydrocarbons and haloalkanes [15L]

1.1 Alkanes: Natural resources and applications, methods of formation: Kolbe reaction, Wurtz reaction, decarboxylation of carboxylic acids; hydrogenation of alkenes and hydrolysis of Grignard reagent reactions: halogenation of alkanes. **[4 L]**

1.2 Alkenes: Natural resources and applications, methods of formation: dehydration of alcohol, dehydrohalogenation of alkyl halides, (Saytzeff's rule), partial catalytic hydrogenation of cis and trans alkenes (Lindlar's catalyst and Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), addition of HX (Markownikoff's and anti-Markovnikov's rule), ozonolysis, hydroboration-oxidation. **[4 L]**

1.3 Alkynes: Natural resources and applications, methods of formation: acetylene from CaC_2, conversion of lower alkynes to higher alkynes, by dehalogenation of tetrahalides, dehydrohalogenation of vicinal dihalides. Reactions: formation of metal acetylides, addition of bromine, ozonolysis and oxidation with alk. $KMnO_4$, preparation of benzene. **[4 L]**

1.4 Alkyl halides: methods of formation: reaction of alcohols with $SOCl_2$ and PCl_5. Reactions: nucleophilic substitution reactions with hydroxide, alkoxide, cyanide, ammonia, amines, silver acetate, applications. **[3 L]**

References:

1. Organic Chemistry, Morrison Boyd & Bhattacharjee, edition 7th, 2012- Pearson India.

2. A Logical Approach to Modern Organic Chemistry, Jagdamba Singh, Pragati Prakashan.

3. A Textbook of Organic Chemistry by Bahl Arun, Bahl B.S., 22nd edition, Chand publications.

Module II: Periodic table and periodicity [15L]

2.1 Periodic table: The need for classification of elements, history of development of periodic table- Dobereiner's triads, Newland's law of octaves, Mendeleev's periodic law, Modern periodic law, long form of periodic table, IUPAC nomenclature for elements with Z > 100, division of periodic table into s, p, d & f blocks. **[5L]**

2.2 Periodic trends in properties: atomic size, ionization energy, electronegativity, electron affinity, metallic and non-metallic character, valency, atomic volume, density, melting & boiling point, oxidising and reducing properties. **[6L]**

2.3 Effective nuclear charge and shielding effect, Slater's rule (problems expected). **[2L]**

2.4 Determination of electronegativity using: Allred and Rochow's scale, Mulliken's scale, Pauling's scale. **[2L]**

References:

1. Concise Inorganic Chemistry, J. D. Lee, 6th Edition.

2. Principles of Inorganic Chemistry, Puri, Sharma and Kalia, 6th edition.

3. Selected topics in Inorganic Chemistry, Malik, Tuli, Madan, S. Chand Publications, Revised edition.

FYBSc Sem II – Practical

Course Learning Outcomes: **The practical is intended to**

1. Read a pH strip and identify as an acid, base or neutral compound.

2. Write characteristics of acids, bases and neutral substances.

3. Synthesize different organic compounds.

4. Separate and identify different cations and anions.

Course I: pH determination and organic preparation (recrystallization, determination of melting point and calculation of quantitative yield to be done)

1. To determine the pH of a given solution through matching its colour developed by an indicator.

2. To determine the pH of NH_4Cl, NaCl, Na_2CO_3 and CH_3COONa solutions using pH meter.

3. Organic preparation: Alkaline hydrolysis of methyl salicylate (ester hydrolysis).

4. Organic preparation: 2,4-dinitro phenyl hydrazine (DNP) derivative of acetone.

5. Organic preparation: Nitration of salicylic acid.

Course II: Inorganic qualitative analysis

Semi-micro qualitative analysis of inorganic mixtures containing two cations and two anions (without interfering anions, minimum 6).

References:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.