Draft Syllabus

(Chemistry)

WEF 2023-24

Raja NL Khan Women's College (Autonomous)

SEMESTER – I

Semester	Course	Paper Code	Name of the Subject	Credit
SEM-I	Major-1	**PAPER : CEM-H-CC1-1-Th** **PAPER : CEM-H-CC1-1-P**	Basic Chemistry - I	04
	SEC-1	**SEC-1 T** **SEC-1 P**	Chemistry of Cosmetics, Perfumes and Presticides	03
	Minor-1	**PAPER : CEM-G-CC1-1-Th** **PAPER : CEM-G-CC1-1-P**	Inorganic Chemistry - I	04

CHEMISTRY MAJOR

PAPER: CEM-H-CC1-1-Th (Credit: Theory -03, Practical – 01) (60 L)

Basic Chemistry – I – Theory: (45 L)

Unit:-I (30L)

Course objectives and expected outcome: The kinetic theory of gases explains the three macroscopic properties of a gas in terms of the microscopic nature of atoms and molecules making up the gas. Usually, the physical properties of solids and liquids can be described by their size, shape, mass, volume etc. However, when we talk about gases, they have no definite shape, size while mass and volume are not directly measurable. The Kinetic theory of gases is useful and can be applied in this case. With the help of the kinetic theory of gases, the physical properties of any gas can be defined generally in terms of three measurable macroscopic properties. This course also deals with the fundamentals of Thermodynamics including thermodynamic systems and properties, relationships among the thermos-physical properties, the laws of thermodynamics and applications of these basic laws in thermodynamic systems. After successful completion of this course the students will be able to: 1. Explain fundamental concepts relevant to thermodynamics. 2. Explain the concepts of work, power, and heat in thermodynamics; determine work and heat sign conventions; determine work involved with moving boundary systems (graphical and analytical methods). 3. Explain the first law of thermodynamics for a closed system. Applications of first law of thermodynamics in chemical reactions. Chemical kinetics is the study of the rates and the mechanism of chemical reactions. Commonly the measure of how fast the products are formed and the reactants consumed is given by the rate values. The study of chemical kinetics has been highly useful in determining the factors that influence the rate, maximum yield and conversion in industrial processes. The mechanism or the sequence of steps by which the reaction occurs can be known. It is also useful in selecting the optimum conditions for maximum rate and yield of the chemical process.

Kinetic Theory and Gaseous state: (15 L)

Kinetic theory of gas: Concept of pressure and temperature from kinetic theory of gas; kinetic gas equation; Nature of distribution of velocities, Maxwell's distribution of speeds in one, two and three dimensions; Kinetic energy distribution in one, two and three dimensions, Calculation of number of molecules having energy $\geq \varepsilon$, Average, root mean square and most probable velocities from Maxwell's velocity distribution law; Collision of gas molecules; Collision diameter; Collision frequency and mean free path; Frequency of binary collisions (similar and different molecules); Wall collision frequency; diffusion and effusion; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases.

Real gas and Virial equation: Deviation of gases from ideal behavior; Compressibility factor; Boyle temperature; Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behavior ; other equations of state (Berthelot, Dietrici); Existence of critical state, Andrew's experiment, Critical constants in terms of van der Waals constants; Reduced equation of state; Law of corresponding states; Virial equation of state; van der Waals equation expressed in the Virial form and significance of second virial coefficient; Intermolecular forces (Debye, Keesom and London interactions; Lennard-Jones potential - elementary idea.)

Chemical Thermodynamics-I: (9 L)

Zeroth and 1st law of Thermodynamics : Scope of thermodynamics, System and surroundings; open, closed and isolated systems, Process, Reversible and irreversible process; Intensive and extensive variables; state and path functions; Partial derivatives, Exact and inexact differentials. Euler's theorem, cyclic rule; zeroth law of thermodynamics; Concept of heat(q), work(w), internal energy(U); Statement of first law of thermodynamics and its mathematical form; consequences of first law of thermodynamics; enthalpy (H), adiabatic relations; relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions; Joule's experiment , Joule Thomson Experiment and J.T.Coefficient for ideal and vanderWaals gases.

Thermochemistry: Heats of reaction; Standard States, enthalpy of formation, enthalpy of combustion, enthalpy of neutralization, enthalpy of solution and their applications; Laws of thermo chemistry; Kirchhoff's equations.

Chemical Kinetics-I: **(6 L)**

Concept of rate, order and molecularity of reaction. Rate laws for zero, fractional, first and second order reactions and in general for any n-th order reaction. Methods of determination of order of a reaction. Rate determining step and steady state approximation.

Unit:-II (15L)

Course objectives and expected outcome: Working through this course, students are expected to apply their knowledge to problem-solve, deduce structures, Bonding geometries of carbon compounds and representation of molecules, concept of chirality , optical activity of chiral compounds and symmetry, and synthesize simple organic molecules using the studied reactions. Relationships between organic chemistry and other disciplines are noted.

Bonding and Physical Properties: **(12 L)**

Valence Bond Theory: Concept of hybridisation, shapes of molecules, resonance (including hyperconjugation); calculation of formal charges and double bond equivalent (DBE); orbital pictures of bonding (sp^3, sp^2, sp: C-C, C-N & C-O systems and s-cis and s-trans geometry for suitable cases).

Electronic displacements: Inductive effect, field effect, mesomeric effect, resonance energy; bond polarization and bond polarizability; electromeric effect; steric effect, steric inhibition of resonance.

MO theory: Qualitative idea about molecular orbitals, bonding and antibonding interactions, idea about σ, σ*, π, π *, n – MOs; concept of HOMO, LUMO and SOMO; sketch and energy levels of π MOs of i) acyclic p orbital system (C=C, conjugated diene, triene, allyl and pentadienyl systems) ii) cyclic p orbital system (neutral systems: [4], [6] annulenes; charged systems: 3-,4-,5-membered ring systems); Hückel's rules for aromaticity up to [8] annulene (including mononuclear heterocyclic compounds up to 6membered ring); concept of antiaromaticity and homoaromaticity; non-aromatic molecules; Frost diagram (qualitative drawing).

Physical properties: Influence of hybridization on bond properties: bond dissociation energy (BDE) and bond energy; bond distances, bond angles; concept of bond angle strain; melting point/boiling point and solubility of common organic compounds in terms of covalent & non-covalent intermolecular forces; polarity of molecules and dipole moments; relative stabilities of isomeric hydrocarbons in terms of heat of hydrogenation and heat of combustion data.

General Treatment of Reaction Mechanism I **(3 L)**

Mechanistic classification: ionic, radical (definition and example); reaction type: addition, elimination and substitution reactions (definition and example); nature of bond cleavage and

bond formation: homolytic and heterolytic bond fission, homogenic and heterogenic bond formation; curly arrow rules in representation of mechanistic steps; reagent type: electrophiles and nucleophiles (elementary idea).

Reference Books

1. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press
2. Castellan, G. W. Physical Chemistry, Narosa
3. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press
4. Engel, T. & Reid, P. Physical Chemistry, Pearson
5. Levine, I. N. Physical Chemistry, Tata McGraw-Hill
6. Maron, S. & Prutton Physical Chemistry
7. Ball, D. W. Physical Chemistry, Thomson Press
8. Mortimer, R. G. Physical Chemistry, Elsevier
9. Laidler, K. J. Chemical Kinetics, Pearson
10. Glasstone, S. & Lewis, G.N. Elements of Physical Chemistry
11. Rakshit, P.C., Physical Chemistry Sarat Book House
12. Zemansky, M. W. & Dittman, R.H. Heat and Thermodynamics, Tata-McGraw-Hill
13. Rastogi, R. P. & Misra, R.R. An Introduction to Chemical Thermodynamics, Vikas
14. Clauze & Rosenberg, Chemical Thermodynamics
15. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012.
16. Keeler, J., Wothers, P. Chemical Structure and Reactivity – An Integrated approach, Oxford University Press. 17. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
18. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
19. Carey, F. A., Guiliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
20. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
21. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
22. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
23. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

Basics of Chemistry – I – Practical: (15 L)

PAPER : CEM-H-CC1-1-P

Course objectives and expected outcome: The course provides training in advanced physical chemistry laboratory techniques. The experiments are guided by demonstrators and are designed both to illustrate the applications of theory covered in the Chemical Physics and lecture courses, and to introduce typical instrumentation. On successful completion of the course students will be able to: 1. Developed expertise relevant to the professional practice of chemistry. 2. Developed an understanding of the breadth and concepts of physical chemistry. 3. An appreciation of the role of physical chemistry in the chemical sciences. 4. Developed an understanding of the role of the chemist in tasks employing physical chemistry. 5. An understanding of methods employed

for problem solving in physical chemistry. 6. Experience in some scientific methods employed in basic and applied physical chemistry. 7. Developed skills in procedures and instrumental methods applied in analytical and practical tasks of physical chemistry. 8. Developed skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments. 9. Developed some understanding of the professional and safety responsibilities residing in working with chemical systems.

(1) Calibration and use of apparatus.

(2) Preparation of primary standard solutions (Oxalic Acid and $K_2Cr_2O_7$)

Acid-Base Titrations:

(3) Standardization of NaOH standard oxalic acid solution.

(4) Estimation of acetic acid in commercial Vinegar.

Oxidation-Reduction Titrimetry:

(5) Standardization of $KMnO_4$ standard oxalic acid solution.

(6) Estimation of Fe(II) using standardized $KMnO_4$ solution.

(7) Estimation of Fe(III) using standard $K_2Cr_2O_7$ solution.

Reference Books: 1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

SEC-1T: CHEMISTRY OF COSMETICS, PERFUMES AND PESTICIDES **Credit 02**
30L

Course objectives and expected outcome: Facilitate the learner to understand about the preparation of cosmetic products and some essential oils. Facilitate the learner to understand about natural and synthetic pesticides, their benefits and adverse effects , technical manufacture and uses of representative pesticides.

Course Contents:

Chemistry of Cosmetics and Perfumes:

A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), antiperspirants and artificial flavours. Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2 phenyl ethyl alcohol, Jasmone, Civetone, Muscone.

Chemistry of Presticides:

General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and

uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

SEC-1P: Practicals Credit 01 15L

Course objectives and expected outcome: Facilitate the learner to understand about the preparation of cosmetic products and some essential oils.

1. Preparation of talcum powder.

2. Preparation of shampoo.

3. Preparation of enamels.

4. Preparation of hair remover.

5. Preparation of face cream.

6. Preparation of nail polish and nail polish remover.

7. To calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.

Minor – (I &II)

(Credits: Theory-03, Practicals-01)

Paper- Minor-1T or Minor-2T
(Theory: 45 Lectures)

Course objectives and expected outcome: Facilitate the learner to make knowledge about Kinetic Theory of Gases and Real gases, Liquids, Chemical Kinetics, Atomic Structure, Chemical Periodicity, Acids and bases. On successful completion of the course students will be able to apply the fundamental principles of organic chemistry in different parts of learning,They will also know about the stereochemistry of organic molecules and elimentary knowlwdge about nucleophilic Substitution and Elimination Reactions.

Kinetic Theory of Gases and Real gases

Concept of pressure and temperature; Collision of gas molecules; Collision number and mean free path. Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy Deviation of real gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states.

Liquids

Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity ofa liquid (qualitative treatment only).

Chemical Kinetics

Introduction of rate law, Order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by halfhalf-life and differential method. Temperature dependence of rate constant; Arrhenius equation, energy of activation.

Atomic Structure

Bohr's theory for hydrogen atom (simple mathematical treatment), atomic spectra of hydrogen and Bohr's model, Sommerfeld's model, quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many-electron atoms, *Aufbau* principle and its limitations.

Chemical Periodicity

Classification of elements on the basis of electronic configuration: general characteristics of s-, p-

, d- and f-block elements. Positions of hydrogen and noble gases. Atomic and ionic radii, ionization potential, electron affinity, and electronegativity; periodic and group-wise variation of above properties in respect of s- and p- block elements.

Acids and bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and leveling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Fundamentals of Organic Chemistry

Electronic displacements: inductive effect, resonance and hyperconjugation; nucleophiles and electrophiles; reactive intermediates: carbocations, carbanions and free radicals.

Stereochemistry

Different types of isomerism; geometrical and optical isomerism; concept of chirality and optical activity (upto two carbon atoms); asymmetric carbon atom; interconversion of Fischer and Newman representations; enantiomerism and diastereomerism, *meso* compounds; *threo* and *erythro*, D and L, *cis* and *trans* nomenclature; CIP Rules: *R/S* (only one chiral carbon atoms) and *E/Z* nomenclature.

Nucleophilic Substitution and Elimination Reactions

Nucleophilic substitutions: SN^1 and SN^2 reactions; eliminations: E1 and E2 reactions (elementary mechanistic aspects); Saytzeff and Hofmann eliminations.

Minor 1 Practical: 15 Lectures

Course objectives and expected outcome: Facilitate the learner to make solutions of various molar concentrations. This may include: The concept of the mole; Converting moles to grams; Converting grams to moles; Defining concentration; Dilution of Solutions; Making different molar concentrations. They will also experiences in different type of titration like acid-base, oxidation-reduction titration.

Paper- CEMG-1P or CEMG-2P

(Practical: 15 Lectures)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

2. Estimation of oxalic acid by titrating it with $KMnO_4$.

3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.

4. Estimation of Fe (II) ions by titrating it with K2Cr2O7 using internal indicator.

5. Estimation of Cu (II) ions iodometrically using Na2S2O3.

6.Estimation of Fe(II) and Fe(III) in a given mixture using $K_2Cr_2O_7$ solution.

SEMESTER – II

Semester	Course	Paper Code	Name of the Subject	Credit
SEM-II	Major-2	**CEM-H-CC2-2-Th** **CEM-H-CC2-2-P**	Basic Chemistry - II	04
	SEC-2		Basic Analytical Chemistry	03
	Minor-2	**CEM-G-CC2-2-Th** **CEM-G-CC2-2-P**	Physical Chemistry	04

CHEMISTRY MAJOR

PAPER : CEM-H-CC2-2-Th (Credit :4, Theory -03, Practical – 01) (60 L)

Basic Chemistry – II – Theory: (45 L)

Unit:-I (30L)

(9L)

Course objectives and expected outcome: Upon successful completion students should be able to apply the fundamental principles of measurement, matter, atomic theory, chemical periodicity, general chemical reactivity and the bonding fundamentals for both ionic and covalent compounds, including electronegativities, bond distances and to predict geometries of simple molecules and knowledge about inorganic acid base concept and strength of acids, idea about use and principle of indicators.

Extra nuclear structure of atoms:

Bohr's postulates, energy and radius of n^{th} Bohr orbit; Rydberg Equation, Atomic spectra of H-atom; Refinement of Bohr's theory; Quantum Numbers and their significances, Aufbau principle and its limitations; Pauli's exclusion principle ; Hund's rules and multiplicity, exchange energy; Ground state term symbols of atoms or ions for atomic number upto 30. Wave-Particle duality; de Broglie hypothesis. Heisenberg's uncertainty principle. Concept of Atomic Orbitals; Schrödinger wave equation, significance of $and\ \Psi^2$; shapes of s, p and d orbitals . Radial and angular wave functions for H-atom; Radial and angular distribution curves. Effective nuclear charge. Shielding and penetration; Slater's rule.

Periodic Table: (6L)

The general idea about modern periodic table, atomic and ionic radii , ionization energy, electron affinity and electro negativity –definition, trends of variation in periodic table and their application in explaining and predicting the chemical behavior of elements and compounds. Electronegativity scales (Pauling's, Mulliken's and Allred-Rochow's scales). Inert pair effect.

Chemical Bonding – I: **(9 L)**

i) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its application and limitations. Packing of ions in crystals. Born-Lande equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. Defects in solids (elementary idea). Solubility energetics of dissolution process.

ii) Covalent bond: Polarizing power and polarizabilty, ionic potential, Fajan's rules, Lewis structures, formal charge, Valence Bond Theory, The hydrogen molecule (Heitler – London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rules, dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs (examples from main group chemistry) and multiple bonding (σ and π bond approach).

Acid-Base reactions: **(6 L)**

Acid-Base concept: Arrhenius concept, theory of solvent system (in H_2O, NH_3, SO_2 and HF), Bronsted-Lowry's concept, relative strength of acids, Pauling's rules. Lux Flood concept, Lewis concept, group characteristics of Lewis acids, solvent levelling and differentiating effects.Thermodynamic acidity parameters, Drago-Wayland equation.Super acids, Gas phase acidity and proton affinity; HSAB principle. Acid-base equilibria in aqueous solution (Proton transfer equilibria in water), pH, buffer. Acid-base neutralisation curves; indicator, choice of indicators.

Unit:- II (15L)

(12 L)

Course objectives and expected outcome: Working through this course, students are expected to apply their knowledge to problem-solve, deduce structures, Bonding geometries of carbon compounds and representation of molecules, concept of chirality , optical activity of chiral compounds and symmetry, and synthesize simple organic molecules using the studied reactions.

Stereochemistry I:

Bonding geometries of carbon compounds and representation of molecules: tetrahedral nature of carbon and concept of asymmetry; Fischer, sawhorse, flying-wedge and Newman projection formulae and their inter translations. Concept of chirality and symmetry: symmetry elements and point groups (C_{av}, C_{nh}, C_{nv}, C_n, D_{ah}, D_{nh}, D_{nd}, D_n, S_n (C_s, C_i); molecular chirality and centre of chirality; asymmetric and dissymmetric molecules; enantiomers and diastereomers; concept of epimers; concept of stereogenicity, chirotopicity and pseudoasymmetry; chiral centres and

number of stereoisomerism: systems involving 1/2/3-chiral centre(s) (AA, AB, ABA and ABC types).

Relative and absolute configuration:

D/L and R/S descriptors; erythro/threo and meso nomenclature of compounds; syn/anti nomenclatures for aldols; E/Z descriptors for C=C, conjugated diene, triene, C=N and N=N systems; combination of R/S- and E/ Z- isomerisms.

Optical activity of chiral compounds:

Optical rotation, specific rotation and molar rotation; racemic compounds, racemisation (through cationic, anionic, radical intermediates and through reversible formation of stable achiral intermediates); resolution of acids, bases and alcohols via diastereomeric salt formation; optical purity and enantiomeric excess; invertomerism of chiral trialkylamines.

General Treatment of Reaction Mechanism II (3 L)

Reactive intermediates: carbocations (carbenium and carbonium ions), non-classical cabocations, carbanions, carbon radicals, carbenes: generation and stability, structure using orbital picture and electrophilic/nucleophilic behavior of reactive intermediates (elementary idea).

Basics of Chemistry – II – Practical: (15 L)

PAPER : CEM-H-CC2-2-P:

Course objectives and expected outcome: Facilitate the learner to understand about iodometric titration and estimation

Iodo-/ Iodimetric Titrations

(1) Standardization of $Na_2S_2O_3$ solution against standard $K_2Cr_2O_7$ solution.

(2) Estimation of Vitamin C

(3) Estimation of (i) arsenite and (ii) antimony iodimetrically

(4) Estimation of available chlorine in bleaching powder.

(5) Estimation of Cu in brass.

(6) Estimation of Cr and Mn in Steel.

(7) Estimation of Fe in cement.

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015

SEC-2T: BASIC ANALYTICAL CHEMISTRY THEORY (Credits 02) (30L)

Course objectives and expected outcome: Facilitate the learner to understand about the Concept of sampling and importance of accuracy, precision and sources of error in analytical measurements in analytical chemistry and to analyze the nature of soil, water, food products. They also know application of chromatography and ion exchange method.

Course Contents:

Introduction:

Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil:

Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration.

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

Ion-exchange: Column, ion-exchange chromatography etc.

SEC-2P: Practical Credits- 01 (15L)

Course objectives and expected outcome: Acquire knowledge about different chromatographic separation technique (ion exchange, Paper) of mixture of Ions. Students get practical knowledge to acquire oxygen demined, quantitative chlorine estimation, estimation of total alkalinity of water samples and preparation of borax and boric acid.

1. Determination of pH of soil samples.
2. Determination of pH, acidity and alkalinity of a water sample.
3. Determination of dissolved oxygen (DO) of a water sample.
4. Analysis of preservatives and colouring matter.
5. Paper chromatographic separation of mixture of metal ion (Fe3+ and Al3+).
6. Determination of ion exchange capacity of anion/cation exchange resin (using batch procedure if use of column is not feasible).

CHEMISTRY MINOR

PAPER : CEM-G-CC2-2-Th (Credit :4, Theory -03, Practical – 01)
(60 L)

Physical Chemistry – Theory: (45 L)

Unit:-I (45L)

Course objectives and expected outcome: The kinetic theory of gases explains the three macroscopic properties of a gas in terms of the microscopic nature of atoms and molecules making up the gas. With the help of the kinetic theory of gases, the physical properties of any gas can be defined generally in terms of three measurable macroscopic properties. This course also deals with the chemical kinetics is the study of the rates and the mechanism of chemical reactions. Commonly the measure of how fast the products are formed and the reactants consumed is given by the rate values. The study of chemical kinetics has been highly useful in determining the factors that influence the rate, maximum yield and conversion in industrial processes. The mechanism or the sequence of steps by which the reaction occurs can be known. It is also useful in selecting the optimum conditions for maximum rate and yield of the chemical process. This course also focused on properties of liquids and conductance

Kinetic Theory of Gases and Real gases:

Concept of pressure and temperature; Collision of gas molecules; Collision diameter; Collision number and mean free path; Frequency of binary collisions (similar and different molecules); Rate of effusion Nature of distribution of velocities, Maxwell's distribution of speed and kinetic energy; Average velocity, root mean square velocity and most probable velocity; Principle of equipartition of energy and its application to calculate the classical limit of molar heat capacity of gases Deviation of gases from ideal behavior; compressibility factor; Boyle temperature; Andrew's and Amagat's plots; van der Waals equation and its features; its derivation and application in explaining real gas behaviour; Existence of critical state, Critical constants in terms of van der Waals constants; Law of corresponding states treatment only)

Liquids:

Definition of Surface tension, its dimension and principle of its determination using stalagmometer; Viscosity of a liquid and principle of determination of coefficient of viscosity using Ostwald viscometer; Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only)

Chemical Kinetics:

Introduction of rate law, Order and molecularity; Extent of reaction; rate constants; Rates of First, second and nth order reactions and their Differential and integrated forms (with derivation); Pseudo first order reactions; Determination of order of a reaction by half-life and differential method; Opposing reactions, consecutive reactions and parallel reactions Temperature dependence of rate constant; Arrhenius equation, energy of activation; Collision theory; Lindemann theory of unimolecular reaction; outline of Transition State theory (classical treatment)

Conductance:

Conductance, cell constant, specific conductance and molar conductance; Variation of specific and equivalent conductance with dilution for strong and weak electrolytes; Kohlrausch's law of independent migration of ions; Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes; Ostwald's dilution law; Application of conductance measurement (determination of solubility product and ionic product of water); Conductometric titrations (acid-base) Transport Number and principles of Hittorf's and Moving boundary method.

Physical Chemistry – Practical: (15 L)

PAPER : CEM-H-CC2-2-P:

Course objectives and expected outcome: The course provides training in advanced physical chemistry laboratory techniques. The experiments are guided by demonstrators and are designed both to illustrate the applications of theory covered in the Chemical Physics and lecture courses, and to introduce typical instrumentation. On successful completion of the course students will be able to: 1. Developed expertise relevant to the professional practice of chemistry. 2. Developed an understanding of the breadth and concepts of physical chemistry. 3. An appreciation of the role of physical chemistry in the chemical sciences. 4. Developed an understanding of the role of the chemist in tasks employing physical chemistry. 5. An understanding of methods employed for problem solving in physical chemistry. 6. Experience in some scientific methods employed in basic and applied physical chemistry. 7. Developed skills in procedures and instrumental methods applied in analytical and practical tasks of physical chemistry. 8. Developed skills in the scientific method of planning, developing, conducting, reviewing and reporting experiments. 9. Developed some understanding of the professional and safety responsibilities residing in working with chemical systems.

(I) Surface tension measurement (use of organic solvents excluded)

a) Determination of the surface tension of a liquid or a dilute solution using a Stalagmometer

b) Study of the variation of surface tension of a detergent solution with concentration.

(II) Viscosity measurement (use of organic solvents excluded)

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer

b) Study of the variation of viscosity of an aqueous solution with concentration of solute

(III) Study the kinetics of the following reactions

a) Initial rate method: Iodide-persulphate reaction b) Integrated rate method:
   (i) Acid hydrolysis of methyl acetate with hydrochloric acid
   (ii) (ii) Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate

(IV) Conductance Perform the following conductometric titrations: (Any one)

(i) Strong acid vs. strong base
(ii) Weak acid vs. strong base

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. Practical Workbook Chemistry (Honours), UGBOS, Chemistry, University of Calcutta, 2015