DEPARTMENT OF CHEMISTRY

LESSON PLAN

Faculty Name: **Barsha Rani Bora**
Course Name: B. Sc. Honours and Regular (CBCS)
Session: 2022-2023 (August–December)

B. Sc. 1st Semester (CBCS): CHE-HC-1026

(PHYSICAL CHEMISTRY I)

Months	Unit/Topic	Week	Days	Class Test/ Assignment
September	**Molecular and Crystal Symmetry:** 1. Elementary ideas of symmetry, symmetry elements and symmetry operations. 2. qualitative idea of point and space groups. 3. seven crystal systems and fourteen Bravais lattices.	3rd – 4th week	6	Nil
	Practical: 1. Surface tension measurements.	3rd – 4th week	2	Nil
October	**Liquid State:** 1. Qualitative treatment of the structure of the liquid state; Radial distribution function 2. physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. 3. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. 4. Qualitative discussion of structure of water.	1st – 4th week (Durga Puja vacation included)	15	Assignment
	Practical: 1. Viscosity measurement using Ostwald's viscometer	1st – 4th week	2	Nil
November	**Solid State:** 1. Nature of the solid state, law of constancy of interfacial angles. 2. law of rational indices, Miller indices 3. X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method.	1st – 2nd week	8	Class test
	Solid State, Oxidation – reduction: 1. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Liquid crystals.	3rd – 4th week	10	

	2. Redox equations, Standard Electrode Potential and its application to inorganic reactions. 3. Practice of previous years question paper.			
	Practical: 1. pH metry	1st – 4th week	4	
December	End semester examination			

B. Sc. 1st Semester (CBCS): CHE-RC/HG-1016

(CHEMISTRY 1)

Months	Unit/Topic	Week	Days	Class Test/ Assignment
September	**Atomic Structure:** 1. Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation	3rd – 4th week	4	Nil
October	**Atomic Structure:** 1. de-Broglie's relation, Heisenberg Uncertainty principle 2. Hydrogen atom spectra. Need of a new approach to Atomic structure.	1st - 3rd week (Durga Puja vacation included)	6	Assignment
	Atomic Structure: 1. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation).	4th week	4	Nil
	Practical: 1. Estimation of oxalic acid by titrating it with KMnO4.	1st – 4th week	2	Nil
November	**Atomic Structure:** 1. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). 2. Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of	1st – 2nd week	8	Class test

	exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.			
	Practical: 1. Estimation of oxalic acid by titrating it with KMnO4.			
December	End semester examination			

****

DEPARTMENT OF CHEMISTRY

LESSON PLAN

Faculty Name**: Barsha Rani Bora**
Course Name: B. Sc. Honours and Regular courses (CBCS)
Session: 2022-2023 (January-June)

B. Sc 2nd Semester (CBCS): CHE-HC-2026

(PHYSICAL CHEMISTRY II)

Months	Unit/Topic	Week	Days	Class Test/ Assignment
January	**Chemical Thermodynamics:** 1 Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. 2. First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H.	3rd – 4th week	8	Nil
	Practical: 1. Checking the calibration of the thermometer	1st – 4th week	2	Nil
February	**Chemical Thermodynamics:** 1. 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. Law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. 2. Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.	1st – 4th week	10	Class test
	Practical: 1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system	1st – 4th week	2	Nil
March	**Chemical Thermodynamics** 1. Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy.	1st – 2nd week	6	Assignment

	Chemical Thermodynamics 1**.** Calculation of entropy change for reversible and irreversible processes. 2. Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.	3rd- 4th week	6	
	Practical **1.** Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system	1st – 4th week	2	Nil
April	**Chemical Thermodynamics** 1. Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; spontaneous process-enthalpy change, entropy change and free energy change considerations. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.	1st – 4th week	10	Class test
	Practical: 1. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.	1st – 4th week	2	
May	**Systems of Variable Composition:** 1. Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.	1st – 4th week	12	Class test
	Practical: 1. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.	1st – 4th week	2	
June	End semester examination			

B. Sc 2nd Semester (CBCS): CHE-RC/HG-2016
(CHEMISTRY 2)

Months	Unit/Topic	Week	Days	Class Test/ Assignment
January	**Liquids** 1. Surface tension and its determination using stalagmometer.	3rd – 4th week	2	Nil
	Practical: 1. Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.	1st – 4th week	2	Nil
February	**Liquids** 1. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. 2. Effect of temperature on surface tension and coefficient of viscosity of a liquid	1st – 4th week	3	Class test
	Practical: 1. Study of the variation of surface tension of a detergent solution with concentration	1st-4th week	2	
March	**Solids** 1. Forms of solids. Symmetry elements, unit cells, crystal systems,	1st-4th week	3	
	Practical: 1. Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.	3rd week		
April	**Solids** 1. Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. X–Ray diffraction by crystals, Bragg's law.	1st-4th week	4	Assignment
	Practical: 1. Study of the variation of viscosity of an aqueous solution with concentration of solute	1st-4th week	2	
May	**Solids** 1. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.		2	
June	End semester examination			

****

DEPARTMENT OF CHEMISTRY

LESSON PLAN

Faculty Name**: Barsha Rani Bora**
Course Name: B. Sc. Honours and Regular (CBCS) & Major/Minor (FYUGP)
Session: 2023-2024 (August–December)

B. Sc. 1st Semester (FYUGP): Chemistry 1

Months	Unit/Topic	Week	Days	Class Test/ Assignment
August	**Atomic structure:** 1. Historical development on structure of atom; Bohr's model, H atom Spectrum; Black Body Radiation; Photoelectric effect (qualitative treatment only); The dual behaviour and uncertainty principle 2. Quantum mechanical approach to atomic structure: Concept of Wave function, well behaved function, operator, Normalised and Orthogonal wave function	1^{st} – 4^{th} week	8	Nil
	Practical: 1. Introduction to laboratory apparatus and safety measures. 2. Calibration of apparatus	1^{st} – 4^{th} week	2	Nil
September	**Atomic structure:** 1. Schrodinger Wave equation, eigenfunction, Significance of Ψ and Ψ^2, Particle in a 1D box; Schrodinger equation of hydrogen atom (no derivation), radial and angular wave functions for hydrogen atom, probability distribution, 2. Quantum numbers, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations.	1^{st} – 4^{th} week	6	Class test
	Practical: 1. Determine the surface tension of a given liquid at room temp using stalagmometer by drop number method.	1^{st} – 4^{th} week	2	Nil
October	**Liquid state** 1. Qualitative treatment of the structure of the liquid state. Physical properties of liquids, vapour pressure, surface tension coefficient of viscosity, and their determination. Temperature variation of viscosity of liquids and comparison with that of gases.	1^{st} – 4^{th} week	6	Assignment
	Practical:	1^{st} – 4^{th} week	4	

	1. Determine the surface tension of a given liquid at room temp using stalagmometer by drop number method.			
November	**Liquid state** 1. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents (micelle formation and critical micelle concentration). 2. Revision of the syllabus	1st – 4th week	6	Class test
	Practical: 1. Determine the surface tension of a given liquid by means of stalagmometer using drop weight method.	1st – 4th week	4	
December	End semester examination			

B. Sc. 3rd Semester (CBCS): CHE-HC-3036
(PHYSICAL CHEMISTRY-III)

Months	Unit/Topic	Week	Days	Class Test/ Assignment
August	**Phase Equilibria:** 1. Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solidliquid,liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. 2. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.	1st – 4th week	16	Nil
	Practical: 1. Study the kinetics of the following reaction . Acid hydrolysis of methyl acetate with hydrochloric acid.	1st – 4th week	2	Nil
September	**Phase Equilibria:** 1. Binary solutions: Gibbs-Duhem-Margules equation n, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial	1st – 2nd week	8	Class test

	miscibility of liquids, CST, miscible pairs, steam distillation.			
	Phase Equilibria, Chemical Kinetics: 1. Nernst distribution law: its derivation and applications. 2. Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws. 3. kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (iv) chain reactions.	3rd - 4th week	10	Assignment
	Practical: 1. Study the kinetics of the following reaction. Acid hydrolysis of methyl acetate with hydrochloric acid.	1st-4th week	2	
October	**Chemical Kinetics:** 1. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates. Reaction mechanism- steady-state approximation and rate determining step approximation methods.	1st week	5	
	Catalysis: 1. Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis. Reaction.	2nd-4th week	6	
	Practical: 1. Study the kinetics of the following reaction. Saponification of ethyl acetate.	1st-4th week	2	

November	**Surface Chemistry:** 1. Physical adsorption, chemisorption, adsorption isotherms, nature of adsorbed state.	1st week	2	Class test
	1. Revision of previous classes	2nd-4th week	12	
December	End semester examination			

B. Sc. 3rd Semester (CBCS): CHE-RC/HG 3016 (CHEMISTRY 3)

Months	Unit/Topic	Week	Days	Class Test/ Assignment
August	**Chemical Energetics**: 1. Review of thermodynamics and the Laws of Thermodynamics. 2. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.	1st – 4th week	8	Nil
	Practical: 1) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.	1st-4th week	4	Nil
September	**Chemical Energetics, Ionic equilibria**: 1. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances. 2. Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water.	1st – 2nd week	8	Class test
	Practical: 1) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.	1st-4th week	4	

October	**Ionic equilibria**: 1**.** Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.	1^{st} – 4^{th} week	6	
	Practical: 1) Determination of enthalpy of ionization of acetic acid.	1^{st}-4^{th} week	4	
November	Revision/Question-Answer discussion	1^{st}-4^{th} week	4	Class test
December	End semester examination			

****

DEPARTMENT OF CHEMISTRY

LESSON PLAN

Faculty Name**: Barsha Rani Bora**
Course Name: B. Sc. Honours and Regular (CBCS) & Major/Minor (FYUGP)
Session: 2023-2024 (January-June)

B. Sc. 2nd Semester (FYUGP): Chemistry II

Months	Unit/Topic	Week	Days	Class Test/ Assignment
January	**Thermodynamics:** 1. Mathematical treatment: Exact and inexact differentials, partial derivatives, Euler's reciprocity, cyclic rules.	4th week	2	Nil
	Practical: 1. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.	4th week	1	Nil
February	**Thermodynamics:** 1. Intensive and extensive variables, isolated, closed and open systems. Cyclic, reversible and irreversible processes. Zeroth law of thermodynamics. First law of thermodynamics, concept of heat (q) and work (w), internal energy (U) and enthalpy (H) in differential forms: their molecular interpretation. Calculation of w, q, ΔU and ΔH for expansion of ideal gas under isothermal and adiabatic conditions for reversible and irreversible processes. Derivation of Joule-Thomson Coefficient and inversion temperature.	1st - 4th week	6	Class test
	Practical: 1. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.	1st - 4th week	2	Nil
March	**Thermodynamics:** 1. Application of First law of thermodynamics: standard state, standard enthalpy changes of physical and chemical transformations: fusion, sublimation, vaporization, solution, dilution, neutralization, ionization. Bond-dissociation energy Kirchhoff's equation, relation between ΔH and ΔU of a reaction. Difference between enthalpy and standard enthalpy.	1st – 4th week	6	Assignment

	Practical: 1. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.	1st - 4th week	2	Nil
April	**Thermodynamics:** 1. Second law of thermodynamics, entropy (S) as a state function, molecular interpretation of entropy. Residual Entropy. Free energy: Gibbs function (G) and Helmholtz function (A) and their molecular interpretation. Difference between free energy and standard free energy. Gibbs-Helmholtz equation, criteria for thermodynamic equilibrium and spontaneity of a process. Maxwell's Relations and their physical significance.	1st – 3rd week	4	Class test
	Sessional examination	4th week		
May	Revision	1st – 4th week	6	Class test
June	End semester examination			

B. Sc. 4th Semester (CBCS): CHE-HC-4036

(Physical Chemistry-IV)

Months	Unit/Topic	Week	Days	Class Test/ Assignment
January	**Conductance** 1. Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivityand their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution.	4th week	2	Nil

February	**Conductance** 1. Kohlrausch law of independent migration of ions. Debye Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. 2. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods.	1st – 4th week	16	Class test
	Practical: 1. Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base	1st-4th week	2	
March	**Conductance:** 1. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.	1st week	4	Assignment
	Electrochemistry: 1. Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials. 2. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes.	2nd -4th week	12	
	Practical: 1. Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base			

April	Electrochemistry 1. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). Applications of electrolysis in metallurgy and industry.	1st-4th week	14	
	Practical: 1) Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base	1st-3rd week	2	
	Sessional Examination	4th week		
May	**Electrical & Magnetic Properties of Atoms and Molecules:** 1. Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.	1st-4th week	12	Class test
June	End semester examination			

B. Sc. 4th Semester (CBCS): CHE-RC/HG 4016

(CHEMISTRY 4)

Months	Unit/Topic	Week	Days	Class Test/ Assignment
January	**Conductance** 1. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.	4th week	2	Nil
February	**Conductance** 1. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of	1st – 4th week	6	Nil

	conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, 16 ionic product of water, hydrolysis constant of a salt. Conductometric titrations			
	Practical: 1. Perform the following conductometric titrations: a. Strong acid vs. strong base b. Weak acid vs. strong base	1st-4th week	2	
March	**Electrochemistry** 1. Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data.	1st – 4th week	4	Assignment
	Practical: 1) Perform the following conductometric titrations: a. Strong acid vs. strong base b. Weak acid vs. strong base	1st - 4th week	2	
April	**Electrochemistry** 1. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode.	1st-3rd week	4	Class test
	Sessional Examination	4th week		
May	**Electrochemistry** 1. Potentiometric titrations - qualitative treatment (acid-base and oxidation-reduction only).	1st-3rd week	3	
	Revision	4th week	1	
	Practical:	1st-2nd week	2	

	1) Perform the following conductometric titrations: a. Strong acid vs. strong base b. Weak acid vs. strong base			
June	End semester examination			

****