JAI HIND COLLEGE
BASANTSING INSTITUTE OF SCIENCE
&
J.T.LALVANI COLLEGE OF COMMERCE
(AUTONOMOUS)

"A" Road, Churchgate, Mumbai - 400 020, India.

Affiliated to
University of Mumbai

Program : B.Sc.

Proposed Course: Chemistry

Semester I

Credit Based Semester and Grading System (CBCS) with effect from the academic year 2020 -21

F.Y. B.Sc. Chemistry Syllabus

Academic year 2020-21

Semester I			
Course Code	**Course Title**	**Credits**	**Lectures /Week**
SCHE101	Concepts of Physical and Inorganic Chemistry - I	2	3
SCHE102	Concepts of Organic and Inorganic Chemistry-I	2	3
SCHE1PR	Practical Course work in Chemistry - I	2	6

Semester I – Theory

Course: SCHE101	**Concepts of Physical and Inorganic Chemistry - I** **(Credits: 2 Lectures/Week: 3)** **Course description:** **Concepts of the Laws of Thermodynamics, Reaction Kinetics, Atomic Structure & Basics of Quantum Mechanics**	
	Objectives: ➢ To understand the fundamental concepts of thermodynamics: inter-relationships of variables and their practical applications through problem solving ➢ To understand kinetics of various reactions: parameters involved, determination of order by various methodologies and practical applications ➢ To clarify the basics of atomic structure using quantum mechanics: shapes of orbital ➢ To understand the special features of the quantum mechanical model of an atom and to define an atomic orbital in terms of its quantum numbers	
	Learning Outcomes: ➢ Learner is equipped with concepts of thermodynamics and is able to apply in deriving relationship between thermodynamic variables ➢ Learner is able to interpret experimental results for determination of reaction order. ➢ Learner is thorough with the concepts of nodes and the shapes of orbital with correct signs of wave functions. ➢ Learner can explain experimental observables by using the quantum mechanical model studied.	
Unit I	**Unit – I: Thermodynamics:**	**15L**
	a) Basic Concepts in Thermodynamics i. Types of systems ii. Properties of system iii. State and state system iv. Types of processes	**(3 L)**
	b) Concept of Heat and Work	**(2 L)**
	c) First Law of Thermodynamics i. Internal energy, Enthalpy ii. Heat capacity, Relation between C_p and C_v in gaseous state iii. Joule –Thomson effect (Qualitative discussion and experimentation) iv. Work done for adiabatic and isothermal processes	**(3 L)**
	d) Second Law of Thermodynamics i. Carnot Cycle-Heat engine, Mechanical efficiency	**(4 L)**

	e) Concept of Entropy i. Relationship between Enthalpy and Entropy changes for reversible and irreversible processes ii. Physical significance of entropy iii. Entropy and spontaneity iv. Entropy changes for Fusion, Vaporization and transition (Numerical expected)	**(3 L)**
Unit II	**Unit – II: Chemical Kinetics** **a) Rate of Reaction** i. Definition and measurement of rate constant ii. Order of reaction iii. Molecularity of reaction iv. Integrated rate equation for zero, first and second order reactions (only a = b) **b) Determination of Order of Reaction** i. Integration method ii. Graphical method iii. Half time method iv. Ostwald's Isolation method **c) Arrhenius equation** i. Effect of temperature on reaction rates ii. Energy of activation **d) Types of Complex Chemical Reactions** i. Reversible ii. Consecutive iii. Parallel iv. Thermal chain reaction (only examples: no derivation) **e) Catalysis** i. General features of a catalyst ii. Classification iii. Examples of catalyzed reactions (Numerical expected)	**15 L** **(3 L)** **(4 L)** **(2 L)** **(3 L)** **(3 L)**
Unit III	**Unit III: Atomic Structure & Basics of Quantum Mechanics in Inorganic Chemistry** **a) Historical perspectives of the Atomic Structure** i. Bohr's theory and its limitations ii. Dual behaviour of matter and radiation iii. de Broglie's relation iv. Heisenberg's Uncertainty Principle v. Hydrogen atom spectra vi. Need for a new approach to Atomic Structure	**15 L** **(4 L)**

	b) Basic principles of Quantum Mechanics i. Time independent Schrodinger's Equation; meaning of various terms involved ii. Significance of ψ^1 and ψ^2 iii. Schrödinger's equation for hydrogen atom (derivation not required) iv. Radial and angular parts of the hydrogenic wave function (atomic orbital) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbital (Graphical representation only) v. Radial and angular nodes and their significance vi. Radial distribution functions and concept of the most probable distance (special reference to 1s and 2s atomic orbital) vii. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. viii. Shapes of s, p and d atomic orbital, nodal planes ix. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s) **c) Aufbau's principle** i. Rules for filling electrons in various orbitals ii. Electronic configurations of different atoms iii. Stability of half-filled and completely filled orbitals iv. Concept of exchange energy v. Relative energies of atomic orbital vi. Anomalous electronic configurations	**(6 L)** **(5 L)**

References:

<u>Unit 1 & 2</u>

1. Barrow, G.M., *Physical Chemistry*, (6th Edition), Tata McGraw Hill Publishing Co. Ltd. New Delhi
2. Levine, I. N., *Physical Chemistry, (*6th Ed. 2010), Tata McGraw Hill
3. Puri, B. R., Sharma, L.R., Pathania, M.S., *Physical Chemistry,* (45th Ed.), Vishal Publishing Co.
4. Glasstone & Lewis, *Principles of Physical Chemistry*, (1948)
5. Atkins P. W., and Paula J. De, *Physical Chemistry*, 10th ed., Oxford University, 12 press (2014)5.
6. Kapoor, K.L. *Textbook of Physical Chemistry*, (2006) McMillan Publishers
7. K. J. Laidler, *Chemical Kinetics* 3rd Ed., Pearson Education, (1987)

Unit 3

1. Lee, J.D. *Concise Inorganic Chemistry*, (1991), ELBS
2. Douglas, B.E. and McDaniel, D.H., (1970), *Concepts Models of Inorganic Chemistry*
3. Prakash,S., Tuli, G.D., Basu, S.K., Madan, R.D., *Advanced Inorganic Chemistry*, Volume I
4. Day, M.C. and Selbin, J., (1962), *Theoretical Inorganic Chemistry*, ACS Publications
5. James E. Huheey, *Inorganic Chemistry*, (1983), Harper & Row Publishers, Asia
6. Shriver, D.F., P.W. Atkins, C. H. Langford, 3rd edition, *Inorganic Chemistry*, Oxford University Press
7. Bahl, Tuli and Anand, *Advanced Inorganic Chemistry*, Volume I and II
8. Manas Chanda, *Atomic structure and Chemical Bond: Including Molecular spectroscopy*, (1972), McGraw-Hill Inc, US

Course: SCHE102	**Concepts of Organic and Inorganic Chemistry-I** **(Credits: 2 Lectures/Week: 3)** **Course description:** **Nomenclature, stereo-electronic effects, stereochemistry of simple organic compounds; and modern periodic table, concept of qualitative analysis**	
	Objectives: ➢ To correlate the systematic name with the structure of organic compound; differentiate and rationalize the bond strength, bond dissociation and therefore, reactivity of different classes of organic compounds ➢ To apply the different parameters of stereo-electronic effects in organic reactions ➢ To correlate the chemical properties of elements with their position in the periodic table ➢ To apply the concept of the solubility product and pH of the medium on precipitation of ionic compounds	
	Learning Outcomes: ➢ Learner is able to account for acidity and basicity in organic compounds based on stereo-electronic effects. ➢ Learner is equipped with the effects in organic chemistry to account for experimental observations as well as to make prediction of reaction outcomes for new reactions. ➢ Learner is capable of discerning the chemical properties of elements based on parameters with predictable trends across periods and groups in periodic table. ➢ Leaner is able to understand the experimental observations in the laboratory in semi-micro analysis with the concept of solubility product.	
Unit I	**Unit – I: Fundamentals of organic chemistry, Saturated hydrocarbons and Halogenated derivatives, Basic Concepts in Thermodynamics** **1. General Organic Chemistry – I** **a) Nomenclature of poly functional organic compounds on the basis of priority order, of the following classes:** i. Aliphatic ii. Alicyclic iii. Aromatic compounds **b) Electronic Effects** i. Inductive Effect ii. Electromeric Effect iii. Mesomeric Effect iv. Hyperconjugative Effect **c) Applications of stereo electronic effects in determining acidity and basicity** i. Concept of K_a, K_b and pK_a, pK_b ii. Comparative study of acidity and basicity of different classes of organic compounds: Carboxylic acids, Phenols,Alcohols, Aliphatic amines, Aromatic amines iii. Other factors affecting acid/base strength: H-Bonding, steric effects and solvation	**15 L** **(8 L)**

	2. Chemistry of Saturated Aliphatic Hydrocarbons **a) Alkanes** i. Preparation: Sources of alkanes – Petroleum, natural gas, LPG, CNG, Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Reduction of alkyl halides (Mechanism not expected) ii. Physical Properties **b) Haloalkanes** i. Nucleophilic substitution: SN^1, SN^2&SN^i; Mechanism and Stereochemistry ii. Factors affecting nucleophilic substitution: Substrate, Solvent, Reagent, Leaving group	**(7 L)**
Unit II	**Unit – II: Stereochemistry - I** **1. Stereo-chemical Modelling** **a) 2D models** i. Projection Formula: Wedge-Dot, Fischer, Newmann, Sawhorse ii. Interconversions of projection formula **b) 3D models** i. Ball-stick & space fill models **2. Conformation** **a) Conformational analysis of alkanes** i. Ethane ii. Propane iii. n-Butane **3. Configuration** **a) Geometrical isomerism in alkenes** i. Stereochemical descriptor: cis/trans; E/Z **b) Optical isomerism** i. Chirality, asymmetry, stereogenecity ii. Enantiomers, diastereomers &meso isomers iii. Compounds with multiple stereogenic centres- number of possible stereoisomers iv. Configurational descriptor for compounds not containing more than 2 stereogenic centres (D/L; erythro/threo; syn-anti; R/S) **4. Optical activity** i. Plane Polarized Light ii. Polarimeter	**15 L** **(3 L)** **(2 L)** **(1 L)** **(5 L)** **(4 L)**

	iii. Specific rotation iv. Racemic mixture (external compensation) v. Resolution (methods of resolution not expected) vi. Optical purity (calculation of ee)	
Unit III	**Unit – III: General trends and Properties of Modern Periodic Table & concept of Qualitative Analysis** **1. Modern Periodic Table** **a) Long form of Periodic Table:** Classification of elements into main group, transition elements and inner transition elements **b) Periodicity in properties:** i. Atomic size and Ionic size ii. Electron gain enthalpy iii. Ionization enthalpy iv. Effective nuclear charge (Slater's rule) v. Electronegativity: Pauling, Mulliken and AlredRochow electronegativity (Numerical problems expected, wherever applicable) **2. Comparative study of 's' block elements:** i. Study the general trends in the properties of these elements w.r.t their family relationship ii. General characteristics: a. Physical properties: Electronic Configurations, Physical state, Atomic and Ionic Radii, ionisation energy, Tendency to form ionic compounds, flame colour, electric conductivity, Hydration energy, reducing properties b. Chemical properties: Reaction with oxygen, water, hydrogen, nitrogen, Action of Carbonates and Bicarbonates, iii. Comparison between Alkali metals & Alkaline earth metals iv. Common features such as thermal stability, solubility of the following compounds of s block elements: Hydrides, oxides, superoxides, nitrates, sulphates v. Complex formation tendency of s-block elements: structure of the following complexes: crown ether, cryptates of group 1; EDTA complex of Ca & Mg vi. Diagonal relationship between Li & Mg; Anomalous behaviour of Li and Be **3. Concept of Qualitative Analysis** i. Testing of Gaseous Evolutes ii. Role in qualitative analyses: Papers impregnated with reagents (Starch iodide, potassium dichromate, lead	**15 L** **(4 L)** **(7 L)** **(4 L)**

	acetate, dimethyl glyoxime and oxime reagents) iii. Precipitation equilibria iv. Solubility product v. Common ion effect vi. Uncommon ions vii. Oxidation states viii. Buffer action ix. Complexing agents for precipitation of ionic compounds	

References:

Unit 1 & 2

1. Morrison, R. T.; Boyd, R. N. (2012). *Organic Chemistry*. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. (2012). *Organic Chemistry (Volume 1)*. Dorling Kindersley (India) Pvt. Ltd. (PearsonEducation).
3. Solomons, T.W.G. (2009) *Organic Chemistry*. John Wiley & Sons, Inc.
4. Kalsi, P. S. (2005) *Stereochemistry Conformation and Mechanism*. New Age International
5. Ahluwalia, V.K.; Parashar, R.K. (2006) *Organic Reaction Mechanisms*.Narosa Publishing House.
6. Mukherji; Singh; Kapoor. (2002) *Reaction Mechanisms in Organic Chemistry*.McMillan

Unit 3

1. Shriver, D. F. and Atkins, P. W. (1999), *Inorganic chemistry*, 3 rd Ed., Oxford University Press,
2. Jolly, W. L. , (1993), *Modern inorganic chemistry*, McGraw Hill Book Co.
3. Douglas, B. E. and McDaniel, H., *Concepts and models in inorganic chemistry*, (1994),3 rd Ed., John Wiley & Sons, Inc., New York,
4. Huheey, J.E., (1993), *Inorganic Chemistry*, Prentice Hall.
5. Lee, J.D., (1993), *Concise Inorganic Chemistry*, ELBS
6. Shriver & Atkins, (1994) *Inorganic Chemistry*, Third Edition, Oxford Press

Course: SCHE1PR	**Practical Course work in Chemistry-I(Credits: 2Practicals/Week: 2)** **Course description:** **Practical Course work on Chemical Kinetics, Thermodynamics, Titrimetric Calculations, Qualitative & Quantitative Analysis in Inorganic Chemistry, Purification of Organic Compounds and determination of Physical Constants, Factors affecting Nucleophilic Substitution reactions, Virtual Lab Experiments**

Objectives:

- To determine the order of reaction; measurement of enthalpy
- To solve numerical problems based on basic concepts involving quantitative analysis
- To apply the concept of solubility product and pH in the formation of a precipitate in semi micro analysis
- To understand titrimetric analysis using different indicators operating at various pH ranges
- To determine various physical constants of an organic compound
- To apply the concepts of nucleophilic substitution in understanding the reactivity of different substrates

Learning Outcomes:

- Learner is able to design experiments to measure change in enthalpy on dissolution of ionic compounds in water.
- Learner is able to deduce the concentrations of chemicals based on titrimetric analysis.
- Learner is able to conclude the qualitative presence of ions in a sample by various tests and can extrapolate the tests to commercial samples for analysis.
- Learner is capable of making a scientific choice of indicator for a titration depending upon the pH value at equivalence point.

PRACTICAL – I

A. Principles of Calculations

a) Molarity, Normality, Mole fraction, Dilution of solution, ppm, ppb (Problem solving)

b) Preparation of 0.1N succinic acid solution and subsequent standardization of the given NaOH solution

B. Chemical Kinetics

a) To determine the rate constant & order for hydrolysis of ester using HCl as a catalyst (graphically, calculations & using method of equifraction of times)

b) To study the base catalyzed hydrolysis (saponification) of ethyl acetate and to evaluate rate constant by calculative and graphical method

C. Thermodynamics

a) To determine the enthalpy of dissociation of salts like NH_4Cl and $CaCl_2$

	PRACTICAL – II **A. Qualitative Analysis** a) Semi-micro analysis of not more than four ionic species (two cation and two anion) (Cations: NH_4^+, K^+, Fe^{+3}, Al^{+3}, Co^{+2}, Cr^{+3}, Ni^{+2}, Mn^{+2}, Zn^{+2}, Cu^{+2}, Bi^{+3}, Ba^{+2}, Sr^{+2}, Ca^{+2} Anions: CO_3^{-2}, NO_3^-, NO_2^-, SO_4^{-2}, Cl^-, Br^-, F^-, I^-) **PRACTICAL – III** **A. Identification of organic compounds-I (**only C, H, [O] as elements) **a)** To determine the solubility profile and functionality present in a given organic compound. **B. Virtual Lab 1:** Nomenclature and Structure of organic compounds using Chemsketch

Evaluation Scheme

A. Evaluation scheme for Theory courses

I. Continuous Assessment (C.A.) - 40 Marks

(i) C.A.-I: Test – 20 Marks of 40 mins. duration

(ii) C.A.-II: Assignment/ Poster/Worksheets for 20 marks

II. Semester End Examination (SEE)- 60 Marks

B. Evaluation scheme for Practical courses

I. Internal Assessment - 40 Marks: Journal/Viva/Experiment Scheme

II. Semester End Examination (SEE)- 60 Marks