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

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

Affiliated to University ofMumbai

Program : B.Sc.

Proposed Course for : Chemistry

Semester II

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

F.Y. B.Sc. Chemistry Syllabus

Academic year 2020-21

Semester II			
Course Code	**Course Title**	**Credits**	**Lectures /Week**
SCHE201	Concepts of Physical and Inorganic Chemistry - II	2	3
SCHE202	Concepts of Organic and Inorganic Chemistry-II	2	3
SCHE2PR	Practical Course work in Chemistry - II	2	6

Semester II –Theory

Course: SCHE201	**Concepts of Physical and Inorganic Chemistry - II** **(Credits: 2 Lectures/Week: 3)** **<u>Course description:</u>** **States of Matter, Ionic Equilibria, Chemical Bonding and Molecular Structure**	
	Objectives: ➢ To understand the theoretical principles of the states of matter, their properties and various applications ➢ To understand the concept of ionic equilibria, pH, theory of ionic products, theory of acids and bases, theory of indicators, solubility product & their practical applications ➢ To understand the formation of chemical bonds, rules governing them, their types and the spatial arrangements leading to various molecular symmetries. ➢ To create and label models of atoms, writing and balancing of chemical equations	
	Learning outcomes: ➢ The students acquire thorough knowledge of the various states of matter, the theoretical principles governing each state, determination of physical parameters and their practical applications. ➢ The students will be having thorough knowledge on ionic equilibria, the theory and applications of electrolytes, theory of acids and bases and sparingly soluble salts. ➢ Students will be having clear understanding of the formation of bonds between various types of atoms thereby leading to the formation of various molecular entities, their geometrical arrangements and the rules governing them. ➢ Students will be practically trained to write chemical equations, balancing them and will be able to create molecular models.	
Unit I	**Unit – I: States of matter** **a) Gaseous state** i. Ideal gas behaviour and kinetic theory of gases (only postulates) ii. Distribution of molecular speed (Maxwell Boltzmann's plot) iii. Real gases: Compressibility factor, Boyle's temperature, van der Waal's equation of state iv. Liquefaction of gases (Numerical expected) **b) Liquid state** i. Introduction ii. Liquid-vapour equilibrium (vapour pressure) iii. Surface tension: determination using stalagmometer, effect of temperature on surface tension, parachor and its applications iv. Viscosity: measurement using Ostwald's viscometer, effect of	**15L** **(8L)** **(7L)**

	temperature on viscosity v. Refractive index: molar refraction and polarizability, determination using Abbe's refractometer vi. Liquid crystals: Introduction, classification and applications (Numerical expected)	
Unit II	**Unit – II: Ionic Equilibria** **a) Strong, moderate and weak electrolytes:** i. Ionization constant and ionic product of water ii. pH scale iii. Common ion effect iv. Dissociation constant of mono-, di- and tri-protic acid v. Buffer solution, buffer capacity and buffer action vi. Henderson's equation for acidic and basic buffer vii. Applications of buffer in biochemical processes **b) Hydrolysis of salts** i. Hydrolysis constant, degree of hydrolysis **c) Theory of acid-base indicators** Action of phenolphthalein and methyl orange **d) Solubility and solubility product of sparingly soluble salts** i. Applications of principles of solubility product **e) Ionic equilibria involving complex ions** (Numerical expected)	**15L** **(8L)** **(4L)** **(1L)** **(1L)** **(1L)**
Unit III	**Unit III: Chemical Bonding and Molecular Structure** **a) Chemical bond** i. Introduction ii. Octet rule **a) Ionic Bonding** i. General characteristics of ionic bonding ii. Polarizing power and polarizability iii. Fajan's rules, ionic character in covalent compounds, iv. Bond moment, dipole moment and percentage ionic character **c) Covalent bonding** i. VB Approach: Shapes of some inorganic molecules Lewis dot structure, Sidgwick and Powell Theory, shape of ions on the basis of VSEPR theory for AB_n type molecules with and without lone pair of electrons (examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements). Isoelectronic principles. ii. Concept of resonance and resonating structures in various	**15L** **(2L)** **(4L)** **(9L)**

	compounds. iii. Applications and limitations of VSPER theory.	

References:

Unit 1 & 2

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., Pamania, M.S., *Physical Chemistry*, (45th Ed.), Vishal Publish Co.
4. Glasston& Lewis, *Principles of Physical Chemistry*
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

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: SCHE202	**Concepts of Organic and Inorganic Chemistry-II** **(Credits: 2 Lectures/Week: 3)** **Course description:** **Reactive Intermediates, Aromaticity, Orientation effect in electrophilic aromatic substitution, Acid base Chemistry- various theories with applications & Redox Chemistry**	
	Objectives: ➢ To list different reactive intermediates and compare their relative stabilities ➢ To define the parameters required for aromaticity ➢ To correlate the orienting influence of a group in electrophilic aromatic substitution with electron density ➢ To list the methods of preparation and reactions of unsaturated aliphatic hydrocarbons and oxygenated derivatives of aliphatic and aromatic systems ➢ To study the various theories of acids and bases & their applications. ➢ To study redox chemistry with respect to electrochemical reactions of ions. **Learning outcomes** ➢ Learner will be able analyse the stability of a given reactive intermediate ➢ Learner will be able to predict the products of electrophilic aromatic substitution based on orienting influence of a group ➢ Learner will be able to recount the methods of preparation and apply it to reactions of alkanes and its oxygenated derivatives ➢ Learner will be able to compare the theories of acids and bases for their advantages and limitations. ➢ Learner will be able to predict the outcome of redox reactions based on the electrochemical series. ➢ Learner will be able to reason the control disproportionation of ions in aqueous solutions based on changes in pH.	
Unit I	**Unit – I: Reactive Intermediates & reactivity of aromatic compounds** **1. General Organic Chemistry – II** **a) Reactive Intermediates: structure shape & relative stability** i. Carbocations ii. Carbanions iii. Free radicals iv. Carbenes **b) Reactivity of organic molecules** i. Nucleophilicity & basicity ii. Electrophilicity & Acidity **c) Reactions involving Intermediates** i. Carbocations- Acid catalysed hydration of alkenes, Friedel-Crafts alkylation reaction ii. Carbanions- homologation of terminal alkynes; iii. Free radical- Halogenation of alkane, selectivity rules (Mechanism expected)	**15L** **(2L)** **(2L)** **(3L)**

	2. Chemistry of Aromatic Compounds- I **a) Aromaticity** i. Conditions of aromaticity ii. Huckel's Rule iii. Aromaticity of arenes & arenium ions **b) Electrophilic Aromatic Substitution** i. ESR- nitration, sulphonation, halogenation (w.r.t. reagents & reaction conditions) ii. Activating, deactivating groups iii. Orientation effect (mono & disubstituted) based on electron density	**(3L)** **(5L)**
Unit II	**Unit – II: Unsaturated aliphatic hydrocarbons & compounds containing oxygen- I** **1. Chemistry of unsaturated aliphatic hydrocarbons** **a) Alkenes** i. Preparation- dehydration of alcohols & dehydrohalogenation of alkyl halides (Saytzeff rule) ii. Reactions: addition of $KMnO_4$ and Br_2 (test for unsaturation); addition of HX (Markownikoff's& anti-Markownikoff's addition), hydration, ozonolysis. **b) Alkynes** i. Preparation- Dehydrohalogenation of vicinal dihalides, reaction of metal acetylides with primary alkyl halides, acetylene from CaC_2 (applications in fruit ripening) ii. Reactions: hydration, addition of bromine & alkaline $KMnO_4$, ozonolysis & oxidation. **2. Chemistry of alcohols & ethers** **a) Alcohols** i. Preparation- Industrial preparation (fermentation), using Grignard reagent, using hydride reducing agents ii. Reactions- with sodium, HX (Lucas test), esterification, oxidation **b) Ethers** i. Preparation- Williamson's synthesis ii. Reactions- cleavage of ethers with HI iii. Uses- ethers as solvents (THF, diethyl ether) in organic synthesis	**15L** **(5L)** **(4L)** **(4L)** **(2L)**
Unit III	**Unit III: Acid-Base & Redox Chemistry** **<u>ACID & BASES</u>** i. Arrhenius concept ii. Bronsted-Lowry concept, Proton transfer theory iii. Lux-Flood concept iv. Solvent-system concept	**15L** **(8L)**

	v. Lewis concept vi. Relative Strength of acids & bases a. Effect of solvent b. Levelling effect. c. Effect of polarity & dielectric constant d. Effect of substituents vii. Hard and soft acids & bases. Person's concept viii. Bonding in hard-hard & soft-soft combinations. ix. HSAB principle & its applications. **OXIDATION REDUCTION CHEMISTRY** i. Definition of Oxidation & Reduction ii. Oxidising & reducing agent iii. Oxidation number concept & calculations iv. Reduction potentials: Half reactions, Balancing the redox reactions (ion electron method& oxidation number method) v. Electrochemical Series (standard Electrode potential) & its application. vi. Disproportionation Reaction. vii. Latimer Poubaix & Frost Diagram.	**(7L)**

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. Ahluwalia, V.K.; Parashar, R.K. (2006) *Organic Reaction Mechanisms.*Narosa Publishing House.
5. Mukherji; Singh; Kapoor. (2002) *Reaction Mechanisms in Organic Chemistry,* McMillan

Unit 3

1. Shriver, D. F and Atkins, P. W. , 1999, *Inorganic chemistry*, 3rd Ed., Oxford University Press
2. W. L. Jolly, 1993, *Modern inorganic chemistry*, McGraw Hill Book Co.
3. Douglas, B. E. and McDaniel, H. , *Concepts and models in inorganic chemistry*, 1994,3rd 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.

Semester II – Practical

Course: SCHE2PR	**Practical Course work in Chemistry-II (Credits: 2 Practicals/Week: 2)** **Course description:** **Viscosity, Surface tension, Ionic Equilibria, Indicators, Gravimetric Analysis, Volumetric analysis (Acid-Base & Redox), Basics of Identification of Organic Compounds & virtual laboratory experiment.**

Objectives:

- To develop the skill of observation, understanding and analysis of data
- To apply the concept of indicators in determining the pH and strengths of solutions
- To estimate analytes through volumetric analysis by performing acid-base and redox titrations.
- To apply the concept of gravimetric analysis in determining the percentage purity of a sample
- To perform preliminary investigations including solubility profile and element detection of mono-functional organic compounds
- To develop the skills for one-step synthesis of organic compounds

Learning Outcomes:

- Learners will be able to make a learned choice of the correct indicator to be used for an acid-base titration.
- Learner will be acquainted with the techniques involved in volumetric analysis and at the end of the experiment be able to understand concepts of accuracy and precision of measurement.
- Learner will develop the requisite skills involved in gravimetric analysis and will also be acquainted with the SOP of an analytical balance.
- Learner will be able to plan a one step organic synthesis and will be able to stoichiometrically calculate the amount of reagent and the percentage yield from the synthesis.

PRACTICAL – I

A. Viscosity

To determine the viscosity of aqueous solutions at room temperature using Ostwald's Viscometer:

i. Ethylene Glycol
ii. Glycerine

B. Surface tension

To determine the surface tension of a given liquid using stalagmometer

C. Ionic Equilibria

i. To determine the pH of various concentrations of sodium acetate and acetic acid buffer solutions
ii. Vitrual Lab 2: Titration curves & choice of indicator for acid-base titrations.

PRACTICAL – II

A. Gravimetric analysis (any one)

i. To determine the percentage purity of a sample of barium sulphate, containing ammonium chloride as impurity.

ii. To estimate the amount of sodium carbonate & bicarbonate in a mixture gravimetrically.

B. Volumetric analysis

i. To estimate the strength of carbonate and bicarbonate present in a mixture.

ii. To study the number of electrons transferred by iodometric titration of potassium dichromate against sodium thiosulphate.

iii. To estimate Fe(II) by titration against potassium dichromate using internal (diphenylamine/N-phenylanthranilic acid) and external (potassium ferricyanide) indicators.

PRACTICAL – III

A. Basics of Identification of Organic compounds-II

a) To determine the solubility profile and elements (N, S, X) present in a given organic compound.

B. One-step synthesis

a) Comparative analysis of the procedure of nitration reaction on different substrates:

i. Nitration of nitrobenzene

ii. Nitration of acetanilide

b) Recrystallization of product formed (not quantitative)

c) Confirmation of purity by melting point

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: Worksheets (Best 3 of 5) 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