Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

of Arts, Science & Commerce

(Autonomous College)

Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for the F.Y. B.Sc.

Program: B.Sc. (Chemistry)

Program Code: RJSUCHE

(CBCS: 2020 -2021)

DISTRIBUTION OF TOPICS AND CREDITS

F.Y. B.Sc. (CHEMISTRY) SEMESTER I

Course	Nomenclature	Credits	Topics
RJSUCHE101	Paper I	02	1. Physical 2. Inorganic 3. Organic
RJSUCHE102	Paper II	02	1. Physical 2. Inorganic 3. Organic
RJSUCHEPR101 RJSUCHEPR102	Practical Paper I Paper II	02	1. Physical 2. Inorganic 3. Organic

F.Y. B.Sc. (CHEMISTRY) SEMESTER II

Course	Nomenclature	Credits	Topics
RJSUCHE201	Paper I	02	1. Physical 2. Inorganic 3. Organic
RJSUCHE202	Paper II	02	1. Physical 2. Inorganic 3. Organic
RJSUCHEPR201 RJSUCHEPR202	Practical Paper I Paper II	02	1. Physical 2. Inorganic 3. Organic

SEMESTER I (THEORY)		L	Cr
Paper-I	**Paper Code: RJSUCHE101**	45	2
UNIT I		15	
Physical Chemistry			
1	**Chemical Thermodynamics - I:** **Thermodynamic terms:** System, surroundings, boundaries, open, closed and isolated systems; intensive and extensive properties, state functions and path functions; processes and their types (isothermal, adiabatic, isobaric, reversible & irreversible processes); zeroth law of thermodynamics, absolute temperature scale. **First law of thermodynamics**: concept of heat (q), work (w), internal energy (U) and statement of first law; enthalpy, relation between heat capacities, sign conventions; calculations of q, w, U and H for reversible, irreversible and free expansion of ideal gases under isothermal and adiabatic conditions (Numericals expected).		
2	**Chemical Calculations:** **Expressing concentration of solutions**: Normality, molality, molarity, mole fractions, percentage (w/w %, w/v % & v/v %), ppm, ppb, millimoles, milliequivalents (Numericals expected), Molecular formulas, stoichiometric calculations		
3	**Graphical Representation of Experimental Data:** Dependent and independent variables, rules for drawing graphs, co-ordinates, equations of straight line, slope and intercept; plotting graphs from the data of chemical properties and problems		
UNIT II		15	
Inorganic Chemistry			
1	**Atomic Structure** Historical perspectives of atomic structure, Rutherford's Atomic model & its drawbacks, Bohr's theory and its limitations, Dual nature of electron, Heisenberg's principle of uncertainty, Quantum numbers, Filling of orbitals in atoms (Aufbau principle, Pauli's exclusion principle and Hund's rule), Atomic spectrum of hydrogen.		
2	**Periodic table and periodicity of properties** Long form of Periodic Table; Classification of elements as main group, transition and inner transition elements, electronic configuration of s, p, d & f block elements. Periodicity in the following properties:		

Atomic and ionic size; electron gain enthalpy; ionization enthalpy, effective nuclear charge (Slater's rule); electronegativity; Pauling, Mulliken and Alfred Rochow electronegativities (Numerical problems expected, wherever applicable).			
UNIT III		15	
Organic Chemistry			
1	**Basics of Organic Chemistry:** **IUPAC nomenclature of organic compounds:** Nomenclature of mono and bi-functional aliphatic compounds (up to six carbon atoms) on the basis of priority order of the following classes of compounds: Alkanes, Alkenes, Alkynes, Haloalkanes, Alcohols, Ethers, Aldehydes, Ketones, Carboxylic acids, Acid Derivatives (Acid halides, Esters, Anhydrides, Amides), Nitro compounds, Nitriles and Amines.		
2	**Fundamentals of organic reactions.** Electronic effects: Inductive effect, Electromeric effect, Resonance and Hyperconjugation effects with examples. **Organic acids and bases:** Comparison of relative strengths of aliphatic carboxylic acids and amines on the basis of inductive and resonance effects. Electrophiles and Nucleophiles.		
3	**Stereochemistry I.** **Basic Concepts:** Configurational isomerism, stereogenic centre, molecular chirality. Fischer and Wedge dot projection formulae, 2^n rule in optical isomerism (up to two stereogenic centers), molecules with similar and dissimilar chiral centers. Enantiomers, diastereomers, meso compounds and racemic mixtures.		

F.Y. BSc.	Semester- I Theory
RJSUCHE101 Paper I	**Course Outcomes:** ➢ Thermodynamic concepts, terminologies & laws; the various ways of expressing the concentration of solutions.; how to plot graphs. ➢ The IUPAC name of mono and bi-functional aliphatic compounds, electronic effects and their applications with respect to stability of reactive intermediates and determination of relative strengths of aliphatic acids and bases. Basic concept of stereochemistry **Learning outcomes:** *On successful completion of this course, students will be able to* ➢ understand the basic terminologies and concepts involved in chemical thermodynamics. ➢ interpret the first law and zeroth law of thermodynamics. ➢ express the concentration of solutions in various units. ➢ plot graphs by using the available data. ➢ understand the structure of an atom and classify the elements to s, p, d & f blocks ➢ determine quantum numbers of an electron of an atom ➢ Understand the periodicity of properties of elements. ➢ Apply IUPAC rule in naming aliphatic compounds. ➢ Understand the importance of electronic effects in organic reactions. ➢ comprehend the basic concept of stereochemistry & their importance.

F.Y. B.Sc. Chemistry Syllabus Semester I & II

SEMESTER I (THEORY)		L	Cr
Paper-II	**Paper Code: RJSUCHE102**	45	2
UNIT I		15	
Physical Chemistry			
1	**Chemical Kinetics:** Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, integrated rate equation (specific reaction rate) of first and second order reactions (with equal initial concentration of reactants) (Numericals expected) Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method (Numericals expected)		
2	**Liquid State:** Characteristic properties of liquid state. Surface tension: Introduction, methods of determination of surface tension by drop number method (Numericals expected) Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer (Numericals expected). **Solid State Chemistry:** Types of solids, crystal lattice, lattice points, unit cell, space lattice and lattice plane.		
UNIT II		15	
Inorganic Chemistry			
1	**Comparative chemistry of Main group elements:** a) Metallic and non-metallic character, oxidation states, electronegativity, anomalous behaviour of second period elements, allotropy, catenation, diagonal relationship. b) Classification, preparation & uses of carbides, nitrides and oxides of group I & II elements. c) Preparation, properties and uses of $NaHCO_3$, Na_2CO_3, NaOH, CaO, $CaCO_3$.		
2	Oxides of C, N, S with respect to environmental aspects which includes sources, health hazards and control techniques, greenhouse effect, photochemical smog, acid rain and ozone depletion.		

UNIT III	15	
Organic Chemistry		
1 **Basics of Organic Chemistry:** **Understanding bonding in organic compounds:** a) Formation of sigma/ π bonds in aliphatic compounds containing C-C, C=C, C≡C,>C=O, R_3(C-N), -C≡N with representative examples. b) Hydrogen bonding and its application.		
2 **Reactive Intermediates** Homolytic and heterolytic bond fission, transition state and intermediates formation, structure and stability of carbocations, carbanions, carbon radicals and carbenes.		
3 **Types of organic reactions and general mechanism of the following types of reaction.** **3.1 Substitution reaction:** SN^1 and SN^2 mechanisms, factors affecting these reactions, Energy profile diagrams. **3.2 Elimination reaction:** E_1, E_2, E1CB mechanism, Saytzeff and Hofmann elimination.		

F.Y. BSc.	Semester- I Theory
RJSUCHE102 Paper II	**Course Outcomes:** ➢ To understand the first and second order reactions, methods of determination of order of reaction. To study the properties of liquids and liquid crystals. ➢ Understand importance of hybridization on molecular structure and reactivity of various functional groups. ➢ To understand the comparative chemistry of Main group elements. ➢ Understand the importance of intermediates during course/ mechanism of organic reactions. ➢ Classification of basic organic reactions, mechanism of different types of substitution & elimination reaction & their applications. **Learning outcomes:** ➢ Learn the basics of chemical kinetics. ➢ Understand the integrated rate expression for first and second order reactions. ➢ Know how to determine the order of a reaction. ➢ Study the characteristic properties of liquids as well as the methods used to determine the surface tension and viscosity of liquids. ➢ Study the comparative chemistry of main group elements with respect to electronegativity, metallic and non-metallic characters. ➢ Study the comparative chemistry of carbides, nitrides, oxides and hydrides of alkali and alkaline earth metals. ➢ Learn about oxidation states, allotropes and catenation ability of main group elements. ➢ Study in detail about some compounds of sodium and calcium. ➢ Understand the effects of oxides of C, N and S on the environment. ➢ Help students to understand the reactivity of different functional groups in reaction mechanisms depending on the hybridization. ➢ Understand different types of bond fission, importance of transition state and intermediates in determining the course of reaction.

	➤ Understand general mechanism & the stereochemical aspects, factors affecting formation of specific products pertaining to Substitution, Elimination reaction.

SEMESTER II (THEORY)		L	Cr
Paper-I	**Paper Code: RJSUCHE201**	45	2
UNIT I		15	
Physical Chemistry			
1	**Gaseous State:** Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), ideal gases, real gases, compressibility factor, Boyle's Temperature (Numericals expected). Deviation from ideal gas laws, reasons for deviation from ideal gas laws, Van der Waals equation of state, Joule-Thomson effect: qualitative discussion and experimentation, inversion temperature.		
2	Reversible and irreversible reactions, law of mass action, dynamic equilibria. Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Le Chatelier's principle, factors affecting chemical equilibrium (Numericals expected). Statements of second law of thermodynamics, concepts of entropy, thermodynamic derivation of equilibrium constant (Numericals expected).		
UNIT II		15	
Inorganic Chemistry			
1	**Concept of Qualitative Analysis:** **i. Types of qualitative analysis:** Macro, semi micro, micro and ultra micro technique. **ii.** Testing of gaseous Evolutes, Role of papers impregnated with reagents in qualitative analysis (with reference to starch iodide, potassium dichromate, lead acetate, dimethylglyoxime and oxine reagents).		

	iii. Precipitation equilibria, solubility product, ionic product, effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds (Balanced chemical equations and numerical problems expected)		
2	**Acid -Base Theories:** Arrhenius, Lowry-Bronsted, Lewis, Solvent-Solute concept of acids and bases. Hard and Soft acids and bases, applications of HSAB, applications of acid base chemistry in understanding organic reactions like Friedel Crafts (acylation/alkylation) reaction. Volumetric analysis with special reference to calculation of titration curve involving strong acid and strong base.		
	UNIT III	15	
	Organic Chemistry		

1	**Chemistry of Alkanes, alkenes and alkynes (up to 6 carbons)**
	 1.1 Alkanes: Preparation of alkanes, Wurtz reaction, reaction – halogenation (mechanism) relative reactivity and selectivity.
	 1.2 Alkenes: Preparation, Dehydrogenation of alkyl halides.
	    Reactions: Markovnikov and anti-Markovnikov addition (mechanism). Epoxidation (using per acid) and hydrolysis to glycols, Ozonolysis of alkenes.
	 1.3 Alkynes: Preparation: From vicinal dihalides.
	    Reaction: Reduction to form cis / trans alkenes, Hydration to form carbonyl compounds, Alkylation of terminal alkynes.
	 1.4 Alkadienes: Types of alkadienes, Diels Alder reaction.		

2	**Aromaticity:** 2.1 Characteristics of aromatic compounds, Huckel's rule, Aromatic character of arenes, cyclic carbocations, carbanions with suitable examples. Anti-aromatic and non-aromatic compounds. 2.**2 Arene electrophilic substitution:** Mechanism of nitration, sulphonation, halogenation, Friedel Crafts alkylation & acylation in benzene.		

F.Y.BSc	Theory Semester II
RJSUCHE201	**Course Outcomes:** ➢ To impart basic and advanced concepts regarding the gaseous state of matter ➢ To give an insight into the Le Chatelier's principle and concept of entropy ➢ Facilitate the students to understand chemistry of alkane, alkene, alkyne and their preparation and reaction. ➢ concept of aromaticity **Learning outcomes:** On completion of this course, the students will be able to ➢ Distinguish between the behaviour of an ideal gas and a real gas ➢ Explain the van der Waals equation of state and Joule-Thomson effect. ➢ Predict the effect of concentration, temperature and pressure on the equilibrium position & equilibrium constant of a chemical reaction. ➢ Understand the concept of entropy ➢ Understand the types of qualitative analysis. ➢ Use the reagent papers in qualitative analysis. ➢ Understand how the ions get precipitated from the solution and the factors affecting the precipitation process. ➢ Explain the acid-base theories and their applications. ➢ Understand methods of preparation of alkanes, alkenes & alkynes & various reactions of alkanes, alkenes & alkynes. ➢ Acquire knowledge on pericyclic reactions. ➢ Understand the concept of Aromaticity & Electrophilic substitution reaction of aromatic compounds.

SEMESTER II (THEORY)		L	Cr
Paper-II	**Paper Code: RJSUCHE202**	45	2
UNIT I		15	
Physical Chemistry			
1	**1.1 Ionic Equilibria:** Strong and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale & pOH, common ion effect, dissociation constants of mono- and di-basic acid, Numericals based on pH & pOH. **Buffers:** Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected) Solubility and solubility product of sparingly soluble salts-applications of solubility product principle. Qualitative treatment of acid-base titration curves (calculation of pH at various stages).		
2	**1.2 Molecular Spectroscopy-I** Electromagnetic radiation, electromagnetic spectrum, Planck's equation, interaction of electromagnetic radiation with matter: Absorption, emission, scattering, fluorescence, electronic, vibrational and rotational transitions (Numericals expected). Definitions of wavelength, frequency, wave number (Numericals expected).		
UNIT II		15	
Inorganic Chemistry			
1	**Chemical bonding:** Types of chemical bonds, comparison between ionic and covalent bonds, polarizability (Fajan's rule), Lewis dot structures, shapes of molecules, Sidgwick Powell theory, VSEPR theory for AB_n type of molecules with and without lone pair of electrons, Isoelectronic principle and limitations of VSEPR theory.		
2	**Oxidation and reduction chemistry:** **Reduction potentials:** Redox half-reactions, balancing of redox reactions (by oxidation number method and ion electron method). **The diagrammatic presentation of potential data:** Latimer diagrams (numericals are expected), Frost diagrams and natural waters.		

	Applications of redox chemistry: (a) Redox reagents in volumetric analysis (I_2 & $KMnO_4$) (b) Titration curves for single electron systems e.g. Ce (IV) against Fe(II).		
	UNIT III	15	
	Organic Chemistry		
1	**3.1 Stereochemistry II** 3.1.1 D/L and Erythro- Threo system. 3.1.2 Fischer, Newmann and Sawhorse Projection formulae of Erythro- Threo isomers of tartaric acid, 2,3 –dichlorobutane, erythrose and threose sugar & their interconversion. 3.1.3 Geometrical isomerism in alkenes and cycloalkanes (cis- trans nomenclature only). 3.1.4 Conformation of ethane & propane, Relative stability with energy diagram.		
2	**3.2 Functional group interconversion** Functional group interconversion of aliphatic compounds for classes - alkyl halide, alcohols, aldehydes & ketones, acids, esters, amides and amines. Their interconversion involving up to three steps. (up to 6 carbons) Illustrative examples expected for all types (mechanism not expected).		

F.Y.BSc	Theory Semester II
RJSUCHE202 Paper II	**Course Outcomes** ➢ To study buffer mechanism, buffer capacity and pH of buffers using Henderson's equations. To introduce molecular spectroscopy, types of energy levels and related transitions. **Learning outcomes:** ➢ Learn the basics of ionic equilibria. ➢ Learn about pH, buffers, buffer capacity and Henderson equation. ➢ Learn the terminologies involved in molecular spectroscopy. ➢ Learn the terminologies involved in solid state chemistry. ➢ Understand the bonding and characteristics of ionic and covalent compounds. ➢ To predict the shape of molecules by applying VSEPR theory. ➢ Understand isoelectronic principle, Lewis dot structure and limitations of VSEPR theory. ➢ Balance redox reactions. ➢ Understand redox chemistry with respect to extraction of elements and reagents used in volumetric analysis. ➢ Learn about reduction potential, Latimer diagram and titration curve for single electron redox systems. ➢ Represent 3-dimensional structure on papers. ➢ Understand cis trans isomerism in cycloalkanes & energy of various conformations of simple molecules. ➢ Carry out functional group interconversions.

Semester I (PRACTICALS)		L	Cr
Practical-I	**Paper Code: RJSUCHEPR101**		1
1	Characterization of organic compounds containing C,H,O,N,S,X (minimum six compounds)		
Practical-II	**Paper Code: RJSUCHEPR102**		1
1	1) **Gravimetric Analysis:** 1.1 To determine the percent purity of a sample of $BaSO_4$ containing NH_4Cl gravimetrically. 1.2 To determine the percent purity of ZnO containing $ZnCO_3$ gravimetrically.		
2	To determine the rate constant for the hydrolysis of ester using HCl as catalyst.		

F.Y.B. Sc.	Semester I, Practical
RJSUCHEPR101 **RJSUCHEPR102**	**Course Outcomes:** To impart the basic knowledge of characterization of organic compounds. To make the learner acquire the skill of gravimetric determination of the percentage purity of a salt. To acquaint the students to determine the rate constant of chemical reactions. **Learning outcomes:** **After successful completion of the course, the learner will be able to** ➢ characterize a given organic compound ➢ estimate the percentage purity of salts ➢ determine rate constant of chemical reactions

F.Y. B.Sc. Chemistry Syllabus Semester I & II

Semester II (PRACTICALS)		L	Cr
Practical-I:	**Paper Code: RJSUCHEPR201**		1
1	1) Qualitative analysis: (Minimum 4 mixtures to be analyzed) Semi-micro qualitative analysis of water soluble mixtures containing two cations and two anions. **Cations:** Ba^{2+}, Cu^{2+}, Fe^{2+}, Ni^{2+}, K^{+}, NH^{4+} **Anions:** CO_3^{2-}, NO_3^{-}, Cl^{-}, SO_4^{2-}, (Scheme of analysis should avoid the use of sulphide ions in any form for precipitation/separation of cations.)		
Practical-II:	**Paper Code: RJSUCHEPR202**		1
1	1) Purification of solid organic compounds by recrystallization using water as solvent. (Any two compounds like benzoic acid and salicylic acid can be used)		
2	2) Commercial analysis of mineral acid.		
3	3) To standardize commercial sample of HCl using borax.		

F.Y. B.Sc.	Practicals Semester II
RJSUCHEPR201 And RJSUCHEPR202	**Course Outcomes:** To impart basic knowledge of semi-micro analysis To train the students to purify organic compounds by crystallization To make the learner to analyze the commercial samples. **Learning outcomes:** **After completion of the course, the learner will be able to** ➢ identify the cations and anions present in the given inorganic mixture ➢ purify organic solids by recrystallization ➢ determine the assay of commercial samples

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5. John E. Mc Murray & Roberts Fay, Chemistry 5th edition Pearson 2011.
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Inorganic Chemistry

1. Principles of Inorganic chemistry, B.R.Puri, A.L.Sharma & A.C.Kalia
2. Advanced Inorganic chemistry,Satya prakash, Madan & Tuli
3. Inorganic chemistry for undergraduates, R.Gopalan, 2009, University press India) pub. Ltd.
4. J.D.Lee, Concise Inorganic Chemistry, 5th ed. Blackwell Science Ltd.,(2005).
5. D.F.Shriver, P.W.Atkins and C.H. Langford, Inorganic Chemistry, 3rd edition Oxford University Press, (1999).

Organic Chemistry

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2. Eliel E.L. and Wilers, S.H. Stereochemistry of organic compounds,John Wiley& sons.
3. Kalsi ,P.S. Stereochemistry Conformation and Mechanism,New Age International, 2005.
4. Mc Murry, J.E.Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. IUPAC nomenclature by S.C.Pal.
6. T.W. Graham Solomons, organic chemistry, 6th edition John Wiley& sons.

Practical

1. Mann F.G. and Saunders B.C. practical organic chemistry, Pearson Education.
2. Vogel A.I., Textbook of practical organic chemistry.

B.Sc. (Chemistry) Semester – I & II

Exam Pattern

Internal exam
Internal 1: MCQ (20 marks)
Internal 2: Short answer questions (20 marks)

Term end exam paper pattern
Total marks: 60
Each question paper will have 4 questions of 15 marks each. All questions will be compulsory.
The nature of Q.1 (from unit 1), Q.2 (from unit 2), Q.3 (from unit 3)   will be as

follows:

Learners to answer any **3** questions out of 5 (each of 5 marks)

Q.4 will be of type:

A or A   from unit 1 of 5 marks

B or B   from unit 2 of 5 marks

C or C   from unit 3 of 5 marks

Semester end practical exam pattern
50 marks per course
Journal: 5 marks
Written test / viva voce based on theory behind all the experiments conducted per course: 10 marks
Experiment: 35 marks