Resolution Number: AC/II(20-21).2.RUS5

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE

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Syllabus for

F.Y.B.Sc

Semester I & II

Program: B.Sc (Chemistry)

Program Code: RUSCHE

(Credit Based Semester and Grading System for academic year 2020–2021)

SEMESTER-I
Course Code-RUSCHE101
Course Title : CHEMISTRY-I
Academic Year 2020-21

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Determine the strengths of solutions using mass based and volume based units of expressing concentration
CO 2	Differentiate between primary standards and secondary standards.
CO 3	Compare ideal gas and real gases using the van Der Waals' equation of state.
CO 4	Comprehend the characteristics of liquid state, physical properties and the concept of viscosity and surface tension and its determination methods.
CO 5	Know the difference between the rate of reaction and molecularity of a reaction and also the methods involved in determining the molecularity of the reaction.
CO 6	Draw planes in a given crystal lattice.

DETAILED SYLLABUS

RUSCHE101	CHEMISTRY-I		Credits-02
	Unit	**Unit Title**	**Lectures**
	I	**1.1 Chemical calculations:**	**(15L)**
		1.1.1 Mole concept, relation with molar mass, conversion of amount into mole and vice versa, relation with the number of particles present. **1.1.2** Amount and concentration, volume based units for concentration, molarity, normality, formality, mass based unit for concentration - molality and mole fraction, ppm and ppb, concept of millimoles and milliequivalents.	

		1.1.3 Problem solving based on various concentration units **1.1.4** Stoichiometry and calculations based on it, concept of limiting reactant and yield for a chemical reaction. **1.1.5** Calculations based on stoichiometry. **1.1.6** Primary standards, properties of primary standards, primary standards for different types of titrations, secondary standards, standardization, standard solutions.	
	II	**2.1 Gaseous State:**	
		2.1.1 Postulates of kinetic theory of gases and Gas Laws. **2.1.2** Ideal and real gases, deviations from the gas laws, reasons for the deviations, compressibility factor, Boyle temperature. **2.1.3** Volume correction and pressure correction, van der Waals equation of state, use of the equation to explain the deviations from the gas laws. **2.1.4** Problem solving based on gaseous laws and vander Waals equation of state **2.1.5**Joule-Thomson effect, Joule-Thomson coefficient, inversion temperature, Linde's process of liquefaction of gases. **2.1.6** Maxwell - Boltzmann's distribution of velocities, the graphical presentation and its interpretation, average velocity, most probable velocity and R.M.S. velocity.	**(10L)**
		2.2 Solid state	**(05L)**

		2.2.1 Solid state and its characteristics, crystalline and amorphous solids. **2.2.2** Space lattice and unit cell. **2.2.3** Laws of crystallography, law of constancy of interfacial angles, law of symmetry, law of rationality of indices. **2.2.4** Weiss coefficients, Miller indices, 100, 110 and 111 planes in a crystal.	
	III	**3.1 Chemical Kinetics:**	**(08L)**
		3.1.1 Rate of a reaction, rate constant and measurement of reaction rates. **3.1.2** Order and molecularity of reaction. **3.1.3** Integrated rate equation for zero, first and second order reactions (with equal and unequal initial concentration of the reactants). **3.1.4** Kinetic characteristics of zero, first and second order reactions. **3.1.5** Numerical problems based on zero, first and second order reactions. **3.1.6** Methods for the determination of the order of a reaction (a) Integration method (b) Graphical method (c) Half time method (d) Ostwald's isolation method (e) differential method.	
		3.2 Liquid State:	**(07L)**
		3.2.1 Introduction to liquid state, characteristics of liquid state, physical properties of the liquids. **3.2.2** Determination of surface tension by drop number method using stalagmometer. **3.2.3** Surface active solutes and surface tension, applications of surface tension measurement.	

		3.2.4 Viscosity: Introduction, coefficient of viscosity. **3.2.5** Determination of coefficient of viscosity by Ostwald viscometer. **3.2.6** Applications of viscosity measurement. **3.2.7** Numerical problems based on calculation of surface tension and viscosity	

Course Code-RUSCHE102
Course Title : CHEMISTRY-II
Academic Year 2020-21

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Correlate earlier theories pertaining to atomic structure.
CO 2	Know the significance of quantum numbers.
CO 3	Differentiate between orbit and orbitals.
CO 4	Draw the shapes of orbitals.
CO 5	Understand the historical development of periodic table of elements.
CO 6	Classify elements depending on entry of valence electrons.
CO 7	Categorize different types of elements.
CO 8	Know the trends in periodic properties.
CO 9	Compare between ionic and covalent bond.
CO 10	Draw Lewis dot structures for given compound.
CO 11	Determine shape of the molecule using VSEPR model.
CO 12	Identify Isoelectronic species.
CO 13	Write IUPAC name of mono and bi-functional aliphatic compounds including their cyclic analogues.
CO 14	Draw structures of organic compounds based on their systematic names.
CO 15	Comprehend the fundamental concepts which govern the structure, bonding, hybridization, bond angles and shapes of molecules.
CO 16	Know the concept of electronic effects.
CO 17	Understand the importance of reaction intermediates

DETAILED SYLLABUS.

RUSCHE102	CHEMISTRY-II		Credits-02
	Unit	**Unit Title**	**Lectures**
	I	**Atomic Structure and Periodic Table and Periodicity of Properties**.	**(15 L)**
		1.1 Atomic Structure **1.1.1** Rutherford's Atomic Model; Bohr's Theory and its limitations, Somerfield extension to Bohr's theory Zeeman effect ; their relationship with quantum number; orbit and orbital. **1.1.2** Quantum Numbers of last electron; Hund's rule, Aufbau principle; Pauli exclusion Principle. **1.1.3** Wave function, Schrodinger wave equation (Mathematical expression not to be discussed), Radial and Angular forms of the wave function; Relationship between Radial function and probability; plots of probability for different orbitals; shapes of orbitals: s,p,d,f. . **1.2 Periodic Table and Periodicity of Properties**. **1.2.1** Long form of the Periodic Table; Classification of elements as main group, transition, and inner transition elements; **1.2.2** Periodicity in the following properties: Atomic and ionic size; electron gain enthalpy; ionization enthalpy, effective nuclear charge (Slater rule); Electronegativity: Pauling and Mulliken (Numerical problems expected, wherever applicable). **1.3 Chemistry of s- block elements** **1.3.1.** Chemical properties, Uses of alkali and alkaline earth metals, Diagonal relationship of Li and Mg. **1.3.2 Role of Na and K in biological systems.**	
	II	**2.1 Chemical Bond and Reactivity**	**(15 L)**

		2.1.1 Types of chemical bonds; comparison between ionic and covalent bonds**;** polarizability and its effect on a bond, (Fajan's Rules). **2.1.2** Shapes of simple molecules: Lewis dot structures; Sidgwick-Powell theory; Basic VSEPR Theory for AB_n type of molecules (neutral or charged species), with and without lone pair of electrons. **2.1.3** Isoelectronic species; applications and limitations of VSEPR Theory.	
	III	**3.1 Nomenclature of Organic Compounds:**	**(05L)**
		3.1.1 IUPAC nomenclature of mono functional aliphatic compounds. 3.1.2 IUPAC nomenclature of bi-functional aliphatic compounds and their cyclic analogues.	
		3.2 Bonding and Structure of organic compounds:	**(05L)**
		Concept of Hybridization (sp3, $sp^2$and sp hybridization) Hybridization: sp^3, $sp^2$and sp hybridization of carbon and nitrogen; sp^3 and sp^2 hybridizations of oxygen in organic compounds and their geometry with suitable examples.	
		3.3 Basic concepts involved in organic reaction mechanism:	**(05L)**
		3.3.1 Electronic Effects: Inductive, electromeric, resonance effects, hyperconjugation.	
		3.3.2 Carbocations, Carbanions and Free radicals: Homolytic and heterolytic fission, examples of the same. Formation of carbocations, carbanions and free radicals. (primary, secondary, tertiary, allyl, benzyl), their relative stability.	
		3.4 Organic acids and bases; their relative strengths.	

Semester-I
Chemistry Practicals

RUSCHEP101	**Credits-02**
	CHEMISTRY-I: **Preparation of a solution of a primary standard for acid base titrations :** **1.**Determination of the strength of the supplied sodium hydroxide solution, using solution of a primary standard for acid base titration. **Preparation of a solution of a primary standard for oxidation reduction titrations:** **2.**Determination of the strength of the supplied sodium thiosulphate solution. **Use of the secondary standard:** **3.**Determination of the strength of the supplied iodine solution using the sodium thiosulphate solution of known strength. [determined in experiment - **2]** **4.**To determine the rate constant of the acid catalyzed hydrolysis of methyl acetate. **5.**To determine relative viscosity of a given polymer solution using Ostwald's viscometer. **CHEMISTRY-II:** 1. Commercial analysis of (ANY ONE) a) Mineral acid b) Acetic acid in vinegar 2. Analysis of solution containing Na_2CO_3 and $NaHCO_3$ using two indicators 3. Gravimetric analysis a) To determine the percentage composition of a mixture of $BaSO_4$ and NH_4Cl. b) To determine the percentage composition of a mixture of ZnO and $ZnCO_3$. 4. Method of Purification**:** Purification of a given organic compound by crystallization. (Minimum three)

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment - 40% (40 Marks)

Sr No	Evaluation Type	Marks
1	Assignment	15
2	Class Test (MCQ / Objectives)	20
3	Active Participation in Class (Seminars/Presentations)	05
	Total	**40**

B) External Examination : 60 % (60 marks)
Semester End Theory Examination :

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern :-
   There shall be **three** questions each of **20** marks. On each unit there will be one question.
   All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions based on
Q.1)	**Any 5 out of 7**	**20**	**Unit I**
Q.2)	**Any 5 out of 7**	**20**	**Unit II**
Q.3)	**Any 5 out of 7**	**20**	**Unit III**
	Total	**60**	

Practical Examination Pattern:

(A) Internal Examination:- 40 % (20 Marks)

Particulars	Paper I	Paper II
Journal	05	05
Experimental Work	10	10
Participation	05	05
Total	**20**	**20**

(B) External Examination : 60 % (30 Marks)

Semester End Practical Examination:

Particulars	Paper I	Paper II
Laboratory Work	25	25
Viva	05	05
Total	**30**	**30**

PRACTICAL BOOK/JOURNAL

- The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.
- **In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In-charge of the department ; failing which the student will not be allowed to appear for the practical examination.**

Overall Examination and Marks Distribution Pattern:

Course	101			102			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals	20	30	50	20	30	50	100

(Total Marks : 300)

SEMESTER-II
Course Code-RUSCHE201
Course Title : CHEMISTRY-I
Academic Year 2020-21

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Identify types of isomers of given organic compounds.
CO 2	Assign stereo-descriptors using CIP rules.
CO 3	Compare the stability of cycloalkanes.
CO 4	Draw the spatial arrangement of alkanes.
CO 5	Know the reactions involved in aliphatic hydrocarbons
CO 6	Recognize the mechanism involved in electrophilic aromatic substitution reactions.
CO 7	Understand the effect of nitro group on nucleophilic aromatic substitution reaction.

DETAILED SYLLABUS

RUSCHE201	CHEMISTRY-I		Credits-02
	Unit	**Unit Title**	**Lectures**
	I	**Stereochemistry:**	**(15L)**
		1.1.1 Optical Isomerism: optical activity, specific rotation, chirality, enantiomers, molecules with two similar and dissimilar chiral-centres, distereoisomers, mesostructures, racemic mixture. **1.1.2** Flying-wedge, Fischer, Newman and Sawhorse projection formulae (erythro, threo isomers) and their interconversion. **1.1.3** Relative and absolute configuration: D/L and R/S designations.	

		1.1.4 Geometrical isomerism in alkenes and cycloalkanes: cis–trans isomerism and E/Z notations with C.I.P rules. **1.1.5** Conformational analysis of alkanes (ethane, propane and n-butane) and their relative stability on the basis of energy diagrams. **1.1.6** Cycloalkanes and Conformational Analysis: Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of cyclohexane: Chair, boat, half chair, and twist boat forms and their relative stability with energy.	
	II	**2.1 Chemistry of Aliphatic Hydrocarbons:**	**(15L)**
		2.1.1 Carbon-Carbon sigma bond: **Chemistry of alkanes:** Methods of Preparation of alkanes, Wurtz reaction, Wurtz-Fittig reaction, reactions of alkanes, free radical substitutions: Halogenation - relative reactivity and selectivity. **2.1.2 Carbon-Carbon pi bonds:** alkenes and alkynes**,** methods of preparation of alkenes and alkynes by elimination reactions: mechanism of E_1 andE_2. Saytzeff and Hofmann eliminations. **2.1.3 Reactions of alkenes:** electrophilic addition and mechanism (Markownikoff/ Anti Markownikoff addition). Mechanism of ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2 and 1, 4-addition reactions in conjugated dienes, Diels-Alder reaction; Allylic and benzylicbromination using N-bromosuccinimide and its mechanism.	

		2.1.4 Methods of Preparation and reactions of alkynes: Acidity, electrophilic and nucleophilic additions. Hydration to form carbonyl compounds, alkylation of terminal alkynes.	
	III	**Aromatic Hydrocarbons:**	**(15L)**
		3.1.1 Aromaticity: Benzene, Kekule's formulation of benzene structure (historical background), Hückel's rule, anti-aromaticity, aromatic character of arenes. **3.1.2**Aromaticity: cyclic carbocations/carbanions and heterocyclic compounds with suitable examples, aromaticity and acidity, relative stabilities. **3.1.3** Electrophilic aromatic substitution: sulphonation and Friedel-Craft alkylation/acylation and mechanisms for the same, mechanism of halogenation, nitration of benzene: **3.1.4** Directing effects of the substituents/groups on electrophilic aromatic substitution, reactions of mono substituted benzene derivatives (-CH_3, -NH_2, -OH, NO_2, -X) **3.1.5**Nucleophilic aromatic substitution of Aryl halides (replacement by –OH group and effect of nitro substituent).	

Course Code-RUSCHE202
Course Title : CHEMISTRY-II
Academic year 2020-21

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Compare the properties of main group elements in the respective groups.
CO 2	Understand Concept of metallic and non metallic character with respect to electro positivity.
CO 3	Know the methods of preparation of the compounds which are commercially available along with their properties and uses.
CO 4	Understand different types of oxides and oxyacid's of Sulphur , nitrogen - their sources and reactions
CO 5	Balance redox reactions using oxidation number method and ion electron method.
CO 6	Calculate equivalent weight of oxidizing and reducing agents.
CO 7	Identify health hazards, environmental implications and remedial measures of oxides of carbon, nitrogen and Sulphur.
CO 8	Identify and signify the basic terms used in thermodynamics.
CO 9	Apply laws of thermodynamics to various systems.
CO 10	Derive an expression for first law of thermodynamics for different processes.
CO 11	Assess thermodynamic application using enthalpy, entropy and free energy.

DETAILED SYLLABUS

RUSCHE202		CHEMISTRY-II	Credits-02
	Unit	Unit Title	Lectures
	I	**Concept of Qualitative Analysis and Acid-Base Theories:**	(15L)
		1.1 Concept of Qualitative Analysis	(09L)
		1.1.1 Macro, Semi-Micro, Micro, Ultra Micro, Trace Analysis **1.1.2** Reactions involving liberation of gases, Use of Papers impregnated with Reagents in qualitative analysis (With reference to papers impregnated with starch-iodide, potassium dichromate, lead acetate, dimethyl glyoxime, and oxine reagents) (balanced Chemical Reactions expected). **1.1.3** Precipitation equilibria: Factors affecting the solubility of an ionic compound viz. common ions, uncommon ions, temperature, nature of the solvent, pH, complexing agents (Balanced Chemical Equations and Numerical Problems Expected)	
		1.2 Acid-Base Theories	(06L)
		1.2.1 Arrhenius; Lowry-Bronsted concept ; Classification of solvents, auto dissociation of amphiprotic solvents, Lewis concept ; Usanovich concept **1.2.2** Hard and Soft Acids and Bases-HSAB (with respect to occurrence and feasibility of chemical reaction);.	

	II	**Oxidation Reduction Chemistry and Environmental impact of oxides of carbon, sulphur and nitrogen.**	**(15L)**
		2.1 Oxidation state, oxidation number, oxidation-reduction in terms of oxidation number **2.2** Balancing redox equations by i) oxidation number method and ii) ion- electron method. **2 3** Calculation of equivalent weight on the basis of chemical nature.	**(09L)**
		2.4 Study of oxides of carbon, sulphur and nitrogen with respect to their Environmental impact.	**(06L)**
	III	**Chemical Thermodynamics -I**	**(15L)**
		3.1 Recapitulation**:** Introduction, terms involved: System, surrounding, open closed and isolated systems, intensive and extensive properties of system, state of a system, state function and path function. Different processes in thermodynamics. **3.2** Heat (q), work (w) and internal energy (U) and their sign conventions. **3.3** Statement of first law, work done in isothermal and adiabatic reversible processes, work done in irreversible process, internal energy change for isothermal and adiabatic processes. **3.4** Enthalpy and enthalpy change in a constant volume and constant pressure process, enthalpy change in a reversible process. **3.5** Limitations of first law, need for the direction of the energy **c**hange**,** conversion of heat into other	

		energy forms, heat engines, mechanical efficiency of a heat engine, Carnot's cycle, Carnot's theorem, Introduction to entropy, second law of thermodynamics, different statements of second law, entropy changes in a reversible and an irreversible process, combined statement of first and second law ,entropy changes for different physical processes. **3.6** Spontaneous processes**,** need for prediction of a spontaneous process**,** Free energy, Gibbs free energy and Helmholtz free energy, changes in Gibbs and Helmholtz's free energy and inter relation between them, criteria for spontaneity of a process. **(Numericals are expected)**	

Semester-II
Chemistry Practicals

RUSCHEP201	Credits: 2
	CHEMISTRY-I 1. **Characterization of organic compound containing C, H, (O), N, S and X** (Minimum of 6 compounds) **Chemical synthesis (one step)** a) Preparation of Iodoformderivative of methyl ketone. b) Preparation of acetylderivative of primary amine. c) Preparation of 2,4-DNPderivative of carbonyl compound. **CHEMISTRY-II:** 1. **Qualitative analysis:** (at least 5 mixtures to be analyzed) Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions. Cations (from amongst): Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}, K^+,NH_4^+ Anions (From amongst): CO_3^{2-}, NO_2^-, NO_3^-,Cl^-, Br^-, I^-, SO_4^{2-}, (The Qualitative analysis should not involve use of H_2S in any form) 2. To determine the valence factor of $KMnO_4$ by titrating with oxalic acid. 3. To determine the acid-neutralizing power of commercially available antacid formulation.

Reference Books:

Organic Chemistry

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education)
2. Stereochemistry, P. S. Kalsi, New Age International Publishers.
3. Paula Y. Bruice, Organic Chemistry, Pearson Education.
4. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Course India Edition.
5. Organic reactions and their mechanism, P.S. Kalsi, New Age International Publishers.
6. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall.

Physical Chemistry

1. The Elements of Physical Chemistry, P.W. Atkins, Oxford University Press, Oxford.
2. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
3. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).
4. Principles of Physical Chemistry. By Maron and Pruton 4th Ed. Oxford and IBH publication.
5. Physical Chemistry, G.M. Barrow, Tata McGraw Hill Publishing Co.Ltd. New Delhi.
6. An Introduction to the Liquid State by P.A. Egelstaff, Publisher OUP Oxford

Inorganic Chemistry

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6thEd.,* Pearson, 2009.
2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
3. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment - 40% (40 Marks)

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3	Active Participation in Class (Seminars/Presentations)	05
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Q.3)	**Any 5 out of 7**	**20**	**Unit III**
	Total	**60**	

Practical Examination Pattern:

(A) Internal Examination:- 40 % (20 Marks)

Particulars	Paper I	Paper II
Journal	05	05
Experimental Work	10	10
Participation	05	05
Total	**20**	**20**

B) External Examination : 60 % (30 Marks)

Semester End Practical Examination:

Particulars	Paper I	Paper II
Laboratory Work	25	25
Viva	05	05
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	Internal	External	Total	Internal	External	Total	
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(Total Marks : 300)