Resolution Number : AC/I(21-22).2(II).RUS5

S.P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for SEMESTER V & VI
Program : T.Y.B.Sc.
Program Code : RUSCHE

(Credit Based Semester and Grading System with effect from the academic year 2024-2025)

Semester V
Course Code:RUSCHE501
Course Title : CHEMISTRY-I
Academic Year 2023-2024

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Comprehend the fundamentals of rotational, vibrational and Raman spectra of molecules.
CO 2	Outline the applications of Galvanic Cells.
CO 3	Apply Raoult's Law and Clapeyron Equation to study Colligative Properties
CO 4	Understand reaction dynamics.
CO 5	Apply principles of Surface Chemistry to Colloids

DETAILED SYLLABUS

RUSCHE501		CHEMISTRY-I	Credits-2.5
	Unit	**Unit Title**	**Lectures**
	I	**MOLECULAR SPECTROSCOPY**	**(15L)**
		1.1. Rotational Spectrum: Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of inter-nuclear distance and isotopic shift. **1.2.** Vibrational spectrum: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtainingvibrational spectrum, selection rule, nature of spectrum.	

		1.3. Vibrational-Rotational (IR) spectrum of diatomic molecule: vibrating rotor, energy levels, selection rule, nature of spectrum, P and R branch lines, anharmonic oscillator, energy levels, selection rule, fundamental band, overtones. Applications of vibrational-rotational spectrum in determining forceconstant and its significance infrared spectra of simple molecules like H_2O and CO_2 **1.4** Raman Spectroscopy: Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum (Stoke's lines and anti Stoke's lines), Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion (example of CO_2 molecule). Number of modes of vibrations for linear and non-linear molecules.	
	II	**ELECTROCHEMISTRY- III: CLASSIFICATION OF GALVANIC CELLS**	**(15L)**
		2.1 Lewis concept of Activity and Activity coefficient, Mean ionic activity and mean ionic activity coefficient of an electrolyte, ionic strength of a solution, Debye-Huckel limiting law. **2.2.** Classification of galvanic cells: Chemical Cells and concentration cells, Cells with transference and without transference, Expression for EMF of each type of cell. **2.3** Origin of liquid junction potential and its elimination.	

		2.4. Determination of solubility product and solubility of a sparingly soluble salt by Chemical cell and by Concentration cell. **2.5** Determination of liquid junction potential.	
	III	**COLLIGATIVE PROPERTIES AND CHEMICAL KINETICS – II**	**(15L)**
		3.1 COLLIGATIVE PROPERTIES	**(09L)**
		3.1.1 Colligative properties, Raoult's law. **3.1.2** Relative lowering of vapour pressure. **3.1.3** Elevation of boiling point – Thermodynamic derivation for relation between elevation of boiling point and molality. **3.1.4** Depression in freezing point-Thermodynamic derivation for relation between depression in freezing point and molality **3.1.5** Osmosis and Osmotic Pressure – Determination of molar mass form Osmotic pressure. Abnormal molar masses of solute, van't Hoff factor (Degree of dissociation and degree of association). Reverse osmosis.	
		3.2 CHEMICAL KINETICS-II	**(06L)**
		3.2.1 Recapitulation, Collision theory ofreaction rates, applications of collision theory to bimolecular reaction and unimolecular reaction (Lindemann's theory), Merits and demerits of Collision theory. Steric factor and Probability factor.	

		3.2.2 Activated complex theory of bimolecular reactions. Merits of Activated complex theory. **3.2.3** Classification of reactions- slow, fast and ultra fast, study of kinetics of fast reactions by Stop Flow method.	
	IV	**SURFACE CHEMISTRY, CATALYSIS AND CHEMISTRY OF COLLOIDS**	**(15L)**
		4.1: Surface Chemistry and Catalysis	**(08L)**
		4.1.1 Adsorption: Physical and Chemical Adsorption, Types of adsorption isotherms, Langmuir's adsorption isotherm. B.E.T. equation for multilayer adsorption, determination of surface area of an adsorbent using B.E.T. equation. **4.1.2.** Catalysis: Homogeneous and heterogeneous catalysis, catalytic activity and selectivity, promoters, inhibitors, catalyst poisoning and deactivation. **4.1.2.1** Acid catalysis and Base catalysis, mechanism and kinetics of acid and base catalysed reactions, effect of pH on acid and base catalysed reactions. **4.1.2.2** Enzyme catalysis, mechanism and kinetics of reaction (Michaelis-Menten equation).	
		4.2 COLLOIDS	**(07L)**
		4.2.1 Introduction to colloidal state of matter. **4.2.2** Origin of charge on colloidal particles. Concept of electrical double layer, zeta potential, Helmholtz and Stern model, electro kinetic phenomena: electrophoresis,	

		electro-osmosis, streaming potential and sedimentation potential. **4.2.3** Colloidal electrolytes. **4.2.4** Donnan Membrane Equilibrium. **4.2.5** Surfactants, Micelle formation, application of surfactants in detergents, food industry and pesticide formulations.	

Course Code: RUSCHE502
Course Title : CHEMISTRY-II
Academic year 2023-2024
Credits:2.5

Course outcomes:

After studying this course, the learner will be able to:	
CO 1	Identify the elements of symmetry.
CO 2	Assign point groups to molecules.
CO 3	Correlate between bond angle and molecular orbitals.
CO 4	Understand band theory and its application to metals.
CO 5	Depict structure of solids and their defects.
CO 6	Compare various aspects of lanthanides and actinides.
CO 7	Describe properties and application of Uranium.
CO 8	Distinguish between properties of Xenon and other noble gases.

DETAILED SYLLABUS

RUSCHE502	**CHEMISTRY-II**		**Credits-2.5**
	Unit	**Unit Title**	**Lectures**
	I	**Molecular Symmetry and Chemical Bonding**	**(15L)**
		1.1 Molecular Symmetry	**(07L)**

		1.1.1 Introduction and Importance of symmetry in chemistry. **1.1.2** Symmetry elements and symmetry operations. **1.1.3** Concept of a Point Group with illustrations using the following pointgroups: (i) $C_{\alpha v}$ (HCl), (ii) $D_{\alpha h}$ (H_2),(iii) C_2v (H_2O), (iv) C_{3v} (NH_3), (v) C_{2h}(trans – trichloroethylene), and (vi) D_{3h}(BCl_3).	
		1.2 Molecular Orbital Theory for Polyatomic Species	**(05L)**
		1.2.1 Simple triatomic species: H_3^+ andH_3 (correlation between bond angle andMolecular orbitals). **1.2.2** Other molecules (consideringonly σ-bonding): i) BeH_2, ii) H_2O iii) CH_4	
		1.3 Metallic Bonding	**(03L)**
		Band theory, explanation of electrical properties of conductors, insulators and semi conductors, intrinsic and extrinsic semiconductors.	
	II	**Solid State Chemistry and Superconductivity**	**(15L)**
		2.1 Structures of Solids	**(11L)**
		2.1.1 Terms involved: crystal lattice, lattice points, unit cells and lattice constants. **2.1.2** Closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected). **2.1.3** Stoichiometric point defects in solids: Frenkel and Schottky defects.	
		2.2 Superconductivity	**(04L)**

		2.2.1 Discovery of superconductivity. **2.2.1** Superconductivity, transition temperature and Meissner effect. **2.2.2** Different types of superconductors viz, conventional superconductors, alkali metal fullerides (A_3C_{60}) and high temperature Superconductors. **2.2.3** Applications of superconducting materials.	
	III	**Chemistry of *f*-block elements**	**(12L)**
		3.1 Introduction: Definition, position in periodic table and electronic configuration of lanthanides and actinides.	**(01L)**
		3.2 Chemistry of Lanthanides	**(11L)**
		3.2.1 Lanthanide contraction and its consequences. 3.2.2 Oxidation states. 3.2.3 Magnetic and spectral properties. 3.2.4 Occurrence, extraction and separation of lanthanides by Solvent extraction. 3.2.5 Applications of lanthanides.	
		3.3 Chemistry of Actinides	**(03L)**
		3.3.1 Comparison between lanthanides and actinides. 3.3.2 Chemistry of Uranium and with reference to occurrence and isolation (solvent extraction method) 3.3.2 Properties and applications of Uranium.	
	IV	**Non Aqueous Solvents and Chemistry of Pseudohalogens, Interhalogens and Xenon**	**(15L)**
		4.1 Chemistry of Non-aqueous Solvents	**(07L)**
		Classification of solvents and importance of non-aqueous solvents.	

		4.1.1 Super critical carbon dioxide and ionic liquids as solvents **4.1.2** Characteristics and study of liquid ammonia, dinitrogentetraoxide as non-aqueous solvents with respect to i) acid base reactions and ii) redox reactions.	
		4.2 Chemistry of Interhalogens:	**(03L)**
		Introduction, preparation, reactions and structures.	
		4.3 **Chemistry of pseudohalogens:**	**(03L)**
		Introduction, preparation, reaction and structures	
		4.4 Chemistry of Xenon:	**(02L)**
		Introduction, Compounds of Xenon: Oxides, fluorides, oxyfluorides w.r.t. preparation , properties and bonding.	

Course Code: RUSCHE503
Course Title : CHEMISTRY-III
Academic year 2023-2024

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Apply fundamentals of Organic Reaction Mechanism to various reactions.
CO 2	Compare various conformations of some organic compounds
CO 3	Apply the concepts of stereochemistry to Organic reactions.

CO 4	Assign IUPAC names to spiro, bicyclo and heterocyclic compounds.
CO 5	Understand Basics of Polymer Chemistry.
CO 6	Illustrate basics of Green Chemistry to Organic Synthesis.

DETAILED SYLLABUS

RUSCHE503	**CHEMISTRY-III**		**Credits-02**
	Unit	**Unit Title**	**Lectures**
	I	**Mechanism of Organic Reactions**	**(15L)**
		1.1 Recapitulation: Curved arrows, intermediates, transition states, Electrophilicity vs acidity and nucleophilicity vs basicity. 1.2 Elimination Reactions: Mechanisms and stereochemistry. 1.2.1 E_1 and E_2 Mechanisms, factors influencing the mechanism: nature of substrate, leaving group, structure of base, solvent; Saytzeff and Hofmann elimination; elimination *vs* substitution. 1.2.2 E_1CB mechanism 1.2.3 Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates. 1.3 Neighbouring group participation in nucleophilic substitution reactions: partcipation of lone pair of electrons, kinetics and stereochemical outcome. 1.4 Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalysed esterification of carboxylic acids and base promoted hydrolysis of esters ($B_{AC}2$).	

		1.5 Mechanism of following rearrangements with examples and stereochemistry wherever applicable. 1.5.1 Migration to electron deficient carbon: Pinacol, Benzylic acid. 1.5.2 Migration to electron deficient nitrogen: Beckmann, Hofmann. 1.5.3 Migration involving a carbanion: Favorski. 2.3 Name reactions: Michael, Wittig(mechanism and examples).	
	II	**Stereochemistry**	**(15L)**
		2.1 Molecular chirality and element of symmetry: Mirror Plane symmetry, inversion centre, rotation-reflection (alternating) axis. Chirality of compounds without stereogenic centre: cummulenes, spirans and biphenyls. 2.2 Conformations of cyclohexane, mono, disubstitutedcyclohexanes and their relative stabilities 2.3 Stereo selectivity and Stereo specificity: Idea of enantioselectivity (ee) and diastereoselectivity (de). Topicity- enantiotopic and diastereotopic atoms, groups and faces. 2.4 Stereochemistry of: 2.4.1 Substitution reactions- $S_N{}^1$, $S_N{}^2$, $S_N{}^i$ (reaction of alcohol with thionyl chloride). 2.4.2 Elimination reactions: E_2-Base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane. 2.4.3 Addition reactions to olefins- i) catalytic hydrogenation ii) bromination (electrophilic anti	

		addition) (iii) synhydroxylation with OsO_4 and $KMnO_4$. iv) epoxidation followed by hydrolysis.	
	III	**IUPAC Nomenclature and Chemistry of Polymers**	**(15L)**
		3.1 IUPAC Nomenclature	**(06L)**
		IUPAC systematic nomenclature of the following classes of compounds (including substituted ones up to two substituents/ functional groups): 3.1.1 Bicyclic compounds- spiro, fused, and bridged (upto 11carbon atoms) - saturated and unsaturated compounds. 3.1.2 Biphenyls. 3.1.3 Cummulenesupto three double bonds.	
		3.2 Polymers	**(09L)**
		3.2.1 Introduction: Review of terms: monomer, polymer, homopolymer, copolymer, thermoplastics and thermosets. 3.2.2 Addition polymers: polyethylene, polypropylene, Teflon, PVC and polystyrene. Uses, recycling	

		3.2.3 Condensation polymers: polyesters, polyamides, polyurethanes, polycarbonates and phenol-formaldehyde resins. Uses 3.2.4 Mechanism of free radical addition polymerization. 3.2.5 Stereochemistry of polymers: Tacticity. Mechanism and stereochemical control of polymerization using Ziegler-Natta catalyst 3.2.6 Natural and synthetic rubbers: polymerization of isoprene: 1,2- and 1,4-addition (*cis*and *trans*), styrene- butadiene copolymer. 3.2.7 Additives to polymers: Plasticizers, stabilizers and fillers. 3.2.8 Biodegradable polymers: Classification and uses. Polylactic acid- structure, properties and use for packaging and medical purposes. (Note: Identification of monomer in a given polymer and the structure of a polymer from given monomer(s) is expected. Conditions for isomerisation not expected).	
	IV	**Synthesis of Organic compounds**	**(15L)**
		4.1 Introduction: Criteria for ideal organic synthesis. Calculation of yields. Concept of selectivity: Linear and convergent synthesis, Multi-component reactions: Mannich reaction, Hanztsch synthesis. 4.2 Introduction to retrosynthesis: Analysis and synthesis, technical terms: target molecules (TM), retrosynthetic analysis, FGA, FGI, Disconnection, synthon and reagent. Retrosynthtic analysis of Limonene, Salbutamol and Proparacaine.	

		4.3 Green chemistry and synthesis: 4.3.1 Introduction to green chemistry: definition, need for and importance of green synthesis, Twelve principles of green chemistry, Atom economy and E-factor calculations and their significance. 4.3.2 Green synthesis in industry: Green starting materials: D-glucose to adipic acid. Green reagents: Selective methylation of active methylene using dimethyl carbonate. Green solvent: Supercritical CO_2, deep eutectic solvents (DES). Green catalyst: Heterogeneous catalysis using tellurium, biocatalysis. Green synthesis of paracetamol. 4.4 Other methods of organic synthesis Microwave assisted organic synthesis (Using organic solvents and in solid state). Ultrasound in organic synthesis, Phase transfer catalysis. Polymer supported synthesis: Merrifield polypeptide synthesis.	

Course Code: RUSCHE504
Course Title: CHEMISTRY-IV
Academic year 2023-2024

Course Outcomes:

After completing this course, the learner will be able to:	
CO 1	Elaborate on the need and importance of sampling and the various methods used for sampling of solid, liquids and gases.
CO 2	Evaluate the analytical data in terms of statistics.
CO 3	Interpret the sources of random errors and their effect on analytical results.
CO 4	State the significance of confidence limits in the error analysis.
CO 5	Specify the standard deviation of calculated results.
CO 6	Explain the Q-test for rejection of data.
CO 7	Outline a procedure for the application of null hypothesis to the data.
CO 8	Discuss the importance of graphical representation of data.
CO 9	Describe the different methods used for locating endpoints in precipitation titrations.
CO 10	Classify the different types of solvents used for non-aqueous titrations with respect to their acid base properties.
CO 11	Illustrate the effect of dielectric constant and nature of solvent on solute behaviour in non aqueous titrations.
CO 12	Explain the basic principle involved in AAS, AES, fluorescence, phosphorescence, turbidimetry and nephelometry.
CO 13	Describe the function of different components of AAS,flame photometer ,Fluorimeter, Phosphorimeter, Turbidimeter and nephelometer.
CO 14	List the factors affecting fluorescence and phosphorescence and also the factors affecting scattering of light in turbidimetry and nephelometry.
CO 15	Relate fluorescence intensity with concentration

DETAILED SYLLABUS

RUSCHE504	**CHEMISTRY-IV**		**Credits-2.5**
	Unit	**Unit Title**	**Lectures**

	I	**Sampling and Treatment of Analytical Data**	**(15L)**
		1.1 Sampling:	**(07L)**
		1.1.1 Sampling, need and importance, terms involved, sampling techniques, non-random and random sampling, sequential sampling, 1.1.2 Sampling of gases, precautions, methods used, pressure and temperature sampling 1.1.3 Sampling of liquids, sample thief, homogeneous and heterogeneous liquids, stationary and flowing liquids, 1.1.4 Sampling of solids, bulk ratio, size to weight ratio, 1.1.5 Sampling and equipment for sampling of compact solids, powdered solids, flowing solids and particulate solids. 1.1.6 Methods of reduction of the size of the sample 1.1.7 Preservation of sample, dissolution of the samples, use of fluxes	
		1.2 Treatment of analytical data	**(08L)**
		1.2.1 Collection and processing of data, concept of classes, and class frequencies, histogram and frequency polygon. 1.2.3 Distribution of random errors, Gaussian distribution curve and its salient features. 1.2..4 Concept of confidence limits and confidence interval, computation of both by using range, student's t and population standard deviation. 1.2.5 Criterion for the rejection of a result, empirical methods like 2.5 d and 4.0 d rule, statistical approach.	

		1.2.6 Testing for significance, null hypothesis, variance ratio test. 1.2.7 Graphical presentation of results, scatter diagram, regression analysis, method of averages, least square method for line of the type $y = mx + c$ and $y = mx$ 1.2.8 Significant figures and their use in data treatment.	
	II	**Titrimetric analysis**	**(15L)**
		2.1 Redox Titrations	**(04L)**
		2.1.1 General introduction, theory of redox indicators, 2.1.2 criterion for choosing an indicator for a redox titration, 2.1.3 Construction of the titration curves in the case of i) Fe(II) vsCe(IV) ii) Fe(II) vs $Cr_2O_7^{2-}$ 2.1.4 Use of diphenyl amine and ferroin as redox indicator.	
		2.2 Precipitation titrations	**(04L)**
		2.2.1 Basic principles of precipitation titrations 2.2.2 Argentimetric titrations, construction of the titration curve for the titration of sodium chloride with silver nitrate. 2.2.3 Mohr's method 2.2.4 Volhard's method 2.2.5 Adsorption indicators, examples and uses.	
		2.3 Complexometric titrations	**(04L)**
		2.3.1 General introduction of complexometric titrations 2.3.2 EDTA titrations	

		2.3.2.1 EDTA as a chelating agent, structure of the chelate, characteristic features of the metal EDTA complexes. 2.3.2.2 Stability constant of the EDTA complexes, conditional stability constants, construction of the titration curve in the titration of a metal ion with EDTA with the example of Ca^{2+}. 2.3.2.3 Types of EDTA titrations. 2.3.2.4 Methods of improving the selectivity of EDTA titrations. 2.3.2.5 Metallochromic indicators	
		2.4 Non-aqueous titrations	**(03L)**
		2.4.1 Need for non-aqueous titrations, 2.4.2 Types of solvents, choice of the solvent for the non-aqueous titrations, 2.4.3 Acid base titrations in non-aqueous media, 2.4.4 Use of glacial acetic acid as the solvent in non-aqueous titrations, non-aqueous titrations with a visual indicator using an instrument 2.4.5 Advantages and limitations.	
	III	**Optical Methods**	**(15L)**
		3.1 Atomic Absorption Spectroscopy (AAS)	**(05L)**
		3.1.1 Atomic energy level diagram, characteristic features of atomic spectra. 3.1.2 Basic principles of Atomic Absorption Spectroscopy, steps involved in the process of atomization. 3.1.3 Instrumentation: Components-hollow cathode lamp, chopper, types of atomizers: (i) premix burner (ii) total consumption burner (iii) electrothermal atomizers.	

		3.1.4 Qualitative and quantitative analysis, calibration curve and standard addition method. 3.1.5 Applications of Atomic Absorption Spectroscopy.	
		3.2 Atomic Emission Methods	**(04L)**
		3.2.1 Flame emission: basic principles of flame photometry 3.2.2 Instrumentation, flames and burners, detectors, 3.2.3 Qualitative and quantitative analysis, calibration curve, standard addition and internal standard method 3.2.4 Applications of flame photometry. 3.2.5 Comparison of atomic absorption and atomic emission methods	
		3.3 Fluorescence and phosphorescence spectroscopy	**(03L)**
		3.3.1 Basic principles of fluorescence and phosphorescence, Jablonski diagram and its utility, factors affecting fluorescence and phosphorescence 3.3.2 Relation between fluorescence intensity and concentration 3.3.3 Instrumentation of fluorimetry and phosphorimetry 3.3.4 Applications of fluorimetry and phosphorimetry 3.3.5 Comparison of fluorimetry and phosphorimetry 3.3.6 Comparison of absorption and fluorimetric techniques.	

		3.4 Nephelometry and turbidimetry	**(03L)**
		3.4.1 Scattering of radiation, basic principles of nephelometry and turbidimetry, 3.4.2 Factors affecting scattering of radiation, particle size, wavelength, concentration, refractive index. 3.4.3 Instrumentation in nephelometry and turbidimetry. 3.4.4 Applications of both techniques.	
	IV	**Miscellaneous Methods**	**(15L)**
		4.1 Thermal Methods	**(04L)**
		4.1.1 Introduction to thermal methods, classification of thermal methods, 4.1.2 Thermo gravimetric analysis, thermogram, factors affecting the thermogravimetric curve 4.1.3 Instrumentation, components, thermo balance, furnace, sample holder, recorder, measurement of temperature 4.1.4 Applications, limitations.	
		4.2 Radioanalytical techniques	**(04L)**
		4.2.1 Neutron Activation Analysis (NAA) 4.2.1.1 Basic principles, characteristic features, operational procedure 4.2.1.2 Advantages, limitations and application of NAA. 4.2.2 Isotope Dilution Analysis (IDA) 4.2.2.1 Basic principles, operational procedure 4.2.2.2 Applications, advantages and limitations of IDA	
		4.3 Mass spectrometry	**(04L)**
		4.3.1 Basic principles 4.3.2 Instrumentation, components, sources, analysers, detectors.	

		4.4 Method validation	**(03L)**
		4.4.1 Need and significance of method validation 4.4.2 Parameters chosen for method validation 4.4.3 Procedure for method validation	

Semester V
Practicals

RUSCHEP501	**Credits-03**
	CHEMISTRY-I **Physical Chemistry** 1. To study the effect of ionic strength on the rate of reaction between $K_2S_2O_8$ and KI using KCl. 2. To study the rate of adsorption of acetic acid on activated charcoal. 3. To study the relative strength of acetic acid and monochloroacetic acid. 4. To determine pK_1 and $pK_2$of phosphoric acid by pH-metry. 5. To determine the amount of weak dibasic by conductometric titration. 6. To determine the standard reduction potential of Cu^{2+}/Cu electrode at room temperature.
	CHEMISTRY-II **Inorganic preparations** 1. Potassium diaquobis- (oxalate)cuprate(II)K2[Cu(C2O4)2.(H2O] 2. Bis(ethylenediamine)iron(II)sulphate[C2H4(NH2)2FeSO4.4H2O]. **Volumetric analysis** 1. Determination of magnesium from the supplied commercial sample of Milk of magnesia tablet 2. Estimation of Nickel(II) complexometrically using murexide indicator (Learners are expected to standardize supplied EDTA solution using ZnSO4.7H20)

	3. Estimation of copper(II) complexometrically using fast sulphon black-F indicator (Learners are expected to standardize supplied EDTA solution using ZnSO4.7H20)
RUSCHEP502	**CHEMISTRY-III** **I) Binary Mixture Separation: Separation of mixture containing (VL + NVL) & (VL+ S) components.** 1. Minimum Six mixtures to be completed by the learners. 2. Components of the liq-liq mixture should include volatile liquids like acetone, methylacetate, ethylacetate, isopropylalcohol, methyl alcohol, ethyl alcohol, chloroform and non- volatile liquids like chlorobenzene, bromobenzene, aniline, N,N-dimethylaniline, acetophenone, nitrobenzene, ethyl benzoate. 3. Components of the liq- solid mixture should include volatile liquids like acetone, methylacetate, ethylacetate, ethyl alcohol, methyl alcohol, isopropylalcohol, chloroform and solids such as water insoluble acids, phenols, bases, neutral. 4. A sample of the mixture one ml to be given to the learnerfor detection of the physical type of the mixture. 5. After correct determination of physical type, separation of the binary mixture to be carried out by distillation method using microscale technique. 6. After separation into component A and component B, the physical constants and the yield of the separated components is to be determined. **II) Organic Preparations:** 1. Acetylation of hydroquinone. 2. Bromination of acetanilide. 3. Hydrolysis of ethyl benzoate. 4. Nitration of acetanilide. 5. Microwave assisted synthesis of Schiff's base from aniline and p-anisaldehyde. 6. Microwave assisted synthesis of coumarin by Knoevenagel reaction from salicylaldehyde andethylacetoacetate in presence of a base.
	CHEMISTRY-IV: 1. Determination of the amount of fluoride in the given solution colorimetrically.

	2. Estimation of Vitamin C content of a given tablet by titration with sodium hydroxide pH metrically 3. To determine potassium content of a commercial salt sample by flame photometry. 4. To determine the amount of chloride in the given sample using Mohr's method. 5. To determine the amount of persulphate in the given sample by back titration with standard Fe(II) ammonium sulphate solution. 6. To estimate Fe(II) in a tablet using diphenylamine as an indicator.

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment - 40% of total marks:

(40 marks)

Sr No	Evaluation type	Marks
1	One Assignment	10
2	One class Test (multiple choice questions / objective)	20
3	Active participation in routine class instructional deliveries (seminars//presentation)	05
4	Overall conduct, participation in co-curricular activities of the department.	05

B) External examination – 60 %

Semester End Theory Assessment - 60% **60 marks**

These examinations shall be of **two hours** duration.
There shall be **Four** questions each of **15** marks. On each unit there will be one question.
All questions shall be compulsory with internal choice within the questions.
Theory question paper pattern is as follows :-

Questions	Options	Marks	Questions on
Q.1)A)	Any 3 out of 5	12	Unit I
Q.1)B)	Any 1 out of 2	03	
Q.2)A)	Any 3 out of 5	12	Unit II
Q.2)B)	Any 1 out of 2	03	
Q.3)A)	Any 3 out of 5	12	Unit III
Q.3)B)	Any 1 out of 2	03	
Q.4)A)	Any 3 out of 5	12	Unit IV
Q.4)B)	Any 1 out of 2	03	

Practical Examination Pattern:

(A)Internal Examination: -				
	RUSCHEP501		**RUSCHEP502**	
	Paper I	**Paper II**	**Paper III**	**Paper IV**
Journal	**05**	**05**	**05**	**05**
Tests	**10**	**10**	**10**	**10**
Active Participation	**05**	**05**	**05**	**05**
Total	**20**	**20**	**20**	**20**
(B) External (Semester end practical examination):-				
Laboratory work	**25**	**25**	**25**	**25**
Viva	**05**	**05**	**05**	**05**
Total	**30**	**30**	**30**	**30**
Grand Total	**100**		**100**	

PRACTICAL 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, Certificate from Head/ Co-ordinator should be submitted, failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Course	**501**			**502**			**Grand Total**
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical	**20**	**30**	**50**	**20**	**30**	**50**	**100**
Course	**503**			**504**			
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical	**20**	**30**	**50**	**20**	**30**	**50**	**100**
							(Total Marks : 600)

SEMESTER VI
Course Code: RUSCHE601
Course Title: CHEMISTRY-I
Academic year 2023-2024

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Understand the basic principles of Nuclear Magnetic Resonance spectroscopy
CO 2	Classify polymers based on various parameters
CO 3	Determine overvoltage and decomposition potential
CO 4	Illustrate the use of X-rays in the study of solid state
CO 5	Differentiate between nuclear fission and nuclear fusion processes
CO 6	Understand the basic operations used in Quantum Chemistry.

DETAILED SYLLABUS

RUSCHE601	**CHEMISTRY-I**		**Credits-2.5**
	Unit	**Unit Title**	**Lectures**
	I	**Nuclear Magnetic Resonance Spectroscopy and Polymer Chemistry**	**(15L)**
		1.1: Nuclear Magnetic Resonance Spectroscopy	**(08L)**
		1.1.1. Nuclear spin, magnetic moment, criteria for nuclei to be NMR active, energy levels,Larmor precession, Relaxation processes in NMR (spin-spin relaxation and spin-lattice relaxation). 1.1.2. NMR Spectrometer, chemical shift, shielding and deshielding ofprotons, low resolution NMR spectrum, high resolution NMR spectrum.	
		1.2 Polymers	**(07L)**
		1.2.1 Classification of polymers based on 1) source, 2) structure, 3)thermal response, 4) Physical properties 1.2.2 Molar mass of polymers: 1) Number average molar mass, 2) Weight average molar mass, 3) Viscosity average molar mass, monodispersity, polydispersity, polydisperity index	

		1.2.3 Methods of determining molar mass of polymers: 1) Ultracentrifugation method 2) Viscosity method of Viscosity average molar mass, Mark-Houwink equation.	
	II	**Electrochemistry – IV And Crystalline State**	**(15L)**
		2.1electrochemistry-IV:Decomposition Potential, Overvoltage And Electroplating	**(08L)**
		2.1.1 Polarization, concentration polarization and its elimination. 2.1.2 Decomposition potential and its experimental determination, factors affecting decomposition potential. 2.1.3 Over voltage and its experimental determination, factors affecting overvoltage. 2.1.4 Tafel's equation for hydrogen overvoltage 2.1.5 Electroplating – Objectives and process	
		2.2 Crystalline State	**(07L)**
		2.2.1. Recapitulation: Laws of Crystallography 2.2.2. Characteristics of simple cubic, face centered and body centered cubic system, inter planar distance in cubic lattices. 2.2.3 Use of X- rays in the study of crystal structure, Bragg's equation, X- ray diffraction method of studying crystal lattices, structure of NaCl, Determination of Avogadro number.	
	III	**Nuclear Chemistry**	**(15L)**
		3.1 Structure of Nucleus. 3.2 Nuclear disintegration/ Nuclear radioactivity, Types of nuclear radiations (α-ray, β-ray and γ-ray).	

		3.3 Nuclear transmutation and Artificial radioactivity, Nuclear transmutation with different types of projectiles. 3.4 Kinetics of radioactivity: units of radioactivity, expression of decay constant and its units, half life of nuclear reactions. 3.5 Radioactive Equilibrium- 1) Secular 2) Transient; Difference between chemical and radioactive equilibrium. 3.6 Mode of decay of radioactive elements: 1) emission of positrons 2) emission of electrons 3) K-electron capture. 3.7 Energy involved in Nuclear reactions: Q-value and Threshold energy. 3.8 Nuclear Fission process and its Characteristics features of nuclear fission process, Factors affecting Nuclear Fission: 1) Multiplication Factor 2) Critical Mass 3.9 Fertile and fissile materials, conversion of fertile material to fissile material. 3.10 Basic components of Nuclear Reactors, Types of Nuclear Reactors: 1) Power Reactor 2)Breeder Reactor. 3.11 Nuclear Fusion - Characteristics; Mechanism of nuclear fusion: 1) Carbon cycle 2) Proton cycle 3.12 Detection and measurement of radioactivity – GM Counter andScintillation Detector 3.13: Applications of Radiochemistry: Carbon dating, isotopic labelling.	
	IV	**Basics of Quantum Mechanics**	**(15L)**

		4.1 Classical mechanics: limitations of classical mechanics: 1) Black body radiation 2) photoelectric effect 3) Compton Effect. 4.2 Introduction to quantum mechanics, Planck's theory of quantization, wave particle duality, de-Broglie equation, Heisenberg's uncertainty principle. 4.3 The Schrodinger wave equation 4.3 Postulates of quantum mechanics 1) State function and its significance 2) Concept of operators: definition, addition, subtraction and multiplication of operators, commutative and non-commutative operators, linear operator, Hermitian operator 3) Eigen function and eigen value, eigen value equation. 4) Wave mechanical operator for evaluating various classical properties. 5) Expectation value. 4.4 Solution of the Schrodinger wave equation for a simple system: Particle in one dimensional box.	

Course Code: RUSCHE602

Course Title : CHEMISTRY-II

Academic year 2023-2024

Course outcomes:

After studying this course, the learner will be able to:	
CO 1	Compare and contrast between Crystal Field Theory and Valence Bond Theory

CO 2	Calculate CFSE of complexes, and thus predict stability
CO 3	Apply MOT to octahedral complexes
CO 4	Carry out Spectral Analysis of Inorganic Compound: determine terms, term symbols and Orgel Diagrams
CO 5	Study Thermodynamic and Kinetic Stability of Complexes.
CO 6	Differentiate between complexes based on their lability.
CO 7	Describe general characteristics of Organometallic Compounds
CO 8	Study Nanomaterials with respect to their synthesis and properties

DETAILED SYLLABUS

RUSCHE602	**CHEMISTRY-II**		**Credits-2.5**
	Unit	**Unit Title**	**Lectures**
	I	**Coordination Chemistry**	
		1.1 Theories of metal-ligand bond	**(11L)**
		1.1.1 Recapitulation of VBT and its limitations. **1.1.2** Crystal field theory and effect of crystal field on central metal valence orbitals in various geometries, **1.1.3** Splitting of *d* orbitals in octahedral, square planar and tetrahedral crystal fields **1.1.4** Distortions from the octahedral geometry : i) Effect of ligand field ii) Jahn- Teller distortions **1.1.5** Crystal field splitting parameter, its calculation and factors affecting it in octahedral complexes, Spectrochemical series. **1.1.6** Crystal field stabilization energy (CFSE), calculation of CFSE, for octahedral and tetrahedral complexes with *d1* to *d10* metal ion configurations.	

		1.1.7 Consequences of crystal field splitting on various properties such as ionic radii, hydration, energy, lattice energy, enthalpies of formation, colour and magnetic properties. **1.1.8** Limitations of CFT **1.1.9:** Evidences for covalence in metal complexes: i) intensities of d-d transitions, ii) ESR spectrum of $[IrCl_6]^{2-}$ iii) Nephelauxetic effect	
		1.2 Molecular Orbital Theory (MOT) of Coordination Complexes:	**(04L)**
		Application to octahedral complexes in case of (i) [Ti(H2O)]3+, (ii) Fluoro complexes of Fe(II) and Fe (III) and (iii) Cyano complexes of Fe(II) and Fe (III).	
	II	**Properties of Co-ordination Compounds**	**(15L)**
		2.1 Electronic Spectra	**(07L)**
		2.1.1 Origin of electronic spectra **2.1.2** Types of electronic transitions in coordination compounds: intra- ligand, charge transfer and intra-metal transitions. **2.1.3** Electronic configuration and electronic micro states, Term symbols, coupling of spin momenta (Ms),orbital momenta (Ml)and spin-orbit coupling or Russell-Saunders coupling. **2.1.4** Determination of Terms for p^2 *and* d^2electronic configuration **2.1.5** Terms and micro-states for transition metal atoms/ions. **2.1.6**Orgel diagrams for D and F terms (i.e. d^1 to d^9 electronic configurations in octahedral crystal fields)	

		2.1.7 Selection rules for electronic transitions : Spin and orbital forbidden transitions (Laporte selection rules)	
		2.2 Stability of Metal Complexes	**(04L)**
		2.2.1 Thermodynamic stability and kinetic stability of complexes with examples. **2.2.2** Stability constants: Stepwise and overall constants and their interrelationship. **2.2.3** Factors affecting thermodynamic stability (Factors related to nature of central metal atom, nature of ligand, chelate effect to be discussed)	
		2.3 : Reactivity of Metal Complexes :	**(04L)**
		2.3.1 Comparison between inorganic and organic reactions **2.3.2** Types of reactions in metal complexes **2.3.3** Inert and labile complexes: Correlation between electronic configuration and lability of Complexes **2.3.4** Ligand substitution reactions: Associative and Dissociative mechanisms **2.3.5** Acid hydrolysis, base hydrolysis and anation reaction	
	III	**Organometallic Chemistry**	**(15L)**
		3.1 Organometallic Compounds of main group metals	**(09L)**
		3.1.1 General characteristics of various types of Organometallic compounds, viz., ionic, sigma bonded and electron deficient compounds 3.1.2 General synthetic methods: (i) Oxidative addition (ii) Metal-Metal exchange	

		(Transmetallation) (iii) Carbanion-Halide exchange (iv) Metal Hydrogen exchange (v) Methylene insertion reactions. 3.1.3Chemical reactions: (i) Reactions with oxygen (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents (iv) Complex formation reactions.	
		3.2 Metallocenes	**(04L)**
		Introduction, Ferrocene; Synthesis, properties, structure and bonding on the basis of VBT	
		3.3 ɗ- bonding in rhenium and molybdenum halide complexes.	**(02L)**
	IV	**Some Selected Topics**	**(15L)**
		4.1 Nanomaterials	**(08L)**
		4.1.1 Introduction and importance of nanomaterials 4.1.2 Chemical methods of synthesis of nanomaterials 4.1.3 Characterisation of Nanomaterials (UV and XRD techniques) 4.1.4 Dimensions and forms of Nanomaterials : Nano films , nano layers , nano tubes , nanowires and nano particles. 4.1.5 Properties (comparison between bulk and nano materials) : 1. Optical 2. Electrical and 3. Mechanical properties	
		4.2.Bio-inorganic and Medicinal Chemistry	**(07L)**
		4.2.1 Metal Co-ordination in biological system: Enzymes, apoenzymes andCoenzymes . 4.2.2 Metal complexes in medicine: cis- platin and gold complexes 4.2.3 Inorganic pharmaceuticals.	

Course Code: RUSCHE603
Course Title: CHEMISTRY-III
Academic year 2023-2024.

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Classify carbohydrates.
CO 2	Study reactions shown by Glucose
CO 3	Illustrate general applications of various catalysts and Reagents
CO 4	Understand basic principles of Photochemistry
CO 5	Know basics of Natural Product chemistry- Including Amino acids, nucleic acids etc
CO 6	Apply Spectral techniques to Structure Determination

DETAILED SYLLABUS

RUSCHE603	**CHEMISTRY-III**		**Credits-2.5**
	Unit	**Unit Title**	**Lectures**
	I	**Chemistry of Carbohydrates and Catalysts and Reagents**	**(15L)**
		1.1 Chemistry of Carbohydrates	**(09L)**
		1.1.1 Introduction: Classification, reducing and non-reducing sugars, DL notation. 1.1.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (Furanose and pyranose forms of pentoses and hexoses). Interconversion: open and Haworth forms of monosaccharides with 5	

		and 6 carbons. Chair conformation with stereochemistry of D-glucose. Stability of chair forms of D- glucose. 1.1.3 Stereoisomers of D-glucose: Enantiomers and diastereomers, anomers and epimers. 1.1.4 Mutarotation in D-glucose with mechanism. 1.1.5 Chain lengthening and shortening reactions: Modified Kiliani-Fischer synthesis (D- arabinose to D-glucose and D-mannose), Wohl method (D-glucose to D-arabinose). 1.1.6 Reactions of D-glucose and D-fructose: (a) osazone formation (b) reduction- H_2/Ni, $NaBH_4$ c) oxidation: bromine water, HNO_3, HIO_4 d) acetylation e) methylation (d and e with cyclic pyranose forms). 1.1.7 Glycosides: general structure, formation of alkyl glycosides and anomeric effect. 1.1.8 Disaccharides: Structures of sucrose and maltose (cyclic forms: Haworth/chair).	
		1.2 Catalysts and Reagents :	**(06L)**
		Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism) 1.2.1 **Catalysts:** Catalysts for hydrogenation: Raney Ni, Pt and PtO_2: C=C, CN, NO_2, aromatic ring; Pd/C: C=C, COCl→ CHO (Rosenmund); Lindlar catalyst: alkynes; Wilkinson's catalyst: olefins. 1.2.2 **Reagents**: (a) LiAlH4 and Red-Al: reduction of CO, COOR, CN, and NO_2. (b) $NaBH_4$: reduction of CO (c) SeO_2: hydroxylation of allylic and benzylic positions,	

		oxidation of CH_2 to CO (d) *m*-CPBA epoxidation of C=C (e) NBS: allylic and benzylicbromination.	
	II	**Chemistry of Amino Acids, Proteins and Nucleic Acids and Photochemistry**	**(15L)**
		2.1 Chemistry of Amino acids, Proteins and Nucleic acids:	**(08L)**
		2.1.1 α-Amino acids: General structure, configuration, essential (valine, leucine, phenylalanine), neutral (glycine, alanine), acidic (glutamic acid) and basic (lysine) amino acids (systematic names with abbreviations). pH dependency of ionic structure and isoelectric point. 2.1.2 Polypeptides and Proteins: Nature of Peptide bond. Nomenclature and representation of peptides (di and tripeptides) 2.1.3 Proteins: general idea of primary, secondary, tertiary and quartenary structures. 2.1.4 Nucleic acids: Controlled hydrolysis of nucleic acids. Sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structure of nucleic acids (DNA and RNA including base pairing).	
		2.2 Photochemistry:	**(07L)**
		2.2.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triple states, allowed and forbidden transitions, fate of excited molecules, photosensitization. 2.2.2 Photochemical reactions of olefins: photoisomerisation, photochemical rearrangement of 1,4-dienes (di π methane)	

		2.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages, photoreduction (e.g. benzophenone to benzpinacol).	
	III	**Spectroscopy-I (UV-Visible, IR and ^{1}H NMR)**	**(15L)**
		3.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency. 3.2 UV- Visible spectroscopy: Basic theory, solvents, nature of UV-VIS spectrum, concept of Chromophore, auxochrome,bathochromic shift, Hypsochromic shift, hyperchromic and hypochromic effects, chromophore-chromophore and chromophore -auxochrome interactions. Calculation of absorption maxima by Woodward-Fieser Rule for conjugated polyenes. Applications of UV-Visible spectroscopy. 3.3 IR Spectroscopy: Basic theory, selection rule, nature of IR spectrum, characteristic vibrational frequencies of functional groups, fingerprint region. Applications IR Spectroscopy. 1.2 ^{1}H NMR Spectroscopy: Basic theory of ^{1}H NMR, nature of ^{1}H NMR spectrum, chemical shift (∂ unit), standard for ^{1}H NMR, solvents used. Factors affecting chemical shift: inductive effect and anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin- spin coupling and coupling constant. Application of deuterium	

		exchange technique. Application of ^{1}H NMR in structure determination.	
	IV	**Spectroscopy-II and Natural Products**	**(15L)**
		4.1 Spectroscopy-II	**(08L)**
		4.1.1 Mass Spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, Nitrogen rule. Fragmentation of alkanes and aliphatic carbonyl compounds including Mclafferty rearrangement. 4.1.2 Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes with respect to UV-VIS, IR, ^{1}H NMR: (1) alkanes (2) alkenes and polyenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) carboxylic acids (9) esters (10) amines (11) amides (broad regions characteristic of different groups are expected). 4.1.3 Problems of structure elucidation of simple organic compounds using individual or combined use of the UV-VIS, IR, ^{1}H NMR and Mass spectroscopic techniques. (index of hydrogen deficiency expected).	
		4.2 Natural Products :	**(07L)**
		4.2.1 Introduction, sources, classification and functions to the following natural products (Structures of the compounds specified are expected) (a) Terpenoids: (isoprene rule). citral, α-terpeniol, camphor and α-pinene. (b) Alkaloids: nicotine, atropine.	

		(c) Vitamins: vitamin A and vitamin C. (d) Hormones: adrenaline, thyroxine. (e) Steroids: cholesterol, progesterone. 4.2.2 Structure determination of natural products: (a) Ozonolysis in terpenoids: Examples of open chain and monocyclic monoterpenoids. (b) Hofmann exhaustive methylation and degradation in alkaloids: simple open chain and monocyclic amines. 4.2.3 Commercial synthesis: (a) camphor from α-pinene (b) α- and β- ionones from citral. 4.2.4 Introduction to primary and secondary metabolites and broad classification of natural products based on biosynthesis.	

Course Code: RUSCHE604
Course Title: CHEMISTRY-IV
Academic year 2023-2024

Course Outcomes:

After studying this course, the learner will be able to:	
CO 1	Outline the basic principles, instrumentation of these advanced separation techniques and electroanalytical methods.
CO 2	Assess advantages and limitations of these techniques.
CO 3	Correlate these techniques with industrial applications.
CO 4	Relate the applications of analytical methods in day-to-day life.

DETAILED SYLLABUS

RUSCHE604	**CHEMISTRY-IV**		**Credits-2.5**
	Unit	**Unit Title**	**Lectures**

	I	**Separation Techniques.**	**(15L)**
		1.1 Gas Chromatography	**(06L)**
		1.1.1 Introduction, basic principles, terms involved, **1.1.2** Rate theory and plate theory of chromatography **1.1.3** Instrumentation, components of the instruments, Types of columns, packing materials. **1.1.4**Types of detectors, TCD, FID, ECD, their relative advantages and imitations **1.1.5** Qualitative and quantitative analysis, **1.1.6** Applications of GC	
		1.2 High Pressure Liquid Chromatography	**(05L)**
		1.2.1 Introduction, basic principles. **1.2.2** Instrumentation and its components. **1.2.3**Solvent reservoirs, degassing system, **1.2.4**Types of pumps, pneumatic, reciprocating, syringe type, their advantages and limitations, **1.2.5**Pre-column, types of columns, packed and capillary, sample injection systems **1.2.6** Detectors, UV-Visible, refractive index, **1.2.7** Applications of HPLC	
		1.3 Ion Exchange Chromatography	**(04L)**
		1.3.1 Introduction, types of ion exchangers, synthetic and natural, cation and anion, properties of resins **1.3.2** Ion exchange equilibria, selectivity coefficient, separation factors, factors affecting separation of ions **1.3.3** Ion exchange capacity and its determination	

		1.3.4 Applications of ion exchange chromatography, preparation of demineralized water, separation of amino acids, separation of lanthanides, preparation of exact concentration of acids or bases	
	II	**Electroanalytical Methods**	**(15L)**
		2.1: Introduction and classification of electroanalytical methods and specific features of each of the major category.	**(01L)**
		2.2 Ion Selective Electrodes:	**(04L)**
		2.2.1 Ion selective and ion specific electrodes, components of ion selective electrode, properties of membrane in ion selective electrode, classification of ion selective electrodes **2.2.2** Solid membrane electrodes: Fluoride ion selective electrode, Glass membrane electrode, Glass electrode. **2.2.3** Liquid membrane electrode: Calcium ion electrode	
		2.3 Polarography	**(07L)**
		2.3.1 Basic principles, polarizable and nonpolarizable electrodes, supporting electrolyte, its function, selection of supporting electrolyte **2.3.2** The polarogram, terms involved, residual current, limiting current, diffusion current, half wave potential. **2.3.3** Oxygen interference and its removal, polarographic maxima and use of maxima suppressors.	

		2.3.4 Equation of polarographic wave, determination of half wave potential and diffusion current from the polarogram **2.3.5**Ilkovic equation, terms involved and their explanation **2.3.6** DME, Construction, working, advantages and limitations; **2.3.7** Instrumentation, H- shaped polarographic cell , Qualitative and quantitative analysis, calibration curve method, standard addition method. **2.3.8** Applications of polarography.	
		2.4 Amperometric titrations	**(03L)**
		2.4.1 Basic principles: construction of the titration curve, Different types of amperometric titration curves, **2.4.2** Rotating platinum electrode, construction, working, advantages and limitations. **2.4.3** Applications of amperometric titrations, **2.4.4** Comparison of amperometry and polarography	
	III	**Miscellaneous Methods**	**(15L)**
		3.1 Potentiometric titrations	**(04L)**
		3.1.1 Potentiometry and potentiometric titrations, basic principles, indicator and reference electrode, types of titrations and indicator electrodes used for each type. **3.1.2** Experimental set up & procedures for the potentiometric titrations, **3.1.3** Determination of equivalence point in potentiometric titrations, use of E vs.V, first and second derivative plots vs. V for the determination of the equivalence point.	

		3.1.4 Advantages and limitations.	
		3.2 Biamperometric titrations,	**(02L)**
		3.2.1 Basic principles, experimental set up, **3.2.2** Biamperometric titration curves, determination of the equivalence point **3.2.3** Determination of water content by Karl Fischer method.	
		3.3 Gel electrophoresis	**(06L)**
		3.3.1 Basic principle, **3.3.2** Factors affecting migration rate, supporting media, SDS page, Isoelectric focussing **3.3.3** 2D gel support, application of the sample, procedure. **3.3.4** Separation and identification methods **3.3.5** Applications	
		3.4 Size exclusion Chromatography	**(03L)**
		3.4.1 Introduction, principles, **3.4.2** Operational procedures, **3.4.3** Applications of size exclusion chromatography	
	IV	**Selected Industrial Applications of Analytical Chemistry**	**(15L)**
		4.1 Food analysis	**(05L)**
		4.1 .1 Milk powder **4.1.1.1** Determination of lactose **4.1.1.2** Determination of calcium and iron **4.1.2 Honey** **4.1.2.1** Total reducing sugars in honey	
		4.2 Cosmetic analysis	**(02L)**

		4.2.1 Talcum powder **4.2.2** Analysis of face powder	
		4.3 Detergent analysis	**(03L)**
		4.3.1 Determination of active anionic matter **4.3.2** Determination of alkalinity **4.3.3** Determination of oxygen releasing capacity.	
		4.4 Water analysis	**(03L)**
		4.4.1 Determination of dissolved oxygen **4.4.2** Determination of chemical oxygen demand	
		4.5 Pharmaceutical Analysis	**(02L)**
		4.5.1 Determination of drugs by non-aqueous titration	

Semester-VI

Practicals

RUSCHEP601	**Credits-3**
	CHEMISTRY-I 1. To determine the energy of activation for the acid catalyzed hydrolysis of methyl acetate. 2. To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement. 3. To determine acidic and basic dissociation constant of amino acid and hence calculate isoelectric point. 4. To determine the amount of weak acid and strong acid in the given mixture by conductometric titration. 5. To determine the solubility and solubility product of AgCl potentiometrically using chemical cell. 6. To determine Critical Micelle Concentration (CMC) using conductometer.

	CHEMISTRY-II **Inorganic preparations** 1. Mercury tetrathiocyanatoCobaltate (II) Hg[Co(SCN)4] 2. Magnesium oxinate[Mg(Ox)2] 3. Tris-acetyl acetonato iron(III) [Fe(AcAc)3] 4. Tetramminecopper(II) sulphate. [Cu(NH3)4]SO4.H2O **Inorganic estimations/ Analysis** 1. Estimation of copper iodometrically using sodium thiosulphate. 2. Estimation of lead by complexometrically using EDTA solution.
RUSCHEP602	**CHEMISTRY-III** **Binary Mixture Separation & identification (Solid + Solid)** (2.0 g mixture to be given) 1. Minimum six mixtures to be completed by the learners. 2. Components of the mixture should include water soluble and water insoluble acids (carboxylic acid), water insoluble phenols (α-naphthol, β-naphthol), water insoluble bases (nitroanilines), water soluble (urea and thiourea) and water insoluble neutrals (Aromatic hydrocarbons, m-dinitrobenzene, anilides, amides) 3. A sample of binary mixture to be given (<1.0 gram) to the learners for detection of chemical type of mixture. After correct determination of the chemical type, the fixing reagent should be decided by the learners for separation. 4. Follow separation scheme with the bulk sample of the binary mixture. 5. After separation of the components into independent components A and B, a. One component (decided by the examiner) is to be analyzed and identified by chemical method with melting point and also by IR spectroscopy. (This component is not to be weighed). b. The other component is to be purified, dried, weighed and melting point is to be determined.
	CHEMISTRY-IV: 1. Estimation of Chromium in water sample by using diphenylcarbazide spectrophotometrically.

	2. Determination of acetic acid content in vinegar sample by using quinhydrone electrode potentiometrically. 3. Determination of phosphoric acid in cola sample pH metrically. 4. Estimation of calcium and magnesium content in Talcum powder. 5. Estimation of reducing sugar in honey by Wilstatter method. 6. Separation and estimation of Mg(II) and Zn(II) from given sample solution using an anion exchanger.

Physical Chemistry

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd.

2. The Elements of Physical Chemistry, P.W. Atkins, Oxford University Press, Oxford..

3. Modern Electrochemistry, J.O.M Bockris& A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer

4. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.

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Inorganic Chemistry

1. D. Banerjea, *Coordination chemistry,* Tata McGraw Hill, New Delhi, (1993).

2. D. F. Shriver and P. W. Atkins, *Inorganic chemistry,* 3rd Ed., Oxford University Press, (1999).

3. N. N. Greenwood and E. Earnshaw, *Chemistry of elements,*Pergamon Press, Singapore, (1989).

4. W. L. Jolly, *Modern inorganic chemistry,* 2nd Ed. McGraw Hill Book Co., (1991).

5. B. E. Douglas and H. McDaniel, *Concepts and models in inorganic chemistry,* 3rd Ed., John Wiley & Sons, Inc., New York, (1994).

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7. R. W. Hay, *Bioinorganic chemistry,* Ellis Harwood, England, (1984).

8. R. C. Mehrotra and A. Singh, *Organometallic chemistry: A unified approach,* Wiley Eastern, New Delhi, (1991).

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10. Microscale Inorganic Chemistry by Z. Szafran, Ronald M. Pike and Mono M. Singh. Pub.John Wiley and Sons1991.p.218.(For preparation of $CuCl_2$.2DMSO.

Organic Chemistry

1. Organic Chemistry, Francis A Carey, Pearson Education, 6th Edition, Special Indian Edition 2008.
2. Organic Chemistry, R.T. Morrison and R.N. Boyd, 6th Edition, Pearson Edition.
3. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 8th Edition, John Wiley & Sons, 2004.
4. Organic Chemistry Baula Y. Bruice, Pearson Edition, 2008.
5. Organic Chemistry, J.G. Smith, 2nd Editionm Special Indian Edition, Tata. McGraw Hill.
6. Stereochemistry, P.S. Kalsi, New Age International Ltd. 4th Edition,2006
7. Organic Spectroscopy by Jag Mohan
8. Furniss, B. S.; Hannaford, A. J.; Rogers, V.; Smith, P. W. G.; Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry, ELBS.

Analytical Chemistry

1. D. Harvey, Modern Analytical Chemistry, The McGraw-Hill Pub. 1st Edition (2000)
2. H.S. Ray, R Sridhar and K.P. Abraham, Extraction of Nonferrous Metals, AffiliatedEast-West Press Pvt. Ltd. New Delhi (1985) reprint 2007.
3. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney , Vogel's Textbook of Qunatitative Chemical Analysis, Fifth edition, ELBS Publication (1996)
4. D.A. Skoog D.M. West and F.J. Holler, Fundametals of Analytical Chemistry, 7thEdition (printed in India in 2001) ISBN Publication.
5. Analytical Chemistry, J.G. Dick,1973 Tata McGraw Hill Publishing Co. Ltd. New Delhi.
6. Quantitative analysis, Dey& Underwood, Prentice Hall of India, Pvt. Ltd. New Delhi
7. Fundamentals of Analytical Chemistry, Skoog 8th edition, Saunders college publishing.

Modality of Assessment

Theory Examination Pattern:

A) Internal Assessment - 40% of total marks:

(40 marks)

Sr No	**Evaluation type**	**Marks**
1	One Assignment	10
2	One class Test (multiple choice questions / objective)	20
3	Active participation in routine class instructional deliveries (seminars//presentation)	05
4	Overall conduct, participation in co-curricular activities of the department.	05

B) External examination – 60 %

Semester End Theory Assessment - 60% **60 marks**

These examinations shall be of **two hours** duration.

There shall be **Four** questions each of **15** marks. On each unit there will be one question.

All questions shall be compulsory with internal choice within the questions.

Theory question paper pattern is as follows :-

Questions	Options	Marks	Questions on
Q.1)A)	Any 3 out of 5	12	Unit I
Q.1)B)	Any 1 out of 2	03	
Q.2)A)	Any 3 out of 5	12	Unit II
Q.2)B)	Any 1 out of 2	03	
Q.3)A)	Any 3 out of 5	12	Unit III
Q.3)B)	Any 1 out of 2	03	
Q.4)A)	Any 3 out of 5	12	Unit IV
Q.4)B)	Any 1 out of 2	03	

<u>Practical Examination Pattern:</u>

(A)Internal Examination: -				
	RUSCHEP601		**RUSCHEP602**	
	Paper I	**Paper II**	**Paper III**	**Paper IV**
Journal	**05**	**05**	**05**	**05**
Tests	**10**	**10**	**10**	**10**
Active Participation	**05**	**05**	**05**	**05**
Total	**20**	**20**	**20**	**20**
(B) External (Semester end practical examination):-				
Laboratory work	**25**	**25**	**25**	**25**
Viva	**05**	**05**	**05**	**05**
Total	**30**	**30**	**30**	**30**
Grand Total	**100**		**100**	

PRACTICAL 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, Certificate from Head/ Co-ordinator should be submitted, failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Course	**601**	**602**	**Grand Total**

	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical	**20**	**30**	**50**	**20**	**30**	**50**	**100**
Course	**603**			**604**			
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**200**
Practical	**20**	**30**	**50**	**20**	**30**	**50**	**100**
(Total Marks : 600)							