Resolution Number: AC/II(23-24).2.RUS5

S.P.Mandali's
Ramnarain Ruia Autonomous College

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Program: B.Sc.

Course: S.Y.B.Sc. Chemistry

Course code: RUSMJCHE

Syllabus for Semester III & IV

Year	Semester	Course Code	Course Title / Unit Title		Credits
SYBSc	III	RUSMJCHEO201	Chemistry Paper I		3
			Unit I	Thermodynamics	
			Unit II	Chemical Bonding	
			Unit III	Reactivity and reactions of halogenated	
		RUSMJCHEPO201	Practicals		1
		RUSMJCHEO202/ RUSMIBOTO202	Chemistry Paper II		3
			Unit I	Electrochemistry-I	
			Unit II	Chemistry of p-block elements (Group 13 & 14)	
			Unit II	Chemistry of Carbonyl Compounds	
		RUSMJCHEPO202/ RUSMIBOTPO202	Practicals		1
		RUSVSCCHEPO201	Practicals		2
SYBSc	IV	RUSMJCHEE211	Chemistry Paper I		3
			Unit I	Phase Equilibria	
			Unit II		
			Unit III	Aromatic Hydrocarbons and epoxide	
		RUSMJCHEPE201	Practicals		1
		RUSMJCHEE212/ RUSMIBOTE212	Chemistry Paper II		3
			Unit I	Electrochemistry-II	
			Unit II	Chemistry of Group 15 and 16 Elements	
			Unit III	Chemistry of Carboxylic and Sulphonic Acids	
		RUSMJCHEPE212/ RUSMIBOTPE212	Practicals		1
		RUSSECCHEPE211	Practicals		2

Semester III
Course Code: RUSMJCHEO201
Course Title: Chemistry I
Academic year 2024-25

Unit	SEM III	Credits
	RUSMJCHEO201	**3**
I Physical Chemistry	**Thermodynamics** 1.1 Variation of internal energy with volume and temperature, internal pressure, The Joule-Thomson effect, liquefaction of gases using an isenthalpic expansion. 1.2 Limitations of first law of thermodynamics, the second law of thermodynamics, Carnot cycle, thermodynamic definition of entropy, entropy change of systems and surroundings for various processes and transformations. Entropy changes during the isothermal mixing of ideal gases, significance of entropy. 1.3 Third law of thermodynamics and determination of absolute entropy is entropy calculations in chemical reactions.	
II Inorganic Chemistry	**2.1 Chemical Bonding:** 2.1.1 Valence bond theory: postulates of VBT, need for hybridisation, Orbitals involved in hybridisation (sp, sp^2, sp^3, dsp,^{2} sp^3d, and sp^3d^2, sd), energetics of hybridisation. 2.1.2 Concept of resonance and Formal Charge; rules for resonance or canonical structures with examples. **2.2 Molecular Orbital Theory:** 2.2.1. Concept of orbital overlaps, types of orbital overlaps (s-s, s-p, p-p) 2.2.2. Linear combination of atomic orbitals to form molecular orbitals (LCAO-MO approach). 2.2.3. Application of MOT to Homonuclear diatomic molecules from He_2 molecule and for all the elements of second period, heteronuclear diatomic molecules (HCl, NO) 2.2.4 Molecular orbital Theory and determination of Bond Order and magnetic behaviour for O_2, O_2^+ O_2^-, O_2^{2-} (Problems are expected wherever applicable)	
III Organic	**3.1. Reactivity and reactions of halogenated**	

Chemistry	**hydrocarbons:** 3.1.1. Alkyl halides: Nucleophilic substitution reactions: SN 1, SN2 and SNi mechanisms with stereochemical aspects, factors affecting nucleophilic substitution reactions: nature of substrate, solvent, nucleophile and leaving group. 3.1.2. Aryl halides: Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (SNAr), addition-elimination and benzyne mechanism. **3.2 Alcohols, Phenols and Amines** **3.2.1 Alcohols: Nomenclature, Methods of Preparation:** 1. Hydration of alkenes 2.Hydrolysis of alkyl halides 3. Reduction of aldehydes and ketones 4. Using Grignard reagent. Properties: Hydrogen bonding, effect of hydrogen bonding on properties. Acidity of alcohols, Reactions of alcohols **3.2.2 Phenols:** methods of preparation, physical properties and acidic character, comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion, reactions of phenols. **3.2.3 Amines:** -.Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines. -Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using Fe-HCI, Sn-HCl, Zn- acetic acid. Reduction of nitriles, ammonolysis of halides, reductive amination, Hofmann bromamide reaction. -Reactions: salt Formation, N-acylation, N- alkylation, Hofmann' exhaustive methylation (HEM), Hofmann-elimination, carbylamine reaction, reaction with nitrous acid, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation. -Diazonium Salts: Preparation, Reactions: Sandmeyer reaction, Gattermann reaction, Gomberg reaction. Replacement of diazo group by -H,- OH. Azo coupling with phenols, naphthols and Aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroxyazobenzene. Synthetic application.	
	Practicals	**1**
RUSMJCHEPO201	**Physical Chemistry:** 1) Determine the rate constant for the reaction between $K_2S_2O_8$ and KI. 2) Study the variation of conductance of strong electrolyte with concentration and verify Onsagar equation.	

	3) Determine the amount of strong acid using pH metric titration. **Inorganic Chemistry:** Qualitative determination of anion and molecular composition of the salts such as copper sulphate pentahydrate, nickel chloride hexahydrate, anhydrous cupric chloride using volumetric methods. (Learners will prepare EDTA solutions). Minimum Three Salt samples will be given to every student. **Organic Chemistry:** Organic preparation and their purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product. Preparation of: 1. To prepare Cyclohexanone oxime from cyclohexanone. 2. To prepare benzoic acid from benzaldehyde. 3. To prepare m-Dinitrobenzene from nitrobenzene	

Semester III

Course Code: RUSMJCHEO202

Course Title: Chemistry II

Academic year 2024-25

Unit	Semester III	Credits
	RUSMJCHEO202/ RUSMIBOTO202	**3**
I Physical Chemistry	**Electrochemistry-I** 1.1 Electronic and electrolytic Conductors: Conductance, cell constant, specific conductance, equivalent conductance and molar conductance and their relationships. Variation of Molar conductance with concentration, for weak and strong electrolytes (Onsager equation). Concept of limiting molar conductance. 1.2 Debye-Huckel theory for strong electrolytes: Relaxation effect and Electrophoretic effect. 1.3 Kohlrausch's law of independent migration of ions. Limiting molar conductances for ions, determination of limiting molar conductance for weak electrolytes. 1.4 Measurement of conductance and determination of cell constant. 1.5 Applications of conductance measurements: Determination of degree of dissociation and dissociation constant of weak electrolyte. Determination of solubility and solubility product of sparingly soluble salts. 1.6 Transport number, the relation between transport number and velocity of ions. Factors affecting transport number. Determination of transport number using the moving boundary method.	
II Inorganic Chemistry	**Chemistry of p-block elements (Group 13 & 14)** **2.1 Chemistry of Group 13 elements:** 2.1.1 Electronic configuration, Trends in metallic characters: Oxidation states and Inert pair effect. 2.1.2 Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications.	

	2.1.3 Preparation of simple boranes like diborane 2.1.4 Structure and bonding in diborane (2e-3c bonds) **2.2 Chemistry of Group 14 elements:** 2.2.1 Electronic configuration, Trends in metallic characters: Oxidation states and Inert pair effect. 2.2.2 Methods of preparation of $SiCl_4$ and its structure. 2.2.3 Preparation of extra pure Silicon – Zone refining and Single Crystal method 2.2.4 Silicones – Preparation, classification, properties and uses.	
III Organic Chemistry	3.1 **Chemistry of Carbonyl Compounds** 3.1.1 Carbonyl Compounds: Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds, structure, reactivity of aldehydes and ketones . methods of preparation: oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes. 3.1.2 Mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions. 3.1.3 Reactions of aldehydes and ketones with NaHSO3, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, LiAlH4 and NaBH4. 3.1.4 Mechanism of the following reactions: Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt and Cannizzaro reaction. 3.1.5 Keto-enol tautomerism: mechanism of acid and base catalysed enolization 3.1.6 Compounds with active methylene: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols. Reactions of Acetylacetone and ethyl acetoacetate: alkylation, conversion to ketone, mono- and dicarboxylic acid	
	Practicals	**1**
RUSMJCHEPO202 / RUSMIBOTPO202	**Physical Chemistry:** 1)To standardise the conductometer and to determine conductance, specific conductance and molar conductance for given samples. 2)To standardise pH-meter and to determine pH of given	

	samples. 3) To standardise the potentiometer and to determine potential of given electrodes using saturated calomel electrodes as a reference electrode. **Inorganic Chemistry:** Inorganic preparation – 1. Tris(ethylene diamine) nickel (II) thiosulphate. 2. preparation of Copper DMSO 3.Preparation of magnesium oxalate. **Organic Chemistry:** Organic preparation and their purification: Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product. Preparation of: 1. Phthalic anhydride from phthalic acid by sublimation 2. Preparation of 5-nitrosalicylic acid from salicylic acid. 3.Benzoic acid from benzamide.	

Semester III

Course Code: RUSVSCCHEPO201

Course Title: Vocational Skill Courses

Academic year 2024-25

	RUSVSCCHEPO201	**2**
	1. To carry out the calibration of pipette and burette. 2. Calculation of standard Deviation and Determination of Precision & Accuracy. 3. Precipitation by Homogeneous and Heterogeneous method. 4. Gravimetric estimation of Nickel (II) as Ni-DMG without impurity. 5. Gravimetric estimation of barium ions as $BaCrO_4$ with impurity of Fe. 6. To determine the COD of given water sample. 7. To determine the Dissolved Oxygen in Given Water Sample.	

MODALITY OF ASSESSMENT

Sem III

Discipline Specific Core/Minor Subject

Sr. No.	Number of Credits	Total Marks	Internal Assessment (Marks)	Internal Assessment (Pattern)	Semester End Examination (Marks)	Semester End Examination (Pattern)	Duration of Sem End Exam
Theory	3	75	30	Class Test of 20 Marks Assignment of 10 Marks	45	Three Questions of 15 Marks each	1 Hr 30 Mins
Practical	1	25	NA	-	25		2Hr

Vocational Skill Course only for Major

Sr. No.	Number of Credits	Total Marks	Internal Assessment (Marks)	Internal Assessment (Pattern)	Semester End Examination (Marks)	Semester End Examination (Pattern)	Duration of Sem End Exam
Practical	2	50	NA	-	50	-	4Hr

Semester IV

Course Code: RUSMJCHEE211

Course Title: Chemistry I

Academic year 2024-25

Unit	SEM IV	Credits
	RUSMJCHEE211	**3**
I Physical Chemistry	**Phase Equilibria** 1.1 Terms involved: Phases, components, and degrees of freedom. Gibbs Phase Rule. Phase diagrams of one-component systems (water, CO_2 and sulphur). Two component systems (lead-silver system) 1.2 Thermodynamics of ideal solutions: ideal solutions and Raoult's law, deviations from Raoult's law. Vapour pressure-composition and temperature–composition curves of ideal and non-ideal solutions. Distillation of liquids forming ideal and non-ideal solutions, Azeotropes, steam distillation. Partially miscible liquids: critical solution temperature; systems with upper critical solution temperature, lower critical solution temperature, and having both. 1.3 Nernst distribution law and its applications to solvent extraction.	
II Inorganic Chemistry	**2.1 Comparative Chemistry of the transition metals:** 2.1.1 Position in the periodic table, electronic configuration. 2.1.2 Significance of special stability of d^0, d^5 and d^{10}configurations, Variable oxidation states and their stabilities in aqueous solutions; ability to form complexes, colour, magnetic property, catalytic property. **2.2 Coordination Chemistry:** 2.2.1 Molecular compounds – Double salts and Complex salts 2.2.2 Werner's theory 2.2.3 Basic terms viz complex ion, charge on the complex, ligands, coordination number, oxidation state, & Nomenclature 2.2.4 Sidgwick – Powel Theory of coordination compounds;	

	Effective atomic number rule. 2.2.5 Stereoisomerism and optical isomerism of coordination compounds (C.N= 4 and 6) 2.2.6 Evidence for the formation of coordination compounds. 2.2.7 Application of coordination compounds. **2.3 Nature of the Metal-Ligand Bond:** Application of VBT to complexes with coordination number 4, 5 & 6, Inner and outer orbital complexes.	
III Organic Chemistry	**Aromatic Hydrocarbons and epoxide** 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 (-CH3, -NH2, - OH, NO2, -X) 3.1.5 Nucleophilic aromatic substitution of Aryl halides replacement by –OH group and effect of nitro substituent). 1.3.3. Epoxides: Nomenclature, methods of preparation and reactivity of epoxides, reactions of epoxides, ring opening reactions by nucleophiles , acid hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. Reactions with ammonia, amines, Grignard reagents, and alkoxides.	

RUSMJC HEPE201	**Practicals** **Physical Chemistry** 1) To determine dissociation constant of weak acid by incomplete titration method using pH-meter. 2) To determine the amount of strong acid in the given solution by conductometric titration. 3) To determine the order of the reaction between $K_2S_2O_8$ and KI for equal initial concentration. **Inorganic Chemistry** 1) Determination of Calcium in Limestone. 2) Determination of Copper in Brass. 3) Determination of Acid Insoluble Residue in Pyrolusite ore. **Organic Chemistry** 1. Qualitative Analysis of organic compounds (minimum four) on the basis of (Bifunctional) i. Preliminary examination ii. Solubility profile iii. Detection of elements C, H, (O), N, S and X. iv. Detection of functional groups v. Determination of physical constants (M.P/B.P) Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysis to be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides.	**2** **2**

Semester IV

Course Code: RUSMJCHEE212

Course Title: Chemistry II

Academic year 2024-25

Unit		Credits
	RUSMJCHEE212/ RUSMIBOTE212	**3**
I Physical Chemistry	**Electrochemistry-II: Electromotive Force of Galvanic Cells** 1.1 Electrochemical cells, galvanic cells, reversible cells, and reversible electrodes, conventions to represent Galvanic cells. 1.2 Types of electrodes, standard electrode potential, Electrochemical series. 1.3 Cell potential and standard cell potential. 1.4 Nernst equation and its importance. 1.5 Calculation of thermodynamic parameters: ΔG, ΔH, ΔS and equilibrium constant from EMF data. Classification of galvanic cells: chemical cells and concentration cells 1.6 Determination of pH using a glass electrode. 1.7 pH and Buffers: pH concept, calculation of pH for strong and weak electrolytes. Buffer, Henderson's equation for acidic and basic buffer. Buffer Capacity.	
II Inorganic Chemistry	**2.1 Chemistry of Group 15 and 16 Elements:** 2.1.1 Trends in physical and chemical properties of Group – 15 and Group – 16 Elements. 2.1.2 Physical properties of Hydrides of Group 15 and 16 Elements with respect to H- bonding. **2.2 Organometallic Chemistry** 2.1.1 Introduction, definition, classification based on hapticity and nature of metal carbon bond. Eighteen electron rule and its applications, exceptions. 2.1.2 Importance and few applications of organometallic compounds as catalysts (e.g. Ziegler-Natta catalyst, Wilkinson), reagents in organic	

	synthesis etc. 2.1.3 Metal carbonyls: Bonding, general method of preparation and properties of $Ni(CO)_4$, $Fe(CO)_5$.	
III Organic Chemistry	**Chemistry of Carboxylic and Sulphonic Acids** 1.1Carboxylic Acids and their derivatives` 1.1.1. Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. 1.1.2. Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard reagent and hydrolysis of nitriles. 1.1.3. Reactions: Acidity, salt formation, decarboxylation, reduction of carboxylic acids with LiAlH4, diborane, Hell-Volhard-Zelinsky reaction, conversion to acid chlorides, esters, amides and acid anhydrides and their relative reactivity. 1.1.4. Mechanism of nucleophilic acyl and acid- catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution. 1.1.5. Mechanism of Claisen condensation and Dieckmann condensation. 1.2 Sulphonic acids: 1.2.1 Nomenclature, preparation of aromatic sulphonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene. 1.2.2 Reactions: Acidity of arene sulfonic acid, comparative acidity of carboxylic acid and sulfonic acids reactions of arenesulphonic acid such as salt formation, desulphonation , phosphorous pentachloride, ipso substitution.	

RUSMJCHEPE212/ RUSMIBOTPE212	**Practicals**	**2**
	Physical Chemistry 1) To determine standard cell potential (E^O cell), standard free energy change (ΔG^O) and equilibrium constant (K) for a given galvanic cell. 2) To determine the concentration of Fe (II) present in the given sample by potentiometric titration. 3) Determination of coefficient of the viscosity of the given liquid. **Inorganic Chemistry** 1) Determination of Salinity of sea water sample. 2) Determination of Magnesium in Milk of Magnesia Tablet. 3) Determination of Zinc in the supplied Topical Agent.(Talcum Powder) **Organic Chemistry** 1. Qualitative Analysis of organic compounds (minimum four) on the basis of (Monofunctional) i. Preliminary examination ii. Solubility profile iii. Detection of elements C, H, (O), N, S and X. iv. Detection of functional groups v. Determination of physical constants (M.P/B.P) Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysis to be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides.	

Semester IV
Course Code: RUSSECCHEPE211
Course Title: Skill Enhancement Courses
Academic year 2024-25

	RUSSECCHEPE211	**2**
	1. Separating mixtures by using a piece of absorbent paper (Paper Chromatography). 2. To carry out assay of a commercial sample aspirin, by titrimetric method. 3. Determination of λ_{max} and molar absorptivity of Manganese in $KMnO_4$ photometrically. To determine the limit of linearity. 4. Determination of amount of metal ion using Standard addition method. 5. Analysis of the given solution of Dolomite ore with respect to the amount of CaO and MgO. 6. Determination of sulphate ion by Benzidine reagent. 7. To determine the amount of Fe (III) present in the given solution by using salicylic acid by colorimetric titration (Static Method) 8. Acid base titration by conductometry i) WA vs SB ii) WA vs WB iii) WB vs SA	

MODALITY OF ASSESSMENT

Sem IV

Discipline Specific Core/Minor Subject

Sr. No.	Number of Credits	Total Marks	Internal Assessment (Marks)	Internal Assessment (Pattern)	Semester End Examination (Marks)	Semester End Examination (Pattern)	Duration of Sem End Exam
Theory	3	75	30	Class Test of 20 Marks Assignment of 10 Marks	45	Three Questions of 15 Marks each	1 Hr 30 Mins
Practical	1	25	NA	-	25		2Hr

Skill Enhancement Course only for Major

Sr. No.	Number of Credits	Total Marks	Internal Assessment (Marks)	Internal Assessment (Pattern)	Semester End Examination (Marks)	Semester End Examination (Pattern)	Duration of Sem End Exam
Practical	2	50	NA	-	50		4Hr