Royal College of Arts Science and Commerce (Autonomous)

Affiliated to University of Mumbai

Program:

A – U.G. Certificate in Chemistry
B – U.G. Diploma in Chemistry
C - B.Sc. (Chemistry)

Syllabus for Semester: III and IV

Syllabus for Undergraduate Programme as per

National Education Policy (NEP-2020) with effect from the academic year 2025-2026

NEP Credit Structure for Science

Level	Sem	Major		Minor	OE	VSC	SEC	AEC	IKS	VEC	OJT/FP /RP/CC /CEP	Cumulative Credits	
		DSC	DSE										
4.5	I	6 (4Th + 2 Pr)		4+2 (4Th + 2 Pr)	2	2		2	2	2		22	**UG Certificate Cumulative Credit:44**
	II	6 (4Th + 2 Pr)		4+2 (4Th + 2 Pr)	2		2	2		2	2	22	
Exit Option: Award of UG Certificate in Major with 40 -44 Credits and an Additional 4 Credits Core NSQF Course / Internship OR Continue with Major and Minor													
5	III	8 (6Th + 2 Pr)		4 (2 Th + 2 Pr)	2+2		2	2			2	22	**UG Diploma Cumulative Credit:88**
	IV	8 (6Th + 2 Pr)		4 (2 Th + 2 Pr)	2+2		2	2			2	22	
Exit Option: Award of' UG Diploma in Major and Minor with 80-88 Credits and an Additional 4 Credits Core NSQF Course / Internship OR Continue with Major and Minor													
5.5	V	10 (8Th + 2 Pr)	4 (2Th + 2 Pr)			4					4	22+	**UG Degree Cumulative Credit:132**
	VI	10 (8Th + 2 Pr)	4 (2Th + 2 Pr)			4					4	22	
	Total	**48**	**8**	**20**	**12**	**10**	**6**	**8**	**2**	**4**	**14**	**132**	

Programme Outcomes (POs) for B.Sc.

Sr. No.	As a graduate of science faculty a student should have:
PO1	Acquired the basic knowledge related to the subject offered.
PO2	Understood the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life
PO3	Acquired the skills in handling scientific instruments
PO4	Acquired the skills of planning and performing laboratory experiments, recording observations and drawing logical inferences from the scientific experiments
PO5	Developed scientific outlook not only with respect to science subjects but also in all aspects related to life.

Programme Specific Outcomes (PSOs) :

Sr. No.	The student graduating with the Degree B.Sc Chemistry should be able to acquire
PSO1	Core competency: Students will acquire core competency in the subject Chemistry, and in allied subject areas.
PSO2	A systematic and coherent understanding of the fundamental concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, and all other related allied chemistry subjects
PSO3	Students will be able to use the evidence-based comparative chemistry approach to explain chemical synthesis and analysis.
PSO4	Students will be able to characterize, identify and separate components of organic or inorganic origin and will also be able to analyze them by making use of the modern instrumental methods learned.
PSO5	Students will be able to understand the basic principle of equipment and instruments used in the chemistry laboratory.
PSO6	Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Chemistry
PSO7	The course curriculum also includes components that can be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.
PSO8	Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues, and key issues facing our society in terms of energy, health, and medicine.
PSO9	Lifelong learner: The course curriculum is designed to inculcate a habit of learning continuously through the use of advanced ICT techniques and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

SEMESTER III

Course/ Paper Title	Physical and Inorganic Chemistry - I : MJ 1
Course offered as	Major
Type	Theory
Course Code	RUSCHMJ301
Semester	3
No. of Credits	2
No. of lecture Hours/week	2 hours

Course Objectives (CO):

CO 1	To understand and derive Gibbs Helmholtz equation, van't Hoff reaction isotherm , van't Hoff reaction isochore and Gibb's Duhem equation
CO 2	Explain the concept of partial molal properties, fugacity and activity.
CO 3	Solve numerical on thermodynamic relations
CO 4	To understand and apply the concepts of ideal solutions, partially miscible and immiscible liquid pairs
CO 5	To provide students with an in-depth understanding of the principles of electrolyte conductance, including key laws and concepts governing ionic migration and transference number.
CO 6	To give an understanding of important aspects of ionic bonding with reference to structure and lattice energy calculations.
CO7	To appraise about the bonding in homonuclear diatomic molecules as per Valence bond theory and molecular orbital theory.

Course Outcomes (OC) :

	On completing the course, the student will be able to:
CO 1	derive Gibbs Helmholtz equation, van't Hoff reaction isotherm , van't Hoff reaction isochore and Gibb's Duhem equation
CO 2	Explain the concept of partial molal properties, fugacity and activity and solve numerical on thermodynamic relations
CO 3	Solve numerical on thermodynamic relations
CO4	Analyze deviations from Raoult's law and non-ideal behavior ,
CO5	Understand the principle of electrolyte conductance , terms associated and experimental technique to determine transport no. of ions
CO6	To analyze different aspects of ionic compounds with reference to structure and lattice energy
CO 7	To determine the bonding in homonuclear diatomic molecules as per Valence bond theory and Molecular orbital theory.

Paper I: MJ1: Physical and Inorganic Chemistry -I

Unit I	Physical Chemistry (20 L)
1.1	**1.1 Chemical Thermodynamics-II (8L)** 1.1.1 Free Energy Functions , Variation of Gibb's free energy with Pressure and Temperature. Thermodynamics derivation of equilibrium constant. Gibb's-Helmholtz equation 1.1.2 Concept of fugacity and activity. 1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature . Gibbs Duhem equation. 1.1.4 Van't Hoff Reaction Isotherm and Van't Hoff Reaction Isochore. (Numerical expected)
1.2	**Solutions: (7 L)** 1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature - composition curves of ideal and non-ideal solutions. Azeotropes and Zeotropes definition and significance in solution behaviour. 1.2.2 Partial miscibility of liquids: Definition, Effect of Temperature, effect of impurity and intermolecular interactions on partial miscibility, Critical solution temperature; Phenol-Water, Triethanolamine – Water and Nicotine – Water systems 1.2.3 Immiscibility of liquids- Nernst distribution law and its applications, solvent extraction.
1.3	**Electrochemistry - II : (5L)** 1.3.1 Kohlrausch law of independent migration of ions. 1.3.2 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts. (Numerical expected). 1.3.3 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.
Unit III	**Inorganic Chemistry (10L)**
3.1	**Chemical Bonding:** Non Directional Bonding Ionic Bond,Types of Ionic Crystals,Radius Ratio rules, Lattice Energy,Born-Lande equation,Kapustinski equation, BornHaber'cycle and its applica**tions.**

3.2	**Chemical Bonding :** Directional Bonding, The Valence bond. theory, Introduction and basic tenets, Interaction between two hydrogen atoms and the potential energy diagram of the resultant system, Molecular Orbital theory Comparing Atomic orbitals and Molecular orbitals.Linear combination of atomic orbitals to give molecular orbitals (LCAO-MO approach for diatomic homonuclear molecules) Molecular orbital theory to explain bonding and magnetic property of homonuclear diatomic molecules of elements of second period.

Paper II: MJ2: Organic and Inorganic Chemistry - I

Course/ Paper Title	**Organic and Inorganic Chemistry I : MJ 2**
Course offered as	Major
Type	Theory
Course Code	RUSCHMJ302
Semester	3
No. of Credits	2
No. of lecture Hours/week	2 hours

Course Objectives (CO):

CO 1	To know the functional group interconversion.
CO 2	To know the reactivity of hydroxyl and carbonyl compounds.
CO 3	To understand the physical and chemical properties of carbonyl and hydroxyl compounds
CO 4	To appraise about the general properties of Group 13,14 and 15 elements with special reference to Boron, Silicon Germanium and Nitrogen compounds
CO 5	know the reaction condition

Course Outcomes (OC) :

	On completing the course, the student will be able to:
CO 1	develop problem solving skills in organic reactions.
CO 2	Correlate the structure, properties and reaction of hydroxy, carbonyl and aryl halides.
CO 3	recognized the role of organic reaction in pharmaceutical products.
CO 4	To predict the trends in the general properties of Group 13,15 and 15.
CO 5	To discuss different aspects of Boron,Silicon, Germanium ,Nitrogen compounds with reference preparation,properties and structure

Paper II : MJ2 : Organic and Inorganic Chemistry - III

Unit I	**Organic Chemistry (10 L)**
1.1	**Alcohols, Phenols and Epoxides (7L)** Method of preparation of alcohols by Hydration, hydroboration of alkene. daily life alcohols Chemical properties of alcohols-Oxidation, action of Hydrogen halide, Phosphorus halide, thionyl Chloride, Dehydration to alkene, Esterification, etherification. Method of preparation of Phenols from cumene, Benzene sulphonic acid. Acidity of phenols. Chemical properties-Electrophilic substitution reaction. Fries rearrangement, Claisen rearrangement. General reactivity and preparation of epoxides.
1.2	Aryl halides: General reactivity and electrophilic substitution reaction. **(3L)**
Unit II	**Organic Chemistry (10L)**
2.1	**Carbonyl compounds:** Nomenclature, Reactivity, Preparation from alkyne, Gattermann -Koch formylation, Acyl Chloride, Friedel Craft acylation. Nucleophilic addition reaction-action of HCN, Sod. bisulphite, alcohols, Grignard reagent. Reaction with ammonia derivatives -hydroxyl amine, phenyl hydrazine, 2,4-DNP. Active methylene compound (alkylation reaction), Enolisation and tautomerism. Name reaction and Mechanism-Cannizzaro's reaction, Benzoin condensation
Unit III	**Inorganic Chemistry (10L)**
3.1	**Chemistry of Boron Compounds :** General properties of Group 13. Preparation of simple boranes like diborane and tetraborane.,Structure and bonding in diborane and tetraborane.
3.2	**Chemistry of Silicon and Germanium** : General properties of Group 14. ,Occurrence and structure of SiO2. Preparation and structure of SiCl4 Occurence and extraction of Germanium,Preparation of extra pure Germanium
3.3	**Chemistry of Nitrogen compounds :** General properties of Group 15. Preparation, preperties and structure of common oxides of nitrogen

Paper III : MJ3: Analytical Chemistry - I

Course/ Paper Title	**Analytical Chemistry -I / Paper 3: MJ3**
Course offered as	Major
Type	Theory
Course Code	RUSCHMJ303
Semester	3
No. of Credits	2
No. of lecture Hours/week	2

Course Objectives (CO):

Students will

CO 1	Learn about the different methods of analysis
CO 2	Understand the types and evaluation of possible errors in analysis
CO 3	Have knowledge about titrimetric and gravimetric methods of analysis
CO4	Understand the basic concepts in spectrometry
CO5	Learn the preparation of standard solutions

Course Outcomes (OC) :

	On completing the course, the student will be able to:
OC 1	Classify the methods of analysis and explain their importance.
OC 2	Identify the type of errors in analysis and evaluate them.
OC 3	Appreciate the various terms in titrimetric analysis and their.
OC 4	Explain the principle of neutralization titrations and select suitable indicator.
OC 5	Perform calculations involved in the preparation of primary and secondary standards in titrimetric analysis
OC 6	Explain the principle, types and steps involved in gravimetry.
OC 7	Draw block diagram of an analytical instrument
OC 8	Define the basic terms in spectrometry
OC 9	Derive expression for Beer' law, Lambert's law and explain the deviations from Beer Lamberts law
OC 10	Explain the principle, construction and working of single and double beam colorimeter.

Paper III : MJ3: Analytical Chemistry - I

Unit I	**Introduction to Analytical Chemistry (10 L)**
1.1	**1.1. Role of Analytical Chemistry [04 L]** 1.1.1. Important terms used in Analytical Chemistry. 1.1.2. Purpose of Chemical Analysis; Analysis Based on (i) the nature of information required:(Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and microanalysis) 1.1.3. Classical and Non-Classical Methods of Analysis; their types and Importance. **1.2. Results of Analysis [06 L]** 1.2.1. Errors in Analysis and their types i) Determinate Errors ii) Indeterminate Errors 1.2.2 Methods of minimizing Determinate errors in analysis i) Calibration of apparatus ii) Carrying out Control determination iii) Carrying out Blank determination 1.2.3 Concept of Precision and Accuracy in Analysis and evaluation involved in the study of Precision and accuracy: i)Mean, Median, Mode, Absolute deviation, Average deviation, standard deviation ii) Absolute error and Relative error. (Numericals expected)
Unit II	**Classical Methods of Analysis (10L)**
2.1	**2.1. Titrimetric Methods [03]** 2.1.1. Terms involved in Titrimetric methods of analysis. 2.1.2. Types of titrimetry i)Neutralization (Acidimetry, alkalimetry) ii) Redox (Iodometry, Iodimetry,) iii) Precipitation iv) Complexometric titrations 2.1.1 Primary and Secondary standards in Titrimetry 2.1.2 Calculations based on preparation of primary and secondary standards.
2.2	**2.2 Neutralization Titration [03]** 2.2.1 Concept of pH and its importance in Neutralization Titrations 2.2.2 Endpoint and Equivalence point of Neutralization titrations 2.2.3 Determination of End point by using Indicators causing colour change 2.2.4 Selection of indicators – Ostwald's theory of indicators
2.3	**2.3 Gravimetric analysis [04]** 2.3.1 Introduction and Principle of Gravimetric analysis

	2.3.2 Types of Gravimetric Methods i) Volatilisation gravimetry ii) Precipitation gravimetry 2.3.3 Precipitation Gravimetry: i) Steps involved in precipitation gravimetric analysis ii) Factors affecting precipitation iii) Concept of Nucleation (Homogeneous and Heterogeneous) and crystal growth iv) Impurities involved in precipitates : Simultaneous precipitation, Post precipitation, Co-precipitation 2.3.4 Digestion and its importance 2.3.5 Filtration, Washing, Drying and Ignition of Precipitate
Unit III	**Basic Concepts in Instrumental Methods (10L)**
3.1 **3.2** **3.3**	3.1 Relation between the Analyte, Stimulus and measurement of change in the observable property. 3.2 Block Diagram of an Analytical Instrument. 3.3 Spectrometry 3.3.1 Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy 3.3.2 Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorptivity 3.3.3 Statement and derivation of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer Lambert's Law 3.3.4 Validity and Deviations from Beer-Lambert's Law (Numerical problems based on BeerLambert's Law) 3.3.5 Block Diagrams for Single beam and double beam Colorimeter (Principle, Construction and working (Details of Components expected, i.e. source, Sample holder, Filter, Detectors)

RUSCHMJP3 : Chemistry Practical III

Course/ Paper Title	**Chemistry Practical III**
Course offered as	Major
Type	Practical
Course Code	RUSCHMJP3
Semester	3
No. of Credits	2
No. of lecture Hours/week	4 hours practical /week

Course Objectives (CO):

CO 1	To understand the principles of conductometry and its application
CO 2	To study kinetics of a reaction using volumetric technique
CO 3	Learn method of organic synthesis
CO 4	To review different qualitative tests used for detection of cations and their analytical separation.
CO 5	To have a basic understanding of the different glassware, devices and components of optical instruments.
CO6	To gain knowledge of the handling and application of colorimetry.
CO 7	To learn basic techniques in gravimetry for quantitative analysis.

Course Outcomes (OC) :

	On completing the course, the student will be able to:
OC 1	Understand the applications of conductometry to verify Ostwalds dilution law and to calculate solubility of sparingly soluble salt
OC 2	analyze the rate of reaction and calculate the order of reaction
OC 3	To prepare organic derivatives from the given compound.(4 compounds)
OC 4	To detect cations present in a mixture and carry out an analytical separation.(4 mixtures)
OC 5	To describe different glassware, devices and components of optical instruments.
OC 6	To perform gravimetric estimation of a given sample.
OC 7	To use a colorimeter for quantitative analysis.

RUSCHMJP3 : Chemistry Practical III

Physical Chemistry : (No. of Experiments : 3)

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine solubility of sparingly soluble salts conductometrically. (any two)
3. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants.

Inorganic Chemistry (No. of Experiments 4):

Identification of 2 cations in a given mixture. (4 mixtures)

Organic Chemistry (No. of Experiments : 4)

1) Determination of chemical type, separation and purification of organic binary mixture. (Minimum 4)
2) To prepare Acetanilide from Aniline

Analytical Chemistry (No. of Experiments : 4)

1. Tools of Analytical Chemistry - I
    a) Diagram and function of Analytical glassware like burettes, pipettes, Standard flasks, Separating funnels.
    b) Principle of Incineration devices: Burners, Electrical Incinerators, Muffle Furnace, Drying Devices: Hot Air Oven, microwave oven, Desiccators.
2. Tools of Analytical Chemistry – II

    Principle, Construction and uses of Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes
3. Gravimetric estimation of nickel (II) as Ni-DMG and calculation of % error
4. Colorimetric estimation of Fe^{2+} using 1,10 - phenanthroline.

Minor Paper : General Chemistry -I

Course/ Paper Title	General Chemistry - I
Course offered as	Minor
Type	Theory
Course Code	**RUSCHMN301**
Semester	3
No. of Credits	2
No. of lecture Hours/week	2 hour

Course Objectives (CO):

Sr No.	**Course Objectives: (RUSCHMN301)**
CO 1	To Classify polymers based on their source, thermal response, and physical properties
CO2	Understand and calculate the various molecular weights of polymers.
CO3	Learn pH and pH Scale, Hendersons equation for buffer solution
CO 4	To enable an understanding about the different aspects of air pollution.
CO 5	To emphasize on the principles of redox reactions and their applications

Course Outcomes (OC) :

	On completing the course, the student will be able to:
CO1	To classify polymers and understand LEP
CO2	Calculate molecular weights
CO3	calculate ratio of reagents required for preparation of buffer solution using Hendersons equation
CO4	To elaborate on the air pollution aspects and different air pollution case studies
CO5	To interpret different redox reactions and their applications in chemistry

Paper I : RUSCHMN301: General Chemistry - I

Unit I	Physical Chemistry (8 L)
1.1	**Polymer Chemistry – I (4L)** 1.1.1 Basic Terms: Macromolecule, monomer, repeat unit, Polymerisation, (addition and condensation polymerization) Degree of Polymerisation 1.1.2 Classification of Polymer based on source, thermal response. Physical properties. Polymer structures linear, branched and cross-linked 1.1.3 Molecular weight of Polymers: Definition and formulae of Number average molecular weight, weight average molecular weight Z- average molecular weight, and viscosity average molecular weight. (numerical expected)
1.2	**pH and Buffer solutions: (4L)** pH, pH scale, type of buffers, Henderson's equation (for acidic and basic buffers), Buffer action and capacity
Unit II	**Inorganic Chemistry (7L)**
2.1	**Environmental Chemistry:** Air Pollution : Definition,Scope, Significance and Case Histories
2.2	**Redox Chemistry:** Reduction potentials, Redox potentials Half reactions,balancing redox reactions, Applications of redox chemistry: Redox reagents in Volumetric analysis a) Iodine b) $KMnO_4$
Unit III	**Organic Chemistry (8L)**
3.1	**Classification of organic reactions(6L)** 3.1.1 **Classification of reagents:** oxidizing reagents and reducing agents, nucleophilic and electrophilic reagents, free radical initiators, Classification based changes in substrate: addition, elimination, substitution, rearrangement, complexation(coordination) with examples 3.1.2 **Classification based upon the reaction pathways**: polar- non polar reactions, pericyclic reactions, oxidation reduction with examples
3.2	**3.2.1 Adsorption and coordination catalysts: (2L)**
Unit IV	**Analytical Chemistry (7L)**
4.1	**4.1. Introduction to Analytical Chemistry [04 L]** 4.1.1. Important terms used in Analytical Chemistry. 4.1.2. Purpose of Chemical Analysis; Analysis Based on (i) the nature of information required:(Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and microanalysis) 4.1.3. Classical and Non-Classical Methods of Analysis; their types and Importance.

	4.2. Results of Analysis [03 L] 4.2.1. Errors in Analysis and their types i) Determinate Errors ii) Indeterminate Errors 4.2.2 Methods of minimizing Determinate errors in analysis i) Calibration of apparatus ii) Carrying out Control determination iii) Carrying out Blank determination

RUSCHMNP1 : Chemistry Practical -I

Course/ Paper Title	**Chemistry Practical**
Course offered as	Minor
Type	Practical
Course Code	RUSCHMNP1
Semester	3
No. of Credits	2
No. of lecture Hours/week	4 hours practical /week

Course Objectives (CO):

CO 1	Learn to set up Daniell cell and emf measurement using potentiometer
CO 2	To study kinetics of a reaction using volumetric technique
CO 3	To enable an understanding of the different types of redox reagents in redox titrations
CO 4	To give an overview of different types of air pollution monitors
CO 5	To have a basic understanding of the different glassware, devices and components of optical instruments.
CO 6	To gain knowledge of the handling and application of colorimetry.
CO 7	To learn basic techniques in titrimetry and gravimetry for quantitative analysis.

Course Outcomes (OC):

	On completing the course, the student will be able to:
OC 1	calculate the emf and free energy change of Daniell cell
OC 2	analyze the rate of reaction and calculate the order of reaction
OC 3	To perform different types of redox titrations.
OC 4	To construct an air pollution monitor
OC 5	To describe different glassware, devices and components of optical instruments.
OC 6	To perform gravimetric estimation of given sample.
OC 7	To use colorimeter for quantitative analysis.

RUSCHMNP1 : Chemistry Practical -I

Physical Chemistry : (No. of Experiments : 3)

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically.
3. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants.

Inorganic Chemistry (No. of Experiments : 4)

1) To estimate the amount of Iron by redox Titration Of Fe(III) with $K_2Cr_2O_7$
2) To estimate the amount of Hydrogen peroxide by redox titration with $KMnO_4$
3) To estimate the amount of I_2 by redox titration with $KMnO_4$
4) Air Pollution Monitor

Organic Chemistry (No. of Experiments : 3)

1) Preparation of aspirin from salicylic acid
2) Estimation of Ibuprofen
3) Sap value of commercial vegetable oil

Analytical Chemistry (No. of Experiments : 4)

1. **Tools of Analytical Chemistry - I**

   i) Diagram and function of Analytical glassware like burettes, pipettes, Standard flasks, Separating funnels.

   ii) Principle of Incineration devices: Burners, Electrical Incinerators, Muffle Furnace; Drying Devices: Hot Air Oven, microwave oven, Desiccators, Vacuum desiccators

2. **Tools of Analytical Chemistry - II**

   Principle, Construction and uses of Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes

3. Estimation of acid content in the given sample by neutralisation titration
4. Determination of % composition of sodium carbonate and bicarbonate in the given sample gravimetrically.
5. Colorimetric estimation of Fe^{2+} using 1,10 - phenanthroline.

Semester III - SEC 2: Laboratory Safety and Reagent Preparation

Course/ Paper Title	**Laboratory Safety and Reagent Preparation**
Course offered as	Skill Enhancement Course
Type	Practicals
Course Code	**RUSCHSECP2**
Semester	3
No. of Credits	2
No. of Practicals Hours/week	4 hour

Course Objectives (CO):

Sr No.	**Course Objectives: (RUSCHSECP301)**
CO 1	To give an understanding of the experimental concepts, procedures, and safety procedures of a chemistry laboratory.
CO 2	To give training in use of reagents and their preparation

Course Outcomes (OC):

	On completing the course, the student will be able to:
CO1	handle chemicals with due precautions
CO2	prepare lab reagents required for day today requirements

RUSCHSECP2 PRACTICALS (SEC - II)

No. of experiments: 12

Laboratory Safety - II

Rules and Regulations:

1) General rules and regulations for lab safety: Minimizing Risks of Hazards, Personal Protective Equipment (PPE) - Hair, Dressing for the Laboratory, Eye Protection, Eyewash fountain, Gloves,
2) Laboratory Protocols, Labeling Chemicals, Careful reading of labels Prevention of Inhaling Harmful Chemicals, Guide to Chemical Hazards, Chemical Spills etc,. Accidents use of fire extinguisher and first aid kit in the laboratory, safety symbols- Preparation of the charts by the students and display of chats in chemistry labs. -
3) Preparation of dilute solutions (Numerical problems). Precautions to be taken in the preparation of dilute acids and bases.
4) Preparation of stock solutions of salts ,with specific examples. (Any Two)
5) Preparation of standard solutions. (any two)
6) Good laboratory practices- maintenance of observation book records.

Preparation of Lab Reagents:

1) Acid base titrations, redox titrations, precipitation titrations and complexometric titrations(Phenolphthalein, Methyl orange, Methyl-red, Potassium Chromate, Diphenylamine, EBT, Murexide, etc)
2) Preparation of buffers - pH 10 ammonical buffer and acetate buffer solutions.
3) Preparation of commonly used reagents :
    1. Ammonium hydroxide solution, Ammonium molybdate reagent, Ammonium hydrogen phosphate solution,
    2. Bayer's reagent, Benedict's solution, Bromine water
    3. Dimethyl glyoxime reagent, 2,4-Dinitrophenyl hydrazine reagent,\
    4. Eriochrome black-T reagent, Fehling solution, Ferric chloride solution, Ferrous sulphate solution,
    5. Iodine solution, Nessler's reagent, Neutral $FeC1_3$,
    6. Schiff's reagent, Silver nitrate solution, Sodium carbonate solution , Sodium hydroxide (Caustic soda) solution, Starch solution,
    7. Tollen's reagent.

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Physical Chemistry :

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7. Paula Y Bruice, Organic Chemistry, 7th Ed, Pearson education, Asia.2014
8. Graham Solomon, Fryhle, Dnyder, Organic Chemistry, Wiley publication. 12 th Ed,2016
9. Bahl and Bahl, Advanced Organic chemistry by S. Chand publication.2010
10. Peter Sykes. Guidebook to the mechanism in Organic chemistry ,6th edition
11. D. Nasipuri. Stereochemistry of Organic Compounds, Principles and Applications, Second Edition
12. Laboratory Experiments in Chemistry I & II, University Practical Book of Chemistry, University of Mumbai.
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Analytical Chemistry

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R.Crouch
2. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr.;Dean,J.A.; Settle,7th Edition
3. Fundamental of Analytical Chemistry Douglas.Skoog,West,F.JamesHoller,S.R. Crouch
4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education
5. Basic Concepts of Analytical Chemistry, S.M. Khopkar, IInd Edition New Age International Publisher
6. Analytical Chemistry, Gary D. Christan, VIth Edition, Wiley Students Edition
7. Modern Analytical Chemistry, David Harvey
8. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Shm K. Anand
9. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition
10. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118 181.
11. A.I. Vogel."Text book of Quantitative Inorganic Analysis", Longman, London (1961).
12. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B. BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.

SEMESTER IV

Course/ Paper Title	**Physical and Inorganic Chemistry - II / Paper 1 : MJ 1**
Course offered as	Major
Type	Theory
Course Code	RUSCHMJ401
Semester	4
No. of Credits	2
No. of lecture Hours/week	2 hours

Course Objectives (CO):

CO 1	To understand and apply the concept of electrode potentials and their use in electrochemical analysis.
CO 2	To understand the criteria for phase equilibrium and apply Gibbs Phase Rule to various systems.
CO 3	To understand the role of acid-base catalysts and enzyme catalysis in chemical reactions and how they influence the reaction mechanism.
CO 4	To give an overview of the transition elements with respect to their position in the periodic table and their characteristic properties
CO 5	To introduce the study of coordination compounds with reference to their properties and applications

Course Outcomes (OC) :

	On completing the course, the student will be able to:
CO 1	explain how electrochemical cells work and their practical applications
CO 2	develop a clear understanding of the criteria for phase equilibrium and apply Gibbs Phase Rule to different systems
CO 3	describe the mechanisms and kinetics of acid-base catalyzed reactions and Michaelis Menten Equation
CO 4	To demonstrate an understanding about the transition elements with reference to their position in the periodic table and their properties.
CO 5	To interpret the properties of coordination compounds with reference to nomenclature ,isomerism, structure.

Paper I: RUSCHMJ401: Physical and Inorganic Chemistry -II

Unit I	Physical Chemistry
1.1	**Electrochemistry-III: (8 L)** 1.1.1 Electrochemical cells, Nernst equation and its importance in generating electricity through chemical reactions. Types of electrochemical cells - Reversible and irreversible cells (Definition, example, characteristics) 1.1.2 Types of electrodes, Standard electrode potential, Electrochemical series. 1.1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. 1.1.4 Calculation of equilibrium constant and pH measurement using Hydrogen electrode and quinhydrone electrode from EMF data. (Numericals to be solved wherever necessary)
1.2	**Phase Equilibria: (7L)** 1.2.1 Introduction to Phase equilibria, Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule. 1.2.2 Derivation of Clapeyron and Clausius – Clapeyron equation and its importance in phase equilibria. 1.2.3 Phase diagrams of one-component systems (water and sulphur). 1.2.4 Two-component systems involving eutectics – Condensed Phase rule, Definition of eutectic Phase diagram of Lead-Silver system. (Numericals to be solved wherever necessary)
1.3	**Catalysis : (5 L)** 1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation 1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH. 1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation)
Unit III	**Inorganic Chemistry (10L)**
3.1	**Comparative Chemistry of Transition elements** Position in the periodic table and electronic configuration of First to fourth Trnsition series. Properties of Transition elements with reference tofirst transition series 1) Oxidation states 2) Magnetic Property 3) Color 4) Ability to form complexes
3.2	**Introduction to Coordination Chemistry** Basic Terms and Nomenclature,Theories of Coordination Compounds: Werner's coordination theory, Effective atomic number rule,Eighteenelectron rule,Isomerism in coordination compounds Valence bond theory to explain metal ligand bond in complex with coordination number 4, 5 and 6 Applications of coordination compounds

Paper II: RUSCHMJ402: Organic and Inorganic Chemistry -II

Course/ Paper Title	Physical and Inorganic Chemistry -II / Paper 2 : MJ 402
Course offered as	Major
Type	Theory
Course Code	RUSCHMJ402
Semester	4
No. of Credits	2
No. of lecture Hours/week	2 hours

Course Objectives (CO):

CO 1	To understand the different methods of preparation and reactivity of organic acids
CO 2	To understand the chemistry of heteroatom based organic compounds.
CO 3	To give an understanding of different acid base concepts and their applications

Course Outcomes (OC) :

	On completing the course, the student will be able to:
CO 1	To explain the concept of reactivity and reactions of organic acids and bases.
CO 2	To know the importance of heterocyclic compounds and their chemistry .
CO 3	To classify different types of acids and bases on the basis of their characteristics

Paper II : RUSCHMJ402: Organic and Inorganic Chemistry -II

Unit I	Organic Chemistry (10 L)
1.1	**Carboxylic acid and their derivatives. (5L)** General reactivity , preparation and reactions((esterification salt formation , amide , decarboxylation, anhydride) **Sulphonic acid:(2L)** General reactivity and preparation. Applications of carboxylic acids and sulphonic acids.
1.2	**Stereochemistry: (3L)** Nomenclature of two and more chiral center asymmetric compound, resolution of racemic mixtures
Unit II	**Organic Chemistry (10L)**
2.1	**Amines:** (4L) Nomenclature, Methods of preparation by Hoffmann Bromamide degradation, Reductive amination, reduction of Cyanide and nitro compounds. Basicity and salt formation. Reaction: Action of nitrous acid, N-acylation, N-Alkylation, Hofmann's elimination. Electrophilic substitution reactions (Bromination, Nitration and sulphonation)

2.2	**Diazonium salt: preparation and general reaction (2L)**
2.3	**Heterocyclic compounds: (4L)** Classification and naming of S/O/N containing 5/6 membered Heterocycles. Synthesis of Pyridine, Pyrrole, Furan and Thiophene. Reaction of Pyridine-Electrophilic substitution, ChiChibabin reaction. Furan/ Pyrrole / Thiophene -Electrophilic substitution reaction, Diels-Alder reaction(only for Furan), Vilsmeier Haack reaction.
Unit III	**Inorganic Chemistry (10L)**
3.1	**Acid- Base Theories:** Arrhenius ,Lowry- Bronsted ,Lewis ,Solvent -Solute concept of acids and bases.Usanovich Concept,Hard and Soft acids and bases,Applications of HSAB
3.2	**Acidity of Cations and Basicity of anions** Hydration of cations, Hydrolysis of cations predicting degree of hydrolysis of cations,effect of charge and radius,Latimer equation, Relationship etween pka,acidity and z2/r ratios of metal ion,Classification of cations and anions on the basis of acidity and basicity , predominance diagram.

Paper III : RUSCHMJ403: Analytical Chemistry -II

Course/ Paper Title	**Analytical Chemistry-II / Paper 3**
Course offered as	Major
Type	Theory
Course Code	RUSCHMJ403
Semester	4
No. of Credits	2
No. of lecture Hours/week	2

Course Objectives (CO):

CO 1	To understand the importance of separation in sample treatment.
CO 2	To learn about the various methods of separation.
CO 3	To gain knowledge of the techniques involved in solvent extraction, paper chromatography and thin layer chromatography.
CO 4	To know the basic principle of potentiometry and pH metry.
CO 5	To know the basic principle and applications of conductometry.
CO 6	To learn about the use of statistics in analysis.

Course Outcomes (OC) :

	On completing the course, the student will be able to:
OC 1	To explain the importance and types of separation methods.
OC 2	To discuss the principle of solvent extraction and calculate percentage extraction.
OC 3	To describe the principle, technique and applications of paper chromatography and thin layer chromatography.
OC 4	To explain the principle of potentiometry and pH metry.
OC 5	To explain the principle and applications of conductometry.
OC 6	To apply statistical tools for analysis of data.

Paper III : RUSCHMJ403: Analytical Chemistry -II

Unit I	**Separation Techniques in Analytical Chemistry (10 L)**
1.1	**1.1. Introduction to Analytical Separations and its importance in analysis. [02L]** **1.2. Types of separation methods** 1.2.1. Based on Solubilities (Precipitation, Filtration Crystallisation) 1.2.2. Based on Gravity-Centrifugation 1.2.3. Based on volatility-Distillation; 1.2.4. Based on Electrical effects-Electrophoresis 1.2.5. Based on retention capacity of a Stationary Phase -Chromatography; 1.2.6. Based on distribution in two immiscible phases-Solvent Extraction **1.3 Solvent extraction [03L]** 1.3.1 Introduction 1.3.2 Nernst distribution Law, Distribution Ratio, Partition Coefficient and Separation factor. 1.3.3 Single-step and multistep extraction, Percentage extraction (Numericals expected) **1.4 Chromatography: [05L]** 1.4.1 Introduction to Chromatography 1.4.2 Classification of chromatographic methods based on stationary and mobile phase 1.4.3 Paper Chromatography and Thin layer Chromatography i) Principle ii) Technique iii) Applications
Unit II	**Instrumental Methods of Analysis (10L)**
2.1	**2.1. Potentiometry (04L)** 2.1.1. Principle. 2.1.2. Role of Reference and indicator electrodes 2.1.3. Graphical methods for detection of endpoints i) Graph of EMF against Volume of titrant added ii) First derivative graph **2.2 pH metry (02L)** 2.2.1 Principle

	2.2.2 Construction and working of glass electrode **2.3. Conductometry (04L)** 2.3.1. Principle 2.3.2. Conductivity cell: Construction 2.3.3. Applications in Neutralization Titrimetry with respect to i. Strong Acid-Strong Base ii. Strong Acid-Weak Base iii. Strong Base-weak Acid iv. Weak Acid- Weak Base. 2.3.4. Advantages and limitations of conductometric titration.
Unit III	**Statistical treatment of analytical data (10L)**
3.1	**3.1. Distribution of random errors** 3.1.1. Gaussian distribution curve. 3.1.2. Equation and salient features of Gaussian distribution curve **3.2. Concept of Confidence limits and confidence interval and its computation using** (i) Student's test (ii) Range **3.3. Tests for rejection of doubtful result** (i) 2.5 d rule (ii) 4.0 d rule (iii) Q test **3.4. Graphical representation of data and obtaining best fitting straight line :** (i) For line passing through origin (ii) For line not passing through origin using Method of averages and Least Square method (Numerical problems expected)

RUSCHMJP4 : Chemistry Practical - IV

Course/ Paper Title	**Chemistry Practical -IV**
Course offered as	Major
Type	Practical
Course Code	RUSHMJP401
Semester	4
No. of Credits	2
No. of lecture Hours/week	4 hours practical /week

Course Objectives (CO):

CO 1	Learn to use conductometer and potentiometer for chemical analysis
CO 2	To appraise about the different types of synthetic methods of complexes and quantitative methods for determination of metal ions by complexometry.
CO 3	to identify the functional group.
CO 4	To determine the structure of compounds and chemical characteristics of organic compounds.
CO 5	To have a basic understanding of the different apparatus, devices and electrodes used in the laboratory.
CO 6	To gain knowledge of the use and application of potentiometry, conductometry and pH metry.

Course Outcomes (OC) :

	On completing the course, the student will be able to:
OC 1	quantify weak acid using conductometric principles
OC 2	apply potetniometric principles to calculate free energy change, equilibrium constant, solubility product.
OC 3	To synthesis complexes and carry out quantitative estimation of metal ions by complexometry.
OC 4	To explain the different apparatus, devices and electrodes used in the laboratory.
OC 5	To use potentiometer and conductometer for quantitative analysis.
OC 6	To determine buffer capacity using pH meter.

RUSCHMJP4 : Chemistry Practical -IV

Physical Chemistry : (No. of Experiments : 4)

1. Estimation of acetic acid in a given sample conductometrically.
2. To determine ΔG^0 and equilibrium constant for cell reaction in the cell set up with copper and silver electrodes.
3. To determine the Solubility product and solubility of AgCl potentiometrically using chemical cell.
4. Determination of energy of activation of acid-catalyzed hydrolysis of methyl acetate.

Inorganic Chemistry (No. of Experiments : 4)

1) Inorganic Preparation of Nickel Dimethyl glyoxime using microscale technique
2) Inorganic Preparation of Tris (ethylenediamine) Nickel (II)
3) Complexometric Titration of Zn with EDTA
4) Complexometric Titration of Cu with EDTA

Organic Chemistry (No. of Experiments: 4)

1. Determination of chemical type, separation and identification of organic binary mixture components. (Minimum 3 Compounds)
2. To prepare para-Bromoacetanilide from acetanilide.

Analytical Chemistry (No. of Experiments : 4)

1) **Analytical tools - III**
   a. Filtration Flasks, Funnels, Separating Funnel, Distillation apparatus, Centrifuge machine
   b. Development chamber for chromatography
2) **Analytical tools – IV**
   a.Care and maintenance of Reference Electrodes, Indicator Electrodes, Conductivity cell, Combined Glass electrode
   b. Types of Salt Bridges and preparation of anyone salt bridge

3) Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically and calculation of % error.
4) Determination of buffer capacity of acidic buffer and basic buffer.

Minor Paper (RUSCHMN401) : General Chemistry -II

Course/ Paper Title	General Chemistry -II
Course offered as	Minor
Type	Theory
Course Code	**RUSCHMN401**
Semester	4
No. of Credits	2
No. of lecture Hours/week	2 hour

Course Objectives (CO):

Sr No.	**Course Objectives: (RUSCHMN401)**
CO 1	Introduce the fundamental laws of crystallography and classify different types of crystals based on structure.
CO2	To develop an understanding of crystal lattice systems, X-ray diffraction techniques, and their applications in determining crystal structures and Avogadro's number.
CO 3	To inculcate an understanding of general principles of metallurgy and the pyrometallurgy of Copper.
CO 4	To appraise about the different aspects of water pollution
CO 5	To know some of the natural flavours and pigment chemistry and synthetically important name reactions

Course Outcomes (OC) :

	On completing the course, the student will be able to:
OC 1	Explain the laws of crystallography and differentiate between simple cubic, face-centered cubic, and body-centered cubic lattices.
OC 2	Apply Bragg's law to interpret X-ray diffraction data and determine crystal structures of NaCl and KCl, Avogadro's number.
OC 3	To elaborate on the principles of metallurgical extraction with emphasis on pyrometallurgy of Copper.
OC 4	To discuss about water pollution and its control measures
OC 5	Illustrate the significance and occurrence of some naturally occurring colouring and flavouring compound . Discuss and Write synthesis of given compound

Minor Paper (RUSCHMN401) : General Chemistry -II

Unit I	Physical Chemistry (8 L)
1.1	**Solid State: (8L)** 1.1.1 Laws of Crystallography and Types of Crystals 1.1.2 Characteristics of simple cubic, face-centered cubic and body-centered cubic systems, interplanar distance in a cubic lattice (only expression for ratio of interplanar distances are expected) 1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected)
Unit II	**Inorganic Chemistry (7L)**
2.1	**Metallurgy:** Types of Metallurgies, General steps of metallurgy, Concentration of ore calcinations, roasting, reduction and refining. Metallurgy of Copper Occurrence, physicochemical principles, Extraction bof Copper from pyrites and refining by electrolysis
2.2	**Water Pollution :**Unique physical and chemical properties of water water quality standards and parameters, Turbidity-pH Dissolved Oxygen-BOD, COD, suspended solids and dissolved solids alkalinity, Hardness of water, Methods to convert hard water to soft water wastewater treatment
Unit III	**Organic Chemsitry (8L)**
3.1	**3.1.1 Synthetically important Name reactions (5L)** Hofmann Elimination, Williamsons Synthesis, Mannich reaction, Fries rearrangement, Knoevenagel reaction with examples
3.2	**3.1.2 Organic colours and flavours:** anthocyanins and flavonoids**(3L)**
Unit IV	**Analytical Chemistry (7L)**
	4.1 Classical Methods of Analysis. [03 L] **4.1.1 Titrimetric Methods** Terms involved in Titrimetric methods of analysis. Difference between primary and secondary standard. Types of titrimetry i)Neutralization (Acidimetry, alkalimetry) ii) Redox (Iodometry, Iodimetry,) iii) Precipitation iv) Complexometric titrations **4.1.2 Gravimetric analysis** Introduction and Principle of Gravimetric analysis Types of Gravimetric Methods i) Volatilisation gravimetry ii) Precipitation gravimetry

	4.2 Electroanalytical methods of analysis [04 L] **4.2.1 Potentiometry :** Principle **,** Graphical methods for detection of endpoints i) Graph of EMF against Volume of titrant added ii) First derivative graph **4.2.2 pH metry** : Principle , Construction and working of glass electrode

RUSCHMNP2 : Chemistry Practical - II

Course/ Paper Title	**Chemistry Practical - II**
Course offered as	Minor
Type	Practical
Course Code	RUSCHMNP2
Semester	4
No. of Credits	2
No. of lecture Hours/week	4 hours practical /week

Course Objectives (CO):

CO 1	To enable students to determine the concentration of a given sample of potassium permanganate ($KMnO_4$) using the colorimetric method, including the determination of λmax and the plotting of a calibration curve.
CO 2	To enable students to determine the concentration of hydrochloric acid (HCl) in a given sample using potentiometric titration
CO 3	To know about the different tests for determination of water quality parameters
CO 4	To have a basic understanding of the different apparatus, devices and electrodes used in the laboratory.
CO 5	To learn basic techniques in gravimetry for quantitative analysis.
CO 6	To gain knowledge of the use and application of pH metry.

Course Outcomes (OC) :

	On completing the course, the student will be able to:
OC 1	Determine the λmax for $KMnO_4$ through Visible spectroscopy and construct a calibration curve for $KMnO_4$ to determine the concentration of an unknown sample based on its absorbance
OC 2	Accurately determine the amount of HCl in a sample by performing a potentiometric titration and analyzing the titration curve to calculate the concentration.
OC 3	To assess quality of water samples on the basis of different water quality parameters
OC 4	To explain the different apparatus, devices and electrodes used in the laboratory.
OC 5	To perform gravimetric and titrimetric analysis of a given sample.
OC 6	To determine buffer capacity using pH meter.

Semester 4 : RUSCHMNP2 : Chemistry Practical -II

Physical Chemistry : (No. of Experiments : 3)

1. To determine concentration of given sample of $KMnO_4$ by colorimetric method (Learners are expected to determine λmax and plot calibration curve).
2. To determine the amount of HCl in the given sample potentiometrically
3. Determination of energy of activation of acid-catalyzed hydrolysis of methyl acetate.

Inorganic Chemistry (No. of Experiments : 4)

1) Estimation of Total hardness
2) Determination of alkalinity
3) Determination of TS, TDS, TSS
4) Determination of COD

Organic Chemistry (No. of Experiments: 4)

Identification of chemical type of binary organic mixture (4 mixtures)

Analytical Chemistry (No. of Experiments 4)

1) **Analytical tools III**
   a. Filtration Flasks, Funnels, Separating Funnel, Distillation apparatus, Centrifuge machine
   b. Development chamber for chromatography

2) **Analytical tools IV**

   a. Care and maintenance of Reference Electrodes, Indicator Electrodes, Conductivity cell, Combined Glass electrode
   b. Types of Salt Bridges and preparation of anyone salt bridge

3) Gravimetric estimation of Ba^{2+} as $BaCrO_4$
4) Determination of buffer capacity of acid buffer and basic buffer.

Semester IV : SEC III : Applied Commercial Analysis

Course/ Paper Title	Applied Commercial Analysis
Course offered as	Skill Enhancement Course -III
Type	Practicals
Course Code	**RUSCHSEC403**
Semester	4
No. of Credits	2
No. of Practicals Hours/week	4 hour

Course Objectives (CO):

Sr No.	Course Objectives: (RUSCHSEC 3)
CO 1	To introduce students to classical and instrumental methods of quantitative chemical analysis through titrimetric, potentiometric, and photometric techniques applied to commercial samples.
CO 2	To develop analytical and critical thinking skills by interpreting data and evaluating the quality and concentration of ingredients in commercial products.
CO 3	To train students in accurate experimental techniques and use of analytical instruments like pH meters, potentiometers, and flame photometers for routine laboratory applications

Course Outcomes (OC) :

	On completing the course, the student will be able to:
OC 1	perform titrimetric and instrumental analysis of commercial and pharmaceutical samples, interpret results, and compare with labeled claims or standard values.
OC 2	demonstrate proficiency in handling laboratory instruments such as potentiometers, pH meters, and flame photometers and apply them to determine specific analytes
OC 3	document experimental data scientifically, analyze sources of error

Semester IV : SEC 3: Applied Commercial Analysis

RUSCHSEC P3 - PRACTICALS

No. of experiments : 11

1) Commercial Analysis of Talcum Powder by titrimetry
2) Commercial Analysis of Bleach by titrimetry
3) Commercial analysis of Vinegar by titrimetry
4) Commercial analysis of caustic soda by titrimetry
5) Commercial analysis of antacids by titrimetry
6) To determine the amount of HCl in the given sample potentiometrically.
7) Estimation of acetic acid in Vinegar sample by using Quinhydrone electrode potentiometrically
8) Determination of Vitamin C content of a given tablet by pH meter.
9) Determination of glucose content of a honey sample by Wilstater's method
10) To determine potassium content of a Fertilizer by Flame Photometry (Calibration curve Method)
11) Determination of phosphoric acid in cola sample pH metrically.

Reference Books :

Physical Chemistry :

15) Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
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Inorganic Chemistry

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9. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
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M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
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1. Concise Graduate Chemistry – I, II, III & IV, University Text Book of Chemistry, University of Mumbai.
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Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994
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4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education
5. Basic Concepts of Analytical Chemistry, S.M. Khopkar, IInd Edition New Age International Publisher
6. Analytical Chemistry, Gary D. Christan, VIth Edition, Wiley Students Edition
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10. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118 181.
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Royal College of Arts, Science and Commerce

(Autonomous)

Theory Examination Pattern for

(Major / Minor)

I	**Internal Assessment**	
a	One class test (Short answers/Objectives/ Multiple Choice)	10
b	Assignment/ Project/ Presentation/Book or research paper Review/	10
	Total	20 marks
II	Semester End Examination	30 Marks
	Duration	1 hours

Question Paper Pattern (Major) :

30 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of **one hour** duration.
2. Theory question paper pattern:

a. There shall be **03** questions each of **10 marks** on each unit

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

Question	**Option**	**Marks**	**Questions Based on**
Q.1	A) Objective questions 4 out of 8	04	Uni I
	B) Subjective questions 2 out of 3	06	
Q.2	A) Objective questions 4 out of 8	04	Unit II
	B) Subjective questions 2 out of 3	06	
Q.3	A) Objective questions 4 out of 8	04	Unit III
	B) Subjective questions 2 out of 3	06	
	Total	**30**	

Evaluation Pattern for

Major/Minor/SEC Practical Course

Duration for End semester examination	External Assessment for Practical	50 Marks
3 hours	Experiment	30
	Viva	10
	Journal	10

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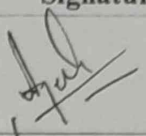
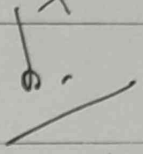
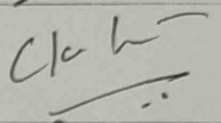
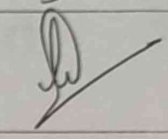
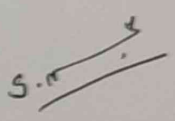
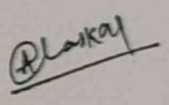
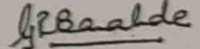
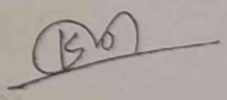
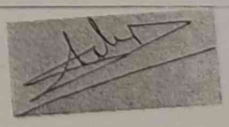
Board of studies in Chemistry

	Category	Name and Designation	Affiliation	Signature
1	Chairperson (Head of Department)	Dr. Aqeela A. S. Qureshi, Associate Professor	Royal College of Arts, Science and Commerce. Mira Road	
2	Internal BOS Members	Prof. Kalpana Patankar Jain. Principal	Royal College of Arts, Science and Commerce. Mira Road	
		Dr. Chitralekha Kotian Associate Professor		
		Dr. Gunwanti ~~Negi~~ Sinwal Assistant Professor		
		Dr. Vibha Bhagat Assistant Professor		
		Dr. Mustaqeem Mohammed - Assistant Professor		
3	External Subject Expert	Prof. Atul Chaska - Professor	Institute of Chemical Technology, Matunga , Mumbai.	
		Prof. Gayatri Barabde - Professor	**The Institute of Science, Mumbai** [Dr. Homi Bhabha State University (HBSU)]	
4	Vice-Chancellor Nominee	Prof. Krishnakant T. Waghmode	Ruparel College of Arts, Science & Commerce,	
5	Industry Representative	Shailesh G. Poojary - Chief Manager, Parle Quality Systems,Parle Products	Parle Products VS Khandekar Marg,Vile Parle East Mumbai-400057	
6	Postgraduate meritorious alumnus	Ms. Pratima Rajesh Yadav PhD. Scholar from ICT, Mumbai.	Institute of Chemical Technology , ,Nathalal Parekh Marg, Matunga, Mumbai – 400019