SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Department of Chemistry

Program: B.Sc.

Course: Chemistry

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

(Implemented from 2018 – 2019)

Credit Based Semester and Grading System

SEMESTER – I

Contents:		
Paper I	:	**General Chemistry**
SIUSCHE11.1	:	Chemical Thermodynamics and Chemical Calculations
SIUSCHE11.2	:	Atomic structure, periodic table and periodicity
SIUSCHE11.3	:	Basics of Organic Chemistry
Paper II	:	**General Chemistry**
SIUSCHE12.1	:	Chemical Kinetics and Liquid states
SIUSCHE12.2	:	Comparative chemistry of main group elements
SIUSCHE12.3	:	Stereochemistry – I
Practical		
SIUSCHE1P	:	Chemistry Practical

SEMESTER – II

Contents:		
Paper I	:	**General Chemistry**
SIUSCHE21.1	:	Gaseous state and Chemical equilibria
SIUSCHE21.2	:	Qualitative analysis and Acid Base theories
SIUSCHE21.3	:	Chemistry of aliphatic hydrocarbons
Paper II	:	**General Chemistry**
SIUSCHE22.1	:	Ionic equilibria, Molecular Spectroscopy and Solid State Chemistry
SIUSCHE22.2	:	Chemical bonding and chemistry of oxidation reduction reactions
SIUSCHE22.3	:	Stereochemistry - II and Aromatic Hydrocarbons
Practical	:	
SIUSCHE2P	:	Chemistry Practical

F.Y.B.Sc. Chemistry Syllabus

SEMESTER I

Course Code	Unit	Topics	Credits	L/Week
SIUSCHE11	1	**Chemical Thermodynamics and Chemical Calculations**	2	1
		1.1 Chemical Thermodynamics		
		1.2 Chemical Calculations		
	2	**Atomic structure, Periodic Table and Periodicity**		1
		2.1 Atomic structure		
		2.2 Periodic Table and Periodicity		
	3	**Basics of Organic Chemistry**		1
		3.1 Classification and nomenclature of organic compounds		
		3.2 Bonding and structure of organic compounds		
		3.3 Fundamentals of organic reaction mechanism		
SIUSCHE12	1	**Chemical Kinetics and Liquid states**	2	1
		1.1 Chemical Kinetics		
		1.2 Liquid state		
	2	**Comparative Chemistry of Main Group Elements**		1
		2.1 Comparative Chemistry of Main Group Elements		
	3	**Stereochemistry – I**		1
SIUSCHE1P		**Chemistry Practical**	2	6

Course Code: SIUSCHE11

Paper I

Credits: 2 Credits (45 Lectures)

Unit – 1, 1 L/Week		15 L
Course Code: SIUSCHE11.1 **LEARNING OBJECTIVES** 1. *To learn the concept of thermodynamics with respect to first law of thermodynamics.* 2. *To learn thermo-chemistry with respect to heats of various reactions, bond energy, bond dissociation and resonance energy.* 3. *To learn mole concept, concentration calculations and various stoichiometric relationships useful in quality control laboratories.*		
1 Chemical Thermodynamics and Chemical Calculations		**15 L**
1.1	**Chemical Thermodynamics:** **Thermodynamic terms:** System, surrounding, boundaries, open, closed and isolated system, intensive and extensive properties, state functions and path functions, zeroth law of thermodynamics. **First law of thermodynamics:** Concept of heat (q), work (w), internal energy (U), statement of first law, enthalpy, relation between heat capacities, sign conventions, calculations of heat (q), work (w), internal energy (U) and enthalpy (H), Statement of second law of thermodynamics, concepts of entropy and free energy, spontaneity and physical significance of free energy. **Thermochemistry:** Heats of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchoff's equation. (Numericals expected from the above unit)	**10 L**
1.2	**Chemical Calculations:** Expressing concentration of solutions: Normality, molality, molarity, formality, mole fractions, weight ratio, volume ratio, weight to volume ratio, ppm, ppb, millimoles, milliequivalents. (Numericals expected from the above unit).	**5 L**

Unit – 2, 1 L /Week		**15 L**
Course Code: SIUSCHE11.2 **LEARNING OBJECTIVES** 1. *Reinforce the historical development that lead to our modern knowledge of the structure of the atom.* 2. *Enable the students to describe the principle features of the modern periodic table.* 3. *Outline the periodicity of element with respect to atomic and ionic radii, ionization energies, electron gain enthalpy and electronegativity.*		
2 Atomic structure, periodic table and periodicity		**15 L**
2.1	**Atomic structure:** (Qualitative treatment only; it is expected that the learner knows the mathematical - statements and understands their physical significance after completing this topic. No derivations of the mathematical equations required) Historical perspectives of the atomic structure, Rutherford's Atomic Model, Bohr's theory and its limitations. Atomic spectrum of hydrogen atom, structure of hydrogen atom and concept of quantum numbers. Hydrogenic atoms: Simple principles of quantum mechanics, Terms involved in Schrodinger wave equation, Atomic orbitals Hydrogenic energy levels: Shells, subshells and orbitals, electron spin, radial shapes of orbitals, radial distribution function and angular shapes of orbitals (s, p and d-orbitals). Many Electron Atoms: Penetration and shielding, effective nuclear charge, Aufbau principle, Pauli's Exclusion principle and Hund's rule.	**10 L**
2.2	**Periodic Table and periodicity:** Long form of Periodic Table; Classification for elements as main group, transition and inner transition elements. Periodicity in the following properties: Atomic and ionic size, electron gain enthalpy, ionization enthalpy, effective nuclear charge (Slater's rule), electronegativity, Pauling, Mulliken and Allred-Rochow electronegativities (Numerical problems expected, wherever applicable.)	**5 L**
Unit – 3, 1L /Week		**15 L**
Course Code: SIUSCHE11.3 **LEARNING OBJECTIVES** 1. *To know the rules for converting names of organic compounds into their structures and vice versa.* 2. *To learn the appropriate geometry of organic molecules through the concept of hybridization.*		

3. *To learn the stability of organic species with the help of various electronic effects and their applications in studying organic reaction mechanism.*		
3 Basics of Organic Chemistry		**15 L**
3.1	**Classification and Nomenclature of Organic Compounds :** Review of basic rules of IUPAC nomenclature. Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds: alkanes, alkenes, alkynes, halo alkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids and its derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines, including their cyclic analogues.	**5 L**
3.2	**Bonding and Structure of organic compounds :** Overlap of atomic orbitals: Overlaps of atomic orbitals to form sigma and pi bonds. Hybridization: sp^3, sp^2, sp hybridization of carbon and nitrogen; sp^3 and sp^2 hybridization of oxygen in organic compounds (alcohol, ether, aldehyde, ketone, carboxylic acid, ester, cyanide, amine and amide), shapes and geometry of organic molecules. Shapes of molecules, Influence of hybridization on bond properties (as applicable to ethane, ethene, ethyne).	**4 L**
3.3	**Fundamentals of organic reaction mechanism:** Electronic Effects: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications, dipole moment, organic acids and bases, their relative strengths. Bond fission: Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles, Nucleophilicity and basicity. Carbocations, Carbanions and Free radicals: Types (primary, secondary, tertiary, allyl, benzyl), their shape and relative stability. **Introduction to types of organic reactions:** Addition, Elimination, Substitution reactions and Rearrangement reactions.(one example of each).	**6 L**

Course Code: SIUSCHE12

Paper II

Credits: 2 Credits (45 Lectures)

Unit – 1, 1 L /Week		**15 L**
Course Code: SIUSCHE12.1 **LEARNING OBJECTIVES** 1. *To learn the rate of a chemical reaction, factors affecting it and its mechanism.* 2. *Concept of order and molecularity of a reaction and their determination.* 3. *To learn the physical properties of liquids such as surface tension, viscosity and refractive index.* 4. *Liquid crystals: classification, properties and their applications.*		
1 Chemical Kinetics and Liquid states		**15 L**
1.1	**Chemical Kinetics:** Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, integrated rate equation of first order reaction and integrated rate of second order reactions (with equal initial concentration of reactants) . Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method. Concept of Energy of Activation, Arrhenius factor. (Numericals expected from the above unit)	**8 L**
1.2	**Liquid State:** Surface tension: Introduction, methods of determination of surface tension by drop number method. Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer. Refractive index: Introduction, molar refraction and polarizability, determination of refractive index by Abbe's refractometer. Liquid crystals: Introduction, classification and structure of thermotropic phases (Nematic, smectic and cholesteric phases), applications of liquid crystals. (Numericals expected from the above unit)	**7 L**
Unit – 2, 1 L /Week		**15 L**
Course Code: SIUSCHE12.2 **LEARNING OBJECTIVES**		

1. *To study the trends of properties of the 's' and 'p' block elements.* 2. *To study the reactions of s-block elements with non-metals.* 3. *To create an awareness about the importance of protection and conservation of our environment.* 4. *To curtail the human activities which leads to the indiscriminate release of air pollutants into the environment.*		
2 Comparative Chemistry of Main Group Elements		**15 L**
2.1	**Comparative chemistry of Main Group Elements:** Metallic and non-metallic nature, oxidation states, inert pair effect, anomalous behaviour of second period elements, allotropy, catenation, diagonal relationship. Comparative chemistry of carbides, nitrides, oxides and hydrides of group I and group II elements. Some important compounds - $NaHCO_3$, Na_2CO_3, NaCl, NaOH, CaO, $CaCO_3$. Oxides of carbon, oxides and oxyacids of sulphur and nitrogen with respect to environmental aspects.	**15 L**
Unit – 3, 1 L/Week		**15 L**
Course Code: SIUSCHE12.3 **LEARNING OBJECTIVES** 1. *To draw the configuration of organic molecules in various projection formulas and interconvert them.* 2. *To recognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers, diastereomers, geometrical isomers, racemic mixture, and meso compounds.* 3. *To Identify the stereocenters in a molecule and assign the configuration as D/L and R or S.*		
3 Stereochemistry – I		**15 L**
3.1	**Stereochemistry I:** Isomerism: Types of isomerism: constitutional isomerism (chain, position and functional) and stereoisomerism. Representation of configuration by Flying wedge, Fischer, Newman and Sawhorse Projection formulae. The interconversion of the formulae using suitable examples. Geometrical isomerism in alkene and cycloalkanes: cis–trans and syn-anti isomerism E/Z notations with CIP rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two similar and dissimilar chiral-centres, diastereoisomers, meso structures, erythro, threo, racemic mixture and resolution (methods of resolution not expected). Relative and absolute configuration: D/L and R/S designations.	**15 L**

SUGGESTED REFERENCE SIUSCHE11.1 & SIUSCHE12.1

1. A text book of Physical Chemistry by K. L. Kapoor.
2. Essentials of Physical Chemistry by B.S. Bahl, Arul Bahl and G.D. Tuli.
3. Chemical Kinetics by Keith J. Laidler.
4. Mathematical preparation for Physical Chemistry by F. Daniel.
5. Principle of Physical Chemistry by Maron and Pruton.
6. Textbook of physical chemistry, 2nd Edition by Samuel Glasstone.

SUGGESTED REFERENCE SIUSCHE11.2 & SIUSCHE12.2

1. J. Barrett and A. Malati, 'Fundamentals of Inorganic Chemistry', East-West Press Edition(2006)
2. C.M. Day and Joel Selbin, 'Theoretical Inorganic Chemistry', Affiliated East West Press Pvt. Ltd., (1985).
3. J.D. Lee, Concise 'Inorganic Chemistry', 5th edition, Blackwell Science Ltd., (2005).
4. James E. Huheey, 'Inorganic Chemistry', 3rd edition, Harper & Row, Publishers, Asia, Pte Ltd., (1983).
5. R.J. Gillespie and I. Hargittai, The VSEPR Model of Molecular Geometry, Dover Publication, (2012).
6. J. Barrett, 'Inorganic Chemistry in Aqueous Solutions'; The Royal Society of Chemistry (2003).
7. T. Moeller and R. O'Connor, 'Ions in Aqueous Systems'; McGraw-Hill Book Company, (1972).
8. Gary L. Miessler, Donald A. Tarr, St. Olaf College, Northfield, Minnesota. Pearson Prentice Hall
9. Inorganic Chemistry, Catherine E. Housecraft and Alan G. Sharpe. Pearson Prentice Hall.

SUGGESTED REFERENCE S SIUS CHE11.3 & SIUSCHE12.3

1. Organic Chemistry: S.H. Pine McGraw Hill. Kogakusha Ltd.
2. Organic Chemistry: John McMurry 5th Edition Cornell University.
3. Advance Organic Chemistry: Jerry March, Wiley Eastern Ltd.
4. A guide to IUPAC Nomenclature of Organic Compound,: Richer Interscience Publications.
5. Organic Chemistry: T.W.G. Solomons, C. B. Fryhle, 2000 John Wiley and Sons.
6. Organic Chemistry: Morrison and Boyd, Allyn & Bacon Inc.
7. Organic Chemistry: Francis A. Carey, 1996 3rd Ed. McGraw Hill.
8. Fundamentals of Organic Chemistry: G. Mare Loudon, 2002 4th Edition.
9. Reaction Mechanism: Peter Sykes, 1999 Orient Longman.
10. Organic Chemistry: Seyhan N. Ege, 1984. D. C. Heath & Co.
11. Organic Reactions with Mechanism: S.P. Bhutani, Ane book Pvt. Ltd.
12. Stereochemistry of Organic Compound: E. L. Eliel and S.H. Wilen, Wiley.
13. Stereochemistry: V.M. Potapov, Mir Publishers, Moscow.
14. Stereochemistry Conformation and Mechanism: P.S. Kalsi, Wiley Eastern Ltd.

15. Stereochemistry of Organic Compound: Principles and Applications: D. Nasipuri, Wiley Eastern Ltd.
16. Stereochemistry and Mechanism: David Whittaker, Oxford Chem. Series.

Course Code: SIUSCHE1P

Paper I, II

Credits: 2 Credits (45 Lectures)

PRACTICAL COURSE CHEMISTRY LABORATORY

Course Code: SIUSCHE1P

LEARNING OBJECTIVES

1. *To learn to perform experiments that has specific aims with correct techniques.*
2. *To develop skills of observation, recording and analyzing data.*
3. *To learn to present the experimental work in a systematic manner.*

Unit	Course Code: SIUSCHE1P1 (Paper – I)
P1.1	**Physical Chemistry** 1. Calibration of volumetric apparatus. 2. To determine the rate constant for the hydrolysis of ester using HCl as catalyst. 3. To determine enthalpy of dissolution of salt (like KNO_3). 4. To prepare 0.1 N succinic acid and standardize sodium hydroxide of two different concentrations.
P1.2	**Inorganic Chemistry** 1. Commercial analysis of (any two) a) Mineral acid b) Organic acid c) Salt of weak acid and strong base. 2. Titration using double indicator: analysis of solution of Na_2CO_3 and $NaHCO_3$.
	Course Code: SIUSCHE1P2 (Paper – II)
P2.1	**Inorganic Chemistry** 1. Gravimetric analysis a) To determine the percentage purity of sample of $BaSO_4$ containing NH_4Cl. b) To determine the percentage purity of ZnO containing $ZnCO_3$.
P2.2	**Organic Chemistry** 1. Purification of any two organic compounds by recrystallization selecting suitable solvent. (Provide 1g.). **Learners are expected to report** a) Solvent for recrystallization.

	b) Mass and melting points of purified compound. **Learners should calibrate thermometer before determination of the melting point.** 2. Chromatography (Any one) a) Separation of a mixture of two sugars by ascending paper chromatography. b) Separation of a mixture of o-and p-nitrophenol by thin layer chromatography (TLC).

SUGGESTED REFERENCE SIUSCHE1P

1. Fundamental of Analytical Chemistry – Skoog D.A. and West D.M. Saunders, College Publication.
2. Introduction to Instrumental Analysis, R. D. Brown, McGraw Hill.
3. Instrumental Methods of Analysis, H. H. Willard, L. L. Meritt and J. A. Dean, Affiliated East-West Press.
4. Quality in the Analytical Chemistry laboratory –Neil T. Crosby, Florence Elizabeth Prichard, Ernest J. Newman – John Wiley & Sons Ltd.
5. Principles and Practice of Analytical Chemistry-Fifield F.W. and Kealey D., Black well Science.
6. Analytical Chemistry, Christian, WSE / Wiley.
7. Basic concepts of Analytical Chemistry, S. M. Khopkar, New Age International (P) Ltd.
8. Quantitative Analysis, R.A Day & A.L. Underwood, Prentice Hall Publication.
9. Chemical Analysis in the laboratory - A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry.
10. Textbook of Quantitative Inorganic Analysis -Vogel A.I.

Section A. P1 and P2 are regular experiments.

Section B. List of Demo experiments: (minimum 01)

1. To study technique of pipetting.
2. To determine the viscosity of liquid by Ostwald viscometer.

Section C. Any one out of the following is compulsory.

1. Students should collect the information of at least five Nobel Laureates in Chemistry with their work. Students should submit detailed report.
2. Students who participate in the study tour must submit report.

SUGGESTED REFERENCE SIUSCHE1P

1. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M. Saunders, College Publication.

2. Introduction to Instrumental Analysis, R. D. Brown, McGraw Hill.
3. Instrumental Methods of Analysis, H. H. Willard, L. L. Meritt and J. A. Dean, Affiliated East-West Press.
4. Quality in the Analytical Chemistry laboratory –Neil T. Crosby, Florence Elizabeth Prichard, Ernest J. Newman – John Wiley & Sons Ltd.
5. Principles and Practice of Analytical Chemistry-Fifield F.W. and Kealey D, Black well Science.
6. Analytical Chemistry, Christian, WSE / Wiley.
7. Basic concepts of Analytical Chemistry, S. M. Khopkar, New Age International (P) Ltd.
8. Quantitative Analysis, R.A Day & A.L Underwood, Prentice Hall Publication.
9. Chemical Analysis in the laboratory –A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry.
10. Textbook of Quantitative Inorganic Analysis -Vogel A.I., 5th Edition.

F.Y.B.Sc. Chemistry Syllabus

SEMESTER II

Course Code	Unit	Topics	Credits	L/Week
SIUSCHE21	1	**Gaseous State and Chemical Equlibria**	2	1
		1.1 Gaseous State		
		1.2 Chemical Equilibria		
	2	**Qualitative Analysis and Acid Base Theories**		1
		2.1 Concept of Qualitative Analysis		
		2.2 Acid Base Theories		
	3	**Chemistry of Aliphatic Hydrocarbons**		1
		3.1 Carbon-Carbon sigma bonds		
		3.2 Carbon-Carbon pi bonds		
		3.3 Reactions of alkynes		
SIUSCHE22	1	**Ionic equilibria, Molecular Spectroscopy and Solid State Chemistry**	2	1
		1.1 Ionic Equilibria		
		1.2 Molecular Spectroscopy		
		1.3 Solid State Chemistry		
	2	**Chemical bonding and chemistry of oxidation reduction reactions**		1
		2.1 Chemical bond and Reactivity		
		2.2 Chemistry of oxidation reduction reactions		
	3	**Stereochemistry - II and Aromatic Hydrocarbons**		1
		3.1 Stereochemistry-II: Conformational Analysis of alkanes and cycloalkanes		
		3.2 Aromatic Hydrocarbons		
SIUSCHE2P		**Chemistry Practical**	2	6

Course Code: SIUSCHE21

Paper I

Credits: 2 Credits (45 Lectures)

Unit – 1, 1 L/Week		15 L
Course Code: SIUSCHE21.1 **LEARNING OBJECTIVES** 1. *To study different gas laws, concept of compressibility factor and van der Waal's equation of state.* 2. *To study reversible and irreversible reactions, concept of equilibrium constant and Le Chatelier's principle.*		
1 Gaseous State and Chemical Equlibria		**15 L**
1.1	**Gaseous State:** Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), ideal gases, real gases, compressibility factor, Boyle's temperature (Numericals expected). Deviation from ideal gas laws, reasons for deviation from ideal gas laws, van der Waals equation of state, Joule-Thomson effect: qualitative discussion and experimentation, inversion temperature. (Numericals expected).	**10 L**
1.2	**Chemical Equilibria:** Reversible and irreversible reactions, law of mass action, dynamic equilibria, equilibrium constant (Kc and Kp), relationship between Kc and Kp, Le Chatelier's principle, factors affecting chemical equilibrium (Numericals expected)	**5 L**
Unit – 2, 1 L/Week		**15L**
Course Code: SIUSCHE21.2 **LEARNING OBJECTIVES** 1. *To curtail wastage of chemical reagents with the knowledge of various techniques involved during qualitative analysis with reference to the role of impregnated test papers.* 2. *To study the concepts and roles of various factors to be considered during qualitative analysis with numerical applications.* 3. *To study the various theories of acid and base.*		
2 Qualitative Analysis and Acid Base Theories		**15 L**
2.1	**Concept of Qualitative Analysis:**	**7 L**

	Types of qualitative analysis: Macro analysis, semi-micro analysis, micro analysis and ultra-micro analysis. Testing of Gaseous Evolutes, Role of Papers impregnated with reagents in qualitative analysis (with reference to papers impregnated with starch iodide, potassium dichromate, lead acetate, dimethyl glyoxime and oxine reagents). Precipitation equilibria, effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds. (Balanced chemical equations and numerical problems expected.)	
2.2	**Acid Base Theories:** Arrhenius theory, Lowry-Bronsted concept, Lewis concept, Solvent-Solute system (autoionisation) concept of acids and bases, Lux Flood concept, Hard and Soft acids and bases (HSAB). Applications of HSAB concept. Applications of acid base chemistry in: i) Understanding organic reactions like Friedel Craft's (acylation/alkylation)reaction ii) Volumetric analysis with special reference to calculation of titration curve involving strong acid and strong base.	**8 L**
Unit – 3, 1 L/Week		**15L**
Course Code: SIUSCHE21.3 **LEARNING OBJECTIVES** 1. *To understand formation of organic compounds which involve cleavage and formation of sigma and pi bonds.* 2. *To study reactions of aliphatic hydrocarbon with their reaction mechanism.*		
3 Chemistry of Aliphatic Hydrocarbons		**15 L**
3.1	**Carbon-Carbon sigma bonds:** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions. Free radical substitutions: Halogenation -relative reactivity and selectivity.	**3 L**
3.2	**Carbon-Carbon pi bonds:** Formation of alkenes and alkynes by elimination reactions: Mechanism of E1, E2, reactions. Saytzeff and Hofmann rule. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), Mechanism of hydroboration-oxidation, ozonolysis, Reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2 and 1, 4 addition reactions in conjugated dienes and Diels-Alder reaction, Allylic and benzylic bromination using N-bromosuccinimide and mechanism e.g. propene, 1-butene, toluene, ethylbenzene.	**10 L**
3.3	**Reactions of alkynes:** Acidity of alkynes, Electrophilic and Nucleophilic addition reactions to alkynes, Hydration reactions of alkyne to form carbonyl compounds, Alkylation of terminal alkynes.	**2 L**

Course Code: SIUSCHE22

Paper II

Credits: 2 Credits (45 Lectures)

Unit – 1, 1 L/Week		**15 L**
Course Code: : SIUSCHE22.1 **LEARNING OBJECTIVES** 1. *To discern the concept of electrolytes, pH and its applications using Henderson equation for acidic and basic buffer solutions respectively* 2. *To figure out the interaction between EMR and matter employing different spectroscopic techniques* 3. *To have a clear idea of crystal structure, arrangement of constituent particles and their relevant properties.*		
1 Ionic equilibria, Molecular Spectroscopy and Solid State Chemistry		**15 L**
1.1	**Ionic Equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect and its applications, dissociation constants of mono-, di- and triprotic acid (exact treatment for monoprotic acid) (Numericals expected). Buffers: Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected).	**7 L**
1.2	**Molecular Spectroscopy:** Electromagnetic radiation, electromagnetic spectrum, Planck's equation, interaction of electromagnetic radiation with matter: Absorption, emission, scattering, fluorescence, electronic, vibrational and rotational transitions, Beer-Lambert's law (Numericals expected).	**4 L**
1.3	**Solid State Chemistry:** Types of solids, crystal lattice, lattice points, unit cell, space lattice and lattice plane. Laws of crystallography: Law of constancy of interfacial angle, law of symmetry and law of rational indices (Numericals expected).	**4 L**
Unit – 2, 1L/Week		**15 L**
Course Code: SIUSCHE22.2 **LEARNING OBJECTIVES** 1. *To classify various types of chemical bonding and identify the shapes of molecules using theories like valence bond theory, Sidgwick Powell theory, VSEPR theory.* 2. *To introduce the concept of isoelectronic principle.*		

3. *To have an idea of balancing of redox equation.* 4. *To study the concept of pH dependence of redox potential of species in water.*		
2 Chemical bonding and chemistry of oxidation reduction reactions		**15 L**
2.1	**Chemical Bond and Reactivity** Types of chemical bonds, comparison between ionic and covalent bonds, polarizability (Fajan's Rule) and shapes of molecules. Lewis dot structure, Valence bond theory, hybridization**,** Sidgwick Powell Theory, basic VSEPR theory for ABn type molecules with and without lone pair of electrons, applications and limitations of VSEPR theory and isoelectronic principles.	**7 L**
2.2	**Chemistry of oxidation reduction reactions** Reduction potentials, Electrochemical series and its applications. Redox potentials: half reactions; balancing redox equations. Redox stability in water i) Latimer and Frost Diagrams (Ebsworth diagram) ii) pH dependence of redox potentials. Applications of redox chemistry i) Extraction of elements: (example: isolation of copper by auto reduction) ii) Redox reagents in volumetric analysis: a) I_2 b) $KMnO_4$ iii) Titration curves: (x) Single electron systems as in Ce(IV) against Fe(II). (y) Multi electron systems as in $KMnO_4$ against Fe(II).	**8 L**
Unit – 3, 1 L/Week		**15 L**
Course Code: SIUSCHE22.3 **LEARNING OBJECTIVES** 1. *To draw various conformations of alkanes and cycloalkanes and predict their relative stabilities.* 2. *To recognize and distinguish between aromatic and antiaromatic compounds by their structures.* 3. *To write the reactions and outline the mechanism of electrophilic aromatic substitution reactions.* 4. *To predict the reactivity and orientation effects of the functional groups in monosubstituted aromatic compounds.*		
3 Stereochemistry - II and Aromatic Hydrocarbons		**15 L**
3.1	**Stereochemistry-II: Conformational Analysis of alkanes and cycloalkanes:** Conformation analysis of alkanes, Relative stability with energy diagrams.	**5 L**

	Types of cycloalkanes and their relative stability, types of strains, Baeyer strain theory, Conformation analysis of cyclohexane: Chair, Boat and Twist boat forms, Relative stability with energy.	
3.2	**Aromatic Hydrocarbons** Aromaticity: Nomenclature, Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft alkylation/acylation with their mechanism, Directing effects of the groups.	**10 L**

SUGGESTED REFERENCE SIUSCHE21.1 & SIUSCHE22.1

1. Principle of the Solid state by H. V. Keer.
2. A text book of Physical Chemistry by Negi Anand.
3. Physical Chemistry by Thomas Engel and Philip Reid.
4. Physical Chemistry by G. W. Castellan.
5. Principle of Physical Chemistry by Maron and Pruton.

SUGGESTED REFERENCE SIUSCHE21.2 & SIUSCHE22.2

1. B. Douglas, D.H. McDaniel and J. J. Alexander, *Concepts and Models of Inorganic Chemistry*, 2nd edition, John Wiley & Sons, (1983).
2. Gary Wulfsberg, *Inorganic Chemistry*; Viva Books PA Ltd., New Delhi; (2002).
3. W. W. Porterfield, *Inorganic Chemistry-An Unified Approach*, Academic press (1993).
4. D. F. Shriver, P. W. Atkins and C.H. Langford, Inorganic Chemistry, 3rd edition Oxford University Press, (1999).
5. Asim K. Das, *Fundamental Concepts of Inorganic Chemistry*, (Volumes-I, II and III) CBS Pub. (2000).
6. N. N. Greenwood and A. Earnshaw, Chemistry of Elements, Pergamon, (1984).
7. P. K. Dutta, 'General and Inorganic Chemistry', Levant Books, 15th Edition, (2003).

SUGGESTED REFERENCE SIUSCHE21.3 & SIUSCHE22.3

1. Organic Chemistry: T. W. G. Solomons, C. B. Fryhle, 2000 John Wiley and Sons.
2. Organic Chemistry: Morrison and Boyd Allyn & Bacon Inc.
3. Organic Chemistry: Francis A. Carey, 1996 3rd Ed. McGraw Hill.
4. Fundamentals of Organic Chemistry: G. Mare Loudon, 2002 4th Ed.
5. Reaction Mechanism: Peter Sykes, 1999 Orient Longman.
6. Advance Organic Chemistry: Jerry March, Wiley Eastern Ltd.
7. Organic Chemistry: Seyhan N. Ege, 1984. D. C. Heath & Co.
8. Organic Reactions with Mechanism: S. P. Bhutani, Ane book Pvt. Ltd.
9. Stereochemistry of Organic Compound: E. L. Eliel and S.H. Wilen, Wiley.
10. Stereochemistry: V. M. Potapov, Mir Publishers, Moscow.

11. Stereochemistry Conformation and Mechanism: P.S. Kalsi, Wiley Eastern Ltd.

12. Stereochemistry of Organic Compound: Principles and Applications: D. Nasipuri, Wiley Eastern Ltd.

13. Stereochemistry and Mechanism: David Whittaker, Oxford Chem. Series.

Course Code: SIUSCHE2P

Paper I, II

Credits: 2 Credits (45 Lectures)

PRACTICAL COURSE CHEMISTRY LABORATORY:

Course Code: SIUSCHE2P	
LEARNING OBJECTIVES 1. *To study the importance of MSDS.* 2. *To perform experiments that has specific aims with correct techniques.* 3. *To develop skills of observation, recording and analyzing data.* 4. *To learn to present the experimental work in a systematic manner.*	
Unit	**Course Code: SIUSCHE2P1 (Paper – I)**
P1.1	**Physical Chemistry** 1. To investigate reaction between $K_2S_2O_8$ and KI (with equal initial concentration). 2. To determine dissociation constant of weak acid (Ka) using Henderson's equation and the method of incomplete titration pH metrically. 3. To verify Beer-Lambert's law, using $KMnO_4$ solution by colorimetric method. 4. To standardize commercial sample of HCl using borax and to write material safety data of the chemicals involved.
P2.2	**Inorganic Chemistry** **1. Qualitative analysis: (at least 4 mixtures to be analyzed)** Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions. Cations (from amongst): Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}, K^+, NH_4^+. Anions (From amongst): CO_3^{2-}, S^{2-}, SO_3^{2-}, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, SO_4^{2-}. (*Scheme of analysis should avoid use of sulphide ion in any form for precipitation / separation of cations.)*
	Course Code: SIUSCHE2P2 (Paper – II)
P2.1	**Inorganic Chemistry**

	1. Redox Titration: To determine the percentage of copper (II) present in a given sample by titration against a standard aqueous solution of sodium thiosulfate (iodometry titration)
P2.2	**Organic Chemistry** **Characterization of organic compound containing C, H, (O), N, S, X elements.** (minimum 6 compounds)

Section A. P1 and P2 are regular experiments

Section B. List of Demo experiments: (minimum 01)

1. To prepare the stock solution.
2. To compare the density of different liquids.

Section C. Any one out of the following is compulsory.

1. Students should collect the information of at least five pioneering institutes in research and their work. Report that in fair journal.
2. Students who participate in the study tour must submit report.

SUGGESTED REFERENCE SIUSCHE2P

1. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M. Saunders, College Publication.
2. Introduction to Instrumental Analysis, R. D. Brown, McGraw Hill.
3. Instrumental Methods of Analysis, H. H. Willard, L. L. Meritt and J. A. Dean, Affiliated East-West Press.
4. Quality in the Analytical Chemistry laboratory –Neil T. Crosby, Florence Elizabeth Prichard, Ernest J. Newman – John Wiley & Sons Ltd.
5. Principles and Practice of Analytical Chemistry-Fifield F.W. and Kealey D, Black well Science.
6. Analytical Chemistry, Christian, WSE / Wiley.
7. Basic concepts of Analytical Chemistry, S. M. Khopkar, New Age International (P) Ltd.
8. Quantitative Analysis, R.A Day &A.L Underwood, Prentice Hall Publication.
9. Chemical Analysis in the laboratory –A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry.
10. Textbook of Quantitative Inorganic Analysis -Vogel A.I.

MODALITY OF ASSESSMENT

I] THEORY EXAMINATION PATTERN:

(A) Semester End Internal Assessment - 40 Marks

Internal Assessment	Marks
Class test	**20**
Assignment / Case Study / Project / Presentation/ etc.)	**15**
Active participation and overall conduct in class	**05**
Total Marks	**40**

(B) Semester End Theory Assessment - 60 Marks

Duration - **Semester End Theory** examinations shall be of **2 Hours** duration

Theory question paper pattern:

1. There shall be **four** questions.
2. Each unit there will be one question with **15** Marks each & fourth one will be based on all the three units with 15 Marks.
3. All questions shall be **compulsory** with internal choices within the questions.

   Question 1 (Unit-1)

   Question 2 (Unit-2)

   Question 3 (Unit-3) &

   Question 4 (combined units) will be of **15** Marks with internal options.
4. All Questions may be sub divided into sub questions of **five** marks each.
5. Please ensure that the allocation of marks depends on the number of lectures allotted for each topic.

Marks distribution pattern for theory examination:

Semester End Examination	Paper I	Paper II	Grand Total
Internal Assessment	**40**	**40**	**80**
Theory	**60**	**60**	**120**
Total Marks	**100**	**100**	**200**

II] PRACTICAL EXAMINATION PATTERN:

Scheme of examination: There will be no internal assessment for practical.

A candidate will be allowed to appear for the semester end practical examination only if the candidate submits a **certified journal** at the time of practical examination or a certificate from the Head of the Department/Institute to the effect that the candidate has completed the practical course of that semester of F.Y.B.Sc. Chemistry as per the minimum requirement.

The duration of the practical examination will be three and half hours per experiment. The questions on slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of chemistry.

Note: Minimum 75% experiments of prescribed syllabus should be completed in the 1st and 2nd semester. Certified journal is a must to be eligible to appear for the semester end practical examination, failing which they will not be allowed to appear for the examination.

Semester end practical examination: 50 Marks per Paper

Sr. No.	Practical Examination	Marks		Total
		Paper I	Paper II	
1.	Experimental work	40	40	80
2.	Journal	05	05	10
3.	Viva Voce	05	05	10
Practical Marks		50	50	100

Overall Examination and Marks Distribution Pattern

Semester End Examination	Paper I	Paper II	Grand Total
Internal Assessment	40	40	80
Theory	60	60	120
Practical	50	50	100
Total Marks	150	150	300

SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Department of Chemistry

Program: B.Sc.

Course: Chemistry

Syllabus for S.Y.B.Sc. Semester III & IV

(Implemented from 2018 – 2019)

Credit Based Semester and Grading System

SEMESTER – III

Contents:		
Paper I	:	**General Chemistry**
SIUSCHE31.1	:	Chemical Thermodynamics – II, Electrochemistry
SIUSCHE31.2	:	Chemical Bonding
SIUSCHE31.3	:	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides
Paper II	:	**General Chemistry**
SIUSCHE32.1	:	Chemical Kinetics – II, Solutions
SIUSCHE32.2	:	Selected topics on p block elements
SIUSCHE32.3	:	Aldehydes, ketones and active methylene compounds
Paper III	:	**Elective (Basics of Analytical Chemistry)**
SIUSCHE33.1	:	Introduction to Analytical Chemistry and Statistical Treatment of analytical data – I
SIUSCHE33.2	:	Classical Methods of Analysis
SIUSCHE33.3	:	Instrumental Methods – I
Practical		
SIUSCHE3P1	:	Chemistry Practical
SIUSCHE3P2	:	Chemistry Practical
SIUSCHE3P3	:	Chemistry Practical

SEMESTER – IV

Contents:		
Paper I	:	**General Chemistry**
SIUSCHE41.1	:	Electrochemistry – II , Phase equilibria
SIUSCHE41.2	:	Comparative chemistry of the transition metals, Coordination chemistry
SIUSCHE41.3	:	Carboxylic Acids and their Derivatives, sulphonic acids
Paper II	:	**General Chemistry**
SIUSCHE42.1	:	Solid State, Catalysis
SIUSCHE42.2	:	Ions in aqueous medium, Uses and Environmental Chemistry of Oxo-acids
SIUSCHE42.3	:	Nitrogen containing compounds and heterocyclic compounds
Paper III	:	**Elective (Basics of Analytical Chemistry)**
SIUSCHE43.1	:	Separation Techniques in Analytical Chemistry
SIUSCHE43.2	:	Instrumental Methods – II
SIUSCHE43.3	:	Statistical treatment of analytical data – II
Practical		
SIUSCHE4P1	:	Chemistry Practical
SIUSCHE4P2	:	Chemistry Practical
SIUSCHE4P3	:	Chemistry Practical

S.Y.B.Sc. Chemistry Syllabus

SEMESTER III

Course Code	Unit	Topics	Credits	L/Week
SIUSCHE31	1	**Chemical Thermodynamics – II, Electrochemistry**	2	1
		1.1 Chemical Thermodynamics – II		
		1.2 Electrochemistry		
	2	**Chemical Bonding**		1
		2.1 Non-Directional Bonding		
		2.2 Directional Bonding: Orbital Approach		
		2.3 Molecular Orbital Theory		
	3	**Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides**		1
		3.1 Reactions and reactivity of halogenated hydrocarbons		
		3.2 Alcohols, phenols and epoxides		
SIUSCHE32	1	**Chemical Kinetics – II, Solutions**	2	1
		1.1 Chemical Kinetics		
		1.2 Liquid state		
	2	**Selected topics on p block elements**		
		2.1 Comparative Chemistry of Main Group Elements		
	3	**Aldehydes, ketones and active methylene compounds**		
SIUSCHE33	1	**Introduction to Analytical Chemistry and Statistical Treatment of analytical data – I**	2	1
		1.1 Role of Analytical Chemistry		
		1.2 Significance of Sampling in Analytical Chemistry		
		1.3 Results of Analysis		
	2	**Classical Methods of Analysis**		
		2.1 Titrimetric Methods		

		2.2 Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry		**1**
		2.3 Neutralisation Titrations		
		2.4 Gravimetric analysis		
	3	**Instrumental Methods – I**		**1**
		3.1 General Introduction to analytical Chemistry		
		3.2 Types of Analytical Instrumental methods		
		3.3 Spectrometry		
SIUSCHE3P1	**1**	**Chemistry Practical**	**1**	**3**
SIUSCHE3P2	**1**	**Chemistry Practical**	**1**	**3**
SIUSCHE3P3	**1**	**Chemistry Practical**	**1**	**3**

Course Code: SIUSCHE31

Paper I

Credits: 2 Credits (45 Lectures)

Unit – 1, 1L/Week		15L
Course Code: SIUSCHE31.1 **LEARNING OBJECTIVES** 4. *To learn the concept of thermodynamics with respect to first law of thermodynamics.* 5. *To comprehend thermo-chemistry with respect to heats of various reactions, bond energy, bond dissociation and resonance energy.* 6. *To figure out the conductivity phenomenon for electrolytes.* 7. *To have knowledge of applications of conductance measurements.* 8. *To deduce the concept of transference number and factors affecting it.*		
1 Chemical Thermodynamics – II, Electrochemistry		**15 L**
1.1	**Chemical Thermodynamics – II :** 1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's free energy with Pressure and Temperature, Gibbs-Helmholtz equation. 1.1.2 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation. 1.1.3 Concept of Fugacity and Activity 1.1.4 Van't Hoff reaction isotherm and Van't Hoff reaction isochore. (Numericals expected)	**8 L**
1.2	**Electrochemistry:** 1.2.1 Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. 1.2.2 Kohlrausch law of independent migration of ions. 1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected). 1.2.4 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.	**7 L**
Unit – 2, 1L/Week		**15L**

Course Code: SIUSCHE31.2 **LEARNING OBJECTIVES** 4. *To learn the basis of chemical bonding and their types.* 5. *The need for bond formation and energy changes involved during the bond formation.* 6. *To study ionic molecules and their crystal structure on the basis if radius ratio rule.* 7. *To study covalent molecules in details with respect to Valence Bond Theory and Molecular Orbital Theory.*		
2 Chemical Bonding		**15 L**
2.1	**Non-Directional Bonding (Ionic Bonding)** 2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond. 2.1.2 Lattice Energy, Borne-Lande Equation 2.1.3 Born-Haber Cycle and its Application 2.1.4 Solvation energy 2.1.5 Kapustinskii equation 2.1.6 Types of Ionic Crystals 2.1.7 Radius Ratio Rules	**5 L**
2.2	**Directional Bonding: Orbital Approach (Covalent Bonding)** 2.2.1 Covalent Bonding: The Valence Bond Theory- Introduction and basic tenets. 2.2.2 Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system. 2.2.3 Corrections applied to the system of two hydrogen atoms- Formation of H_2 2.2.4 Homonuclear diatomic molecules from He_2 to Ne_2. 2.2.5 Resonance and the concept of Formal Charge, Rules for Resonance or Canonical structures. 2.2.6 Bonding in Polyatomic Species: The role of Hybridization and types of hybrid orbitals-*sp, sp^2, sp^3, sp^3d, sp^2d^2, sp^2d and sp^3d^2*. 2.2.7 Equivalent and Non-Equivalent hybrid orbitals. 2.2.8 Contribution of a given atomic orbital to the hybrid orbitals (with reference to sp^3 hybridisation as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3).	**6 L**

2.3	**Molecular Orbital Theory** 2.3.1 Comparing Atomic Orbitals and Molecular Orbitals. 2.3.2 Linear combination of atomic orbitals to give molecular orbitals LCAO-MO approach for diatomic homonuclear molecules). 2.3.3 Wave mechanical treatment for molecular orbitals (H_2^+, and H_2 ,) Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2, O_2^+, O_2^-, O_2^{2-}. (Problems and numerical problems expected wherever possible)	**4L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE31.3 **LEARNING OBJECTIVES** *Students should understood –* 1. *To learn different types of nucleophilic substitution reactions.* 2. *To study the kinetics, mechanism & stereochemistry of these reactions.* 3. *To study the nomenclature, synthesis, chemical reactions and uses of alcohols, phenols and epoxides.* 4. *To know comparative acidic strengths of alcohols and phenols.* 5. *To predict the conversion of one functional group into other.* 6. *To interpret M-C bond nature and reactivity order of organometallic compounds.* 7. *To learn synthesis, importance organometallic compounds*		
3 Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides		**15L**
3.1	**Reactions and reactivity of halogenated hydrocarbons:** **3.1.1 Alkyl halides:** Nucleophilic substitution reactions: S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group. **3.1.2 Aryl halides:** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S_NAr) addition-elimination mechanism and benzyne mechanism.	**6L**
3.2	**Alcohols and phenols:** **3.2.1 Alcohols:** Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols **3.2.2 Phenols: Pr**eparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols.	**6L**
3.3	**Organomagnesium and organolithium compounds:** Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl /	**3L**

	aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO_2, amides, esters, cyanides and epoxides.	

Course Code: SIUSCHE32

Paper II

Credits: 2 Credits (45 Lectures)

Unit – 1, 1L/Week		15L
Course Code: SIUSCHE32.1 **LEARNING OBJECTIVES** 5. *To study the rate of a chemical reaction, factors affecting it and its mechanism.* 6. *Concept of order and molecularity of a reaction and their determination.* 7. *To learn the physical properties of liquids such as surface tension, viscosity and refractive index.* 8. *Liquid crystals: classification, properties and their applications.*		
1 Chemical Kinetics – II, Solutions.		**15 L**
1.1	**Chemical Kinetics-II.** 1.1.1 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected), Thermal chain reactions: H and Br reaction. (Only steps involved, no kinetic expression expected). 1.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (E_a). (Numericals expected). 1.1.3 Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories (Qualitative treatment only)	**7 L**
1.2	**Solutions:** 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. Distillation of solutions, Lever rule, Azeotropes. 1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water, Triethylamine – Water and Nicotine – Water systems. 1.2.3 Immiscibility of liquids- Principle of steam distillation. 1.2.4 Nernst distribution law and its applications, solvent extraction.	**8 L**

Unit – 2, 1L/Week		**15L**
Course Code: SIUSCHE32.2 **LEARNING OBJECTIVES** 1. *To study the properties and structure of boron compounds, discuss their electron deficient nature of compounds like BH_3, BF_3, BCl_3.* 2. *To study the structure, bonding in diborane and tetraborane* 3. *To learn the semiconducting properties, reaction, preparation of Silicon and Germanium.* 4. *To discuss trends, reactivity, preparation of nitrogen compounds.*		
2 Selected topics on p block elements:		**15L**
2.1	**Chemistry of Boron compounds:** 2.1.1 Inert pair effect with respect to group 13 elements and stability of oxidation state. 2.1.2 Electron deficient compounds – BH_3, BF_3, $BCl_3$and BBr_3 with respect to Lewis acidity and applications. 2.1.3 Preparation of simple boranes like diborane and tetraborane. 2.1.4 Structure and bonding in diborane and tetraborane (2e-3c bonds) 2.1.5 Synthesis of Borax.	**6L**
2.2	**Chemistry of Silicon and Germanium:** 2.2.1 Silicon compounds: Occurrence , Structure and inertness of SiO_2 2.2.2 Preparation of structure of $SiCl_4$ 2.2.3 Occurrence and extraction of Germanium 2.2.4 Preparation of extra pure Silicon (Zone refining)and Germanium (Czholarskii's pulling technique)	**5 L**
2.3	**Chemistry of Nitrogen:** 2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen. 2.3.2 Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4. 2.3.3 Synthesis of ammonia by Bosch – Haber process.	**4 L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE32.3 **LEARNING OBJECTIVES** 1. *To know the trivial and IUPAC names of carbonyl compounds.* 2. To interpret the structure and study reactivity of carbonyl compounds. 3. *To study preparation of aldehydes and ketones.*		

4. *To study reactions of aldehydes and ketones with their reaction mechanism.* 5. *To study some selected name reactions and active methylene compounds reactions with their reaction mechanism.*		
3 Aldehydes, Ketones and active methylene Compounds:		**15 L**
3.1	**Aldehydes, ketones and active methylene Compounds:** 3.1.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and 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 General mechanism of nucleophilic addition and acid catalyzed nucleophilic addition reactions. 3.1.3 Reactions of aldehydes and ketones with $NaHSO_3$, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2, 4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$. 3.1.4 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Cannizzaro reaction, Perkin reaction, Witting reaction and Aldol condensation reaction. 3.1.5 Keto-enol tautomerism: Mechanism of acid and base catalysed enolization. 3.1.6 Acidity of methylene hydrogens, Methods of formation: ethylacetoacetate. Active methylene compounds: Acetylacetone, ethyl acetoacetate, diethyl malonate, stabilised enols. Reactions of Acetylacetone and ethyl acetoacetate (alkylation, conversion to ketone, mono- and dicarboxylic acid).	**15L**

Course Code: SIUSCHE33

Paper III (Elective)

Credits: 2 Credits (45 Lectures)

Unit – 1, 1L/Week		**15L**
Course Code: SIUSCHE33.1 **LEARNING OBJECTIVES** 1. *Select a method of analysis* 2. *Decide how to identify a sample and prepare it for analysis* 3. *Select a procedure for analysis* 4. *Identify sources of possible errors in the results obtained.* *(Problems including numerical expected wherever necessary)*		
1 Introduction to Analytical Chemistry and Statistical Treatment of analytical data – I		**15 L**
1.1	**Role of Analytical Chemistry :** 1.1.1 Language of analytical chemistry: important terms and their significance in Analytical Chemistry. 1.1.2 Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis) 1.1.3 Classical and Non-Classical Methods of Analysis; their types and importance.	**7 L**
1.2	**Significance of Sampling in Analytical Chemistry:** Terms involved in Sampling, Types of Sampling, Sampling techniques	**2 L**
1.3	**Results of Analysis:** 1.3.1 Errors in Analysis and their types 1.3.2 Precision and Accuracy in Analysis 1.3.3 Corrections for Determinate Errors *(Problems including Numericals expected wherever required)*	**6 L**
Unit – 2, 1L/Week		**15L**
Course Code: SIUSCHE33.2 **LEARNING OBJECTIVES** 1. *Introduce classical methods of chemical analysis by titrimetric and gravimetric method.* 2. *To study the various types of titrimetric method and role of indicators in these titrations.* 3. *To study gravimetry and their types.* 4. *To learn various parameters involved during precipitation gravimetry.*		

2 Classical Methods of Analysis		**15 L**
2.1	**Titrimetric Methods:** 2.1.1 Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry. 2.1.2 Conditions suitable for titrimetry. 2.1.3 Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations. Tools of Titrimetry: Graduated glasswares and Callibration.	**3L**
2.2	2.2.1 **Standard solutions** (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry.	**1 L**
2.3	**Neutralization Titrations:** 2.3.1 Concept of pH and its importance in Neutralisation Titrations 2.3.2 End point and Equivalence point of Neutralisation titrations 2.3.3 Determination of End point by using i. Indicators causing colour change ii. Change in potential, (by potentiometry) iii. Change in conductance (by conductometry) 2.3.4 Construction of titration curve (on the basis of change in pH)of a titration of i) Strong acid-weak base ii) Strong base-weak acid	**5 L**
2.4	**Gravimetric analysis:** 2.4.1 General Introduction to Gravimetry. 2.4.2 Types of Gravimetric Methods . 2.4.3 Precipitation Gravimetry: i. Steps involved in precipitation gravimetry analysis ii. Conditions for precipitation iii. Completion of precipitation, iv. Role of Digestion, Filtration, Washing, Drying and Ignition of precipitate. v. Applications of Gravimetric Analysis: Determination of sulfur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime. Determination of Aluminum by converting it into its oxide.	**6 L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE33.3 **LEARNING OBJECTIVES**		

1. *To know the various instrumental methods of analysis.* 2. *To know advantages and applications of different analytical tools according to analyte.* 3. *To select a suitable instrumental method for analysis.* 4. *To choose suitable method for photometric titrations.*		
3 Basic concepts in instrumental methods		**15 L**
3.1	**General introduction to analytical Chemistry:** 3.1.1 Relation between the analyte, stimulus and measurement of change in the observable property 3.1.2 Block Diagram of an analytical instrument.	**1 L**
3.2	**Types of analytical instrumental methods based on** 3.2.1 Optical interactions (eg. spectrometry: UV-Visible, polarimetry) 3.2.2 Electrochemical interactions (eg. potentiometry, conductometry) 3.2.3 Thermal interactions (eg. thermogravimetry)	**2 L**
3.3	**Spectroscopy:** 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 of Beer's Law and Lambert's law, combined mathematical expression of Beer-Lambert's law, validity of Beer-Lambert's law, deviations from Beer-Lambert's law (real deviations, instrumental deviations and chemical deviations) (numerical problems based on Beer-Lambert's law) 3.3.4 Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers 3.3.5 Block diagrams for single beam and double beam colorimeter and single beam spectrophotometer (Principles, construction and working-details of components expected i.e. source, sample holder, filters/monochromators, detectors such as photomultiplier tube) 3.3.6 Applications of UV-Visible spectrophotometry. i) Qualitative analysis like identification of functional groups in organic Compounds, chromophores and auxochromes, c*is* and *trans* isomers ii) Quantitative analysis by calibration curve method. 3.3.7 Photometric titrations: Principle, instrumentation, types of photometric titration curves with examples.	**12 L**

Suggested References for SIUSCHE31.1 & SIUSCHE32.1

7. A text book of Physical Chemistry by K. L. Kapoor.

8. Essentials of Physical Chemistry by B.S. Bahl, Arul Bahl and G.D. Tuli.
9. Chemical Kinetics by Keith J. Laidler
10. Principles of Physical Chemistry by Maron and Pruton.
5. Chemical Thermodynamics by I.M.Klotz

Suggested References for SIUSCHE31.2 & SIUSCHE32.2

10. J. Barrett and A. Malati, 'Fundamentals of Inorganic Chemistry', East-West Press Edition(2006)
11. C.M. Day and Joel Selbin, 'Theoretical Inorganic Chemistry', Affiliated East West Press Pvt. Ltd., (1985).
12. J.D. Lee, Concise 'Inorganic Chemistry', 5th edition, Blackwell Science Ltd., (2005).
13. James E. Huheey, 'Inorganic Chemistry', 3rd edition, Harper & Row, Publishers, Asia, Pte Ltd., (1983).
14. R. J. Gillespie and I. Hargittai, The VSEPR Model of Molecular Geometry, Dover Publication, (2012).
15. J. Barrett, 'Inorganic Chemistry in Aqueous Solutions'; The Royal Society of Chemistry (2003).
16. T. Moeller and R. O'Connor, 'Ions in Aqueous Systems'; McGraw-Hill Book Company, (1972).
17. Gary L. Miessler Donald A. Tarr, St. Olaf College, Northfield, Minnesota. Pearson Prentice Hall
18. Inorganic Chemistry, Catherine E. Housecroft and Alan G. Sharpe. Pearson Prentice Hall.

Suggested References for SIUSCHE31.3 & SIUSCHE32.3

17. Organic Chemistry: S. H. Pine McGraw Hill. Kogakusha Ltd.
18. Organic Chemistry : John Mc Murry 5th Edition Cornell University
19. Advance Organic Chemistry: Jerry March, Wiley Eastern Ltd.
20. A guide to IUPAC Nomenclature of Organic Compound,: Richer Interscience Publications
21. Organic Chemistry : T. W. G. Solomons, C. B. Fryhle, 2000 John Wiley and Sons
22. Organic Chemistry: Morrison and Boyd, Allyn& Bacon Inc.
23. Organic Chemistry: Francis A. Carey, 1996 3rd Ed. McGraw Hill
24. Fundamentals of Organic Chemistry: G. Mare Loudon, 2002 4th Edition.
25. Reaction Mechanism: Peter Sykes, 1999 Orient Longman
26. Organic Chemistry: Seyhan N. Ege, 1984. D. C. Heath & Co.
27. Organic Reactions with Mechanism: S. P. Bhutani, Ane book Pvt. Ltd.
28. Stereochemistry of Organic Compound: E. L. Eliel and S.H. Wilen, Wiley.
29. Stereochemistry: V. M. Potapov, Mir Publishers, Moscow.
30. Stereochemistry Conformation and Mechanism: P.S. Kalsi, Wiley Eastern Ltd.
31. Stereochemistry of Organic Compound: Principles and Applications: D. Nasipuri, Wiley Eastern Ltd.

32. Stereochemistry and Mechanism: David Whittaker, Oxford Chem. Series.

33. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2012.

18. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

Suggested References for SIUSCHE33.1

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 by Douglas A. Skoog, West, F. James Holler, S. R. Crouch
4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education

Suggested References for SIUSCHE33.2

1. Skoog et al. "Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, chapter 13, 14 and 15.
2. Day and Underwood, "Quantitative analysis" prentice hall 1991, chapter 3.
3. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher.
4. Gary D. Christian," Analytical Chemistry", VIth Edition, Wiley Students Edition, Chapter No 8,9,10.
5. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.
6. Modern Analytical Chemistry, David Harvey (page numbers 232 -265)

Suggested References for SIUSCHE33.3

1. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal ,Sham K.Anand pp 2.107-2.148
2. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.
3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118-181.

Course Code: SIUSCHE3P

Paper I, II, III

Credits: 2 Credits (45 Lectures)

PRACTICAL COURSE CHEMISTRY LABORATORY:

Course Code: SIUSCHE3P

LEARNING OBJECTIVES

1. *To learn to calibrate volumetric apparatus.*
2. *To learn to perform experiments that has specific aims with correct techniques.*
3. *To develop skills of observation, recording and analyzing data.*
4. *To learn to present the experimental work in a systematic manner.*

Unit	Course Code: SIUSCHE3P1 and SIUSCHE3P2 (Paper – I and II)
1	**Physical Chemistry** 1. To verify Ostwald's dilution law for weak acid conductometrically. 2. To determine dissociation constant of weak acid conductometrically. 3. To determine the critical solution temperature (CST) of Phenol - Water System. 4. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate. 5. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants. 6. To determine solubility of sparingly soluble salts (any two) conductometrically.
2	**Inorganic Chemistry** 1. Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions (Minimum 4 mixtures). Cations (from amongst): Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}, Co^{2+}, K^+, NH_4^+. Anions (From amongst): CO_3^{2-}, SO_3^{2-}, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, SO_4^{2-}. (*Scheme of analysis should avoid use of sulphide ion in any form for precipitation / separation of cations.)* 2. To estimate the amount of ferrous and ferric ions in the given sample. 3. Estimation of total hardness of water sample. 4. Determination of total salinity of water sample.
3	**Organic Chemistry**

	Short 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. One step preparation of: 1. Cyclohexanone oxime from cyclohexanone. 2. Glucosazone from dextrose or fructose 3. Tribromoaniline from aniline. 4. *m*-Dinitrobenzene from nitrobenzene 5. Dibenzalpropanone from Benzaldheyde and acetone 6. *N*-acetylation of *p*-toluidine 7. *p*-Bromoacetanilide from acetanilide 8. Iodoform from acetone (Any seven preparations)
	Course Code: SIUSCHE3P3 (Paper – III) (Elective)
1	**Tools of Analytical Chemistry-I:** a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels. b) Weighing tools such as two pan balance and monopan balance, digital balances. c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace. d) Drying Devices: Hot Air Oven, Microwave Oven, Desiccators, Vacuum desiccators e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes. (The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his/her journal)
2	1. Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error. 2. Colorimetric Determination of Copper ions in given Solution by using calibration curve method and calculation of % error. 3. Determination of buffer capacity of acid buffer and basic buffer. 4. Estimation of Aspirin 5. Gravimetric estimation of barium ions using K_2CrO_4 as precipitant and calculation of % error.

Suggested References for SIUSCHE3P1 and SIUSCHE3P2

11. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M. Saunders, College Publication.
12. Quality in the Analytical Chemistry laboratory –Neil T. Crosby, Florence Elizabeth Prichard, Ernest J. Newman – John Wiley & Sons Ltd.
13. Principles and Practice of Analytical Chemistry-Fifield F.W. and Kealey D, Black well

Science

14. Chemical Analysis in the laboratory –A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry
15. Textbook of Quantitative Inorganic Analysis -Vogel A.I.
16. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
17. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
18. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
19. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).
20. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
21. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
22. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
23. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
24. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
25. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

Suggested References for SIUSCHE3P3

1. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.
2. A.I. Vogel. “Textbook of Quantitative Inorganic Analysis,” Longman, London (1961).
3. R.V. Dilts. “Analytical Chemistry. Methods of Separation,” van Nostrand, N.Y. (1974).
4. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.Baruah, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi

S.Y.B.Sc. Chemistry Syllabus

SEMESTER IV

Course Code	Unit	Topics	Credits	L/Week
SIUSCHE41	1	**Electrochemistry – II , Phase equilibria**	2	1
		1.1 Electrochemistry – II		
		1.2 Phase Equilibria		
	2	**Comparative chemistry of the transition metals and Coordination chemistry**		1
		2.1 Comparative chemistry of the transition metals		
		2.2 Coordination chemistry		
	3	**Carboxylic Acids and their Derivatives, sulphonic acids**		1
		3.1 Carboxylic Acids and their Derivatives		
		3.2 Sulphonic acids		
SIUSCHE42	1	**Solid State, Catalysis**	2	1
		1.1 Solid State		
		1.2 Catalysis		
	2	**Ions in aqueous medium, Uses and Environmental Chemistry of oxo-acids**		
		2.1 Ions in aqueous medium		
		2.2 Uses and Environmental Chemistry of oxo-acids		
	3	**Nitrogen containing compounds and heterocyclic compounds**		
		3.1 Amines		
		3.2 Diazonium salts		
		3.3 Heterocyclic compounds		
SIUSCHE43	1	**Separation Techniques in Analytical Chemistry**		1
		1.1 An Introduction to Analytical Separations and its importance in analysis.		

		1.2 Estimation of an analyte without effecting separation.	**2**	
		1.3 Types of separation methods.		
		1.4 Electrophoresis		
		1.5 Solvent extraction		
		1.6 Chromatography		
	2	**Instrumental Methods – II**		**1**
		2.1 Potentiometry		
		2.2 pH metry		
		2.3 Conductometry		
	3	**Statistical Treatment of analytical data – II**		**1**
		3.1 Nature of Indeterminate Errors.		
		3.2 Distribution of random errors		
		3.3 Concept of Confidence limits and confidence interval and its computation		
		3.4 Criteria for rejection of doubtful result		
		3.5 Test of Significance		
		3.6 Graphical representation of data and obtaining best fitting straight line		
SIUSCHE4P1	**1**	**Chemistry Practical**	**1**	**3**
SIUSCHE4P2	**1**	**Chemistry Practical**	**1**	**3**
SIUSCHE4P3	**1**	**Chemistry Practical (Elective)**	**1**	**3**

Course Code: SIUSCHE41

Paper I

Credits: 2 Credits (45 Lectures)

Unit – 1, 1L/Week		15L
Course Code: SIUSCHE41.1 **LEARNING OBJECTIVES** 1. *To learn the concept of reversible and irreversible cell, electrochemical series.* 2. *To figure out the different thermodynamic properties and calculation of equilibrium constant.* 3. *To learn Gibbs phase rule and its thermodynamic derivation.* 4. *To interpret phase diagrams of one component system and two component systems.*		
1 Electrochemistry – II and Phase equilibria		**15 L**
1.1	**Electrochemistry-II:** 1.1.1 Electrochemical conventions, Reversible and irreversible cells. 1.1.2 Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected). 1.1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected) 1.1.4 Calculation of equilibrium constant from EMF data. (Numericals expected) 1.1.5 Concentration cells with transference and without transference. Liquid junction potential and salt bridge. 1.1.6 pH determination using hydrogen electrode and quinhydrone electrode. (Numericals expected)	**8 L**
1.2	**Phase Equilibria:** 1.2.1 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. 1.2.2 Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (Numericals expected) 1.2.3 Phase diagrams of one-component systems (water and sulphur). 1.2.4 Two component systems involving eutectic system (lead-silver system).	**7 L**

Unit – 2, 1L/Week		15L
Course Code: SIUSCHE41.2 **LEARNING OBJECTIVES** 1. *To learn the basic concepts of transition elements, position in periodic table and their properties.* 2. *To study the oxide and chloride chemistry for Titanium and Vanadium.* 3. *To study the qualitative detection of selected transition metal ions.* 4. *To understand the role of transition elements as coordination compounds.* 5. *To study theories of coordination compounds and with application.* 6. *To study Werner's theory, Effective atomic number rule, Eighteen electron rule and Valence Bond theory.*		
2 Comparative chemistry of the transition metals and Coordination chemistry		**15 L**
2.1	**Comparative Chemistry of the transition metals :** **2.1.1** Position in the periodic table; Natural occurrence principle ores and minerals; **2.1.2** Significance of special stability of d^0, d^5 and d^{10} leading to variable oxidation states, unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium and chromium.) **2.1.3** Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry and ability for charge transfer. **2.1.4** Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons, equation for spin only and spin-orbital magnetism in terms of Bohr magneton (No derivation of relevant equations expected), reasons for quenching of orbital moments. **2.1.5** Chemistry of Titanium and Vanadium: properties of oxides and chlorides, use in titrimetric analysis **2.1.6** Qualitative tests for transition metal ions: General considerations in devising tests (with reference to Chromium, Manganese, Iron, Cobalt, Nickel and Copper)	**9 L**
2.2	**Coordination Chemistry:** **2.2.1 Introduction to Chemistry of Coordination Compounds** i. Historical perspectives: Early ideas on coordination compounds ii. Basic terms and nomenclature. iii. Types of ligands iv. Isomerism : General Types with special reference to stereoisomerism of coordination compounds (Coordination number = 6) v. Evidence for the formation of coordination compounds.	**6 L**

	2.2.2 Theories of coordination compounds i. Werner's Theory of coordination compounds. ii. Effective atomic number rule. iii. Eighteen electron rule. **2.2.3 Nature of the Metal-Ligand Bond:** i. Valence Bond Theory; Hybridization of the central metal orbitals-sp^3, sd^3/d^3s, sp^3d^2/d^2sp^3, sp^2d. ii. Inner and outer orbital complexes (suitable examples of Mn(II), Fe(II), Fe(III), Co(II)/Co(III), Ni(II), Cu(II), Zn(II) complexes with ligands like aqua, ammonia CN^- and halides may be used) iii. Limitations of V.B.T **2.2.4 Application of coordination compounds**	
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE41.3 **LEARNING OBJECTIVES** 1. *To know the method of naming carboxylic acids and sulphonic acids.* 2. *To understand the basic properties of carboxylic acids and sulphonic acids.* 3. *To learn various methods of preparation of carboxylic acids and sulphonic acids.* 4. *To study the comparative acidity of carboxylic acid and sulfonic acids.* 5. *To study the mechanism of various reactions of carboxylic acid and sulfonic acids.* 6. *To study the term arenium ion and ipso substitution.*		
3 Carboxylic acids and their derivatives, sulphonic acids.		**15 L**
3.1	**Carboxylic acids and their derivatives :** **3.1.1.** Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. **3.1.2** Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard reagent and hydrolysis of nitriles. **3.1.3** Reactions: Acidity, salt formation, decarboxylation, reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard-Zelinsky reaction, conversion of carboxylic acid to acid derivatives and their relative reactivity. **3.1.4** Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution. **3.1.5** Mechanism of Claisen condensation and Dieckmann condensation. **3.1.6** Preparation and properties of dicarboxylic acid.	**9L**

3.2	**Sulphonic acids:** Nomenclature, preparation of aromatic sulphonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene, Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids. Salt formation, desulphonation. Reaction with alcohol, phosphorus pentachloride, IPSO substitution.	**3L**
3.3	**Epoxides:** Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides.	**3L**

Course Code: SIUSCHE42

Paper II

Credits: 2 Credits (45 Lectures)

Unit – 1, 1L/Week		**15L**
Course Code: SIUSCHE42.1 **LEARNING OBJECTIVES** 1. *To learn the laws of crystallography and types of crystals.* 2. *To study characteristics of SC, BCC and FCC crystal lattice, Bragg's equation, X-ray diffraction method.* 3. *To study the catalytic reaction mechanism of acid-base reactions, kinetics of enzyme catalyzed reactions.*		
1 Solid State, Catalysis		**15 L**
1.1	**Solid State:** 1.1.1 Recapitulation of 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 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).	**7 L**
1.2	**Catalysis:** 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	**8 L**

	equation) 1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst.	
Unit – 2, 1L/Week		**15L**
Course Code: SIUSCHE42.2 **LEARNING OBJECTIVES** 1. *To study the hydrolysis of cations and anions and classification of non-aqueous solvents* 2. *To learn about acidic and basic nature in aqueous medium and various factors affecting it.* 3. *To study the properties of concentrated oxo-acids and their chemistry with special emphasis on environment aspects.*		
2 Ions in aqueous medium, uses and Environmental Chemistry of oxo-acids		**15 L**
2.1	**Acidity of Cations and Basicity of Anions:** 2.1.1 Hydration of cations; Hydrolysis of cations predicting degree of hydrolysis of cations-effect of charge and radius. 2.1.2 Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical presentation. 2.1.3 Classification of cations on the basis of acidity category – non acidic, moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples 2.1.4 Hydration of anions- effect of charge and radius; hydration of anions- concept, diagram classification on the basis of basicity.	**9L**
2.2	**Uses and Environmental Chemistry of oxo-acids** 2.2.1 Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid. 2.2.2 Uses and environments aspects of these acids.	**6L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE42.3 **LEARNING OBJECTIVES** 1. *To know the trivial & IUPAC names of aliphatic and aromatic amines.* 2. *To understand the effect of substituent on basicity of aliphatic and aromatic amines.* 3. *To study the reactions of aliphatic amines.* 4. *To study Electrophilic substitution in aromatic amines.* 5. *To study diazonium salts preparation and their reactions/synthetic application.* 6. *To study classification, nomenclature, electronic structure, aromaticity in 5-membered and 6-membered rings containing one heteroatom.* 7. *To study synthesis and reactions of 5-membered and 6-membered rings containing one*		

	heteroatom.	
3 Nitrogen containing compounds and Heterocyclic compounds		**15L**
3.1	**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-HCl, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination , Hofmann bromamide reaction. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM), Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation.	**4 L**
3.2	**Diazonium Salts:** Preparation and their reactions/synthetic application-Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by –H and OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydrazobenzene.	**3 L**
3.3	**Heterocyclic compounds:** 3.3.1 Classification, nomenclature, electronic structure, aromaticity in 5- membered and 6-membered rings containing one heteroatom. 3.3.2 Synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis). 3.3.3 Reactivity and reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Ring opening. Pyrrole: Acidity and basicity of pyrrole, comparison of basicity of pyrrole and pyrrolidine. 3.3.4 Pyridine: Reactivity, basicity, comparison of basicity of pyridine, pyrrole and piperidine, sulphonation of pyridine (with and without catalyst), Chichibabin reaction.	**8 L**

Course Code: SIUSCHE43

Paper III (Elective)

Credits: 2 Credits (45 Lectures)

Unit – 1, 1L/Week	**15L**
Course Code: SIUSCHE43.1 **LEARNING OBJECTIVES** 1. *Various methods of separation.* 2. *How to select a method of separation of an analyte from the matrix?* 3. *How a solute gets distributed between two immiscible phases?* 4. *Principle of solvent extraction and various terms involved therein.*	

5. *Effect of various parameters on solvent extraction of a solute.* 6. *Classification of Chromatographic methods.*		
1 Separation Techniques in Analytical Chemistry		
1.1	**An Introduction to Analytical Separations and its importance in analysis.**	**1L**
1.2	**Estimation of an analyte without effecting separation.**	**1L**
1.3	**Types of separation methods.** 1.3.1 Based on Solubilities (precipitation, filtration and crystallisation). 1.3.2 Based on Gravity- Centrifugation. 1.3.3 Based on volatility-Distillation. 1.3.4 Based on Electrical effects-Electrophoresis. 1.3.5 Based on retention capacity of a Stationary Phase –Chromatography. 1.3.6 Based on distribution in two immiscible phases-Solvent Extraction. 1.3.7 Based on capacity to exchange with a resin-Ion Exchange.	**3L**
1.4	**Electrophoresis** 1.4.1 Principles, basic instrumentation, working and application in separation of biomolecules like enzymes and DNA.	**1L**
1.5	**Solvent extraction** 1.5.1 Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient. 1.5.2 Conditions of extraction: Equilibration time, solvent volumes, temperature, pH. 1.5.3 Single step and multi-step extraction, percentage extraction for single step and Multi-step extraction. Separation factor. 1.5.4 Batch and continuous extraction.	**4L**
1.6	**Chromatography** 1.6.1 Introduction to Chromatography. 1.6.2 Classification of chromatographic methods based on stationary and mobile phase. 1.6.3 Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations. 1.6.4 Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction.	**5L**
Unit – 2, 1L/Week		**15L**
Course Code: SIUSCHE43.2 **LEARNING OBJECTIVES**		

1. *The nature of chemical reactions that influence potential of a given cell.* 2. *Familiar with the various types of electrodes or half cells.* 3. *Appreciate the nature, need and importance of pH* 4. *Expected to know the applications of the various instrumental methods dealt with in this unit.*		
2 Instrumental Methods – II		
2.1	**Potentiometry** Principle, Role of reference and indicator electrodes, Applications in neutralisation reactions with reference to the titration of a strong acid against a strong base (using quinhydrone electrode) and Graphical methods for detection of end point.	**5 L**
2.2	**pH metry** Principle, Types of pH meters, Construction Working and Care of Combined Glass electrode, Applications in Titrimetry (Strong acid-Strong Base) biological and environmental analysis.	**4 L**
2.3	**Conductometry** Principle, Conductivity cell its construction and care. 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 Advantages & limitations of conductometric titrations.	**6L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE43.3 **LEARNING OBJECTIVES** 1. *To know the statistical methods in chemical analysis.* 2. *To know the nature of various kinds of analytical errors.* 3. *To know how to select the suitable analytical method with minimum error.*		
3 Statistical treatment of analytical data		
3.1	**Nature of indeterminate errors** 3.1.1 The true and acceptable value of a result of analysis. 3.1.2 Measures of central tendency: Mean, median, mode, average. 3.1.3 Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation (σ), variance, coefficient of variation.	**4L**
3.2	**Distribution of random errors**	**2L**

	3.2.1 Gaussian distribution curve. 3.2.2 Equation and salient features of Gaussian distribution curve.	
3.3	**Concept of confidence limits and confidence interval and its computation using** Population standard deviation, Student's *t* test and Range.	**3L**
3.4	**Criteria for rejection of doubtful result** 2.5 d rule, 4.0 d rule and Q test.	**2L**
3.5	**Test of significance** Null hypothesis and F-test (variance ratio test)	**2L**
3.6	**Graphical representation of data and obtaining best fitting straight line** i) For line passing through origin ii) For line not passing through origin [Numerical problems wherever possible, expected]	**2L**

Suggested Reference for SIUSCHE41.1 & SIUSCHE42.1

1. A text book of Physical Chemistry by Kapoor.
2. Essentials of Physical Chemistry by B.S. Bahl, Arul Bahl and G.D. Tuli.
3. Chemical Kinetics by Keith J. Laidler.
4. College Physical Chemistry by Baliga and Zaveri.
5. Basic Principle in Physical Chemistry by S.H.S Bohra, K. Raghuraman and D. V. Prabhu.
6. Mathematical preparation for Physical Chemistry by F. Daniel.
7. Principle of Physical Chemistry by Maron and Pruton.

Suggested Reference for SIUSCHE41.2 & SIUSCHE42.2

1. Fundamentals of Inorganic Chemistry by J. Barrett and A. Malati, East-West Press Edition(2006)
2. Theoretical Inorganic Chemistry by C.M. Day and Joel Selbin, Affiliated East West Press Pvt. Ltd., (1985).
3. Inorganic Chemistry by J. D. Lee, Concise 5th edition, Blackwell Science Ltd., (2005).
4. Inorganic Chemistry by James E. Huheey, 3rd edition, Harper & Row, Publishers, Asia, Pte Ltd., (1983).
5. The VSEPR Model of Molecular Geometry by R.J. Gillespie and I. Hargittai, Dover Publication, (2012).
6. Inorganic Chemistry in Aqueous Solutions by J. Barrett, The Royal Society of Chemistry (2003).
7. Ions in Aqueous Systems by T. Moeller and R. O'Connor, McGraw-Hill Book Company, (1972).
8. Gary L. Miessler Donald A. Tarr, St. Olaf College, Northfield, Minnesota. Pearson Prentice Hall
9. Inorganic Chemistry by Catherine E. Housecroft and Alan G. Sharpe. Pearson Prentice Hall.

Suggested Reference for SIUSCHE41.3 & SIUSCHE42.3

1. Organic Chemistry by S. H. Pine McGraw Hill. Kogakusha Ltd.
2. Organic Chemistry by John Mc Murry 5th Edition Cornell University
3. Advance Organic Chemistry by Jerry March, Wiley Eastern Ltd.
4. A guide to IUPAC Nomenclature of Organic Compound by Richer Interscience Publications
5. Organic Chemistry by T. W. G. Solomons, C. B. Fryhle, 2000 John Wiley and Sons
6. Organic Chemistry by Morrison and Boyd, Allyn& Bacon Inc.
7. Organic Chemistry by Francis A. Carey, 1996 3rd Ed. McGraw Hill
8. Fundamentals of Organic Chemistry by G. Mare Loudon, 2002 4th Edition.
9. Organic Chemistry by Seyhan N. Ege, 1984. D. C. Heath & Co.
10. Organic Reactions with Mechanism by S. P. Bhutani, Ane book Pvt. Ltd.
11. Organic Chemistry by Clayden J., Greeves, N., Warren S., Wothers P., Oxford University Press.
12. Name reactions in Heterocyclic Chemistry, Jie-Jack Li, Wiley Interscience publications, 2005
13. Handbook of Heterocyclic Chemistry, 2nd Edition, Alan R Karitzsky and Alexander F Pozahrskii, Elsevier Science Ltd., 2000.
14. Heterocyclic Chemistry, 5th Edition, John A. Joule and Keith Mlls, Wiley Publication, 2010.
15. Heterocyclic Chemistry, 3rd Edition, Thomas L. Gilchrist Pearson Education, 2007.

Suggested Reference for SIUSCHE 43.1

1. Fundamentals of Analytical chemistry by D.A. Skoog, D.M. West, F.J. Holler and CX.R. Crouch, 8th edition
2. Solvent extraction in analytical chemistry by G.H. Morrison and H. Freiser
3. Chromatographic separations, Analytical chemistry by open Learning P. G. Swell and B. Clarke, John Wiley and sons, 1987
4. Modern Analytical Chemistry by David Harvey

Suggested Reference for SIUSCHE 43.2

1. Principles of Instrumental analysis by D. A. Skoog, 3rd edition, Saunders college publishing.
2. Vogel's Text book of quantitative inorganic analysis, 4th edition, ELBS/ Longman.
3. Instrumental methods of analysis by B. K. Sharma, Goel publishing house. Miscellaneous methods.

Suggested Reference for SIUSCHE43.3

1. Modern Analytical Chemistry by David Harvey
2. Fundamentals of analytical chemistry by Skoog and West

Course Code: SIUSCHE4P
Paper I, II, III
Credits: 2 Credits (45 Lectures)
PRACTICAL COURSE CHEMISTRY LABORATORY:

Course Code: SIUCHE4P1

LEARNING OBJECTIVES

1. *To learn to calibrate volumetric apparatus.*
2. *To learn to perform experiments that has specific aims with correct techniques.*
3. *To develop skills of observation, recording and analyzing data.*
4. *To learn to present the experimental work in a systematic manner.*

Unit	Course Code: SIUCHE4P1and SIUCHE4P2 (Paper – I and II)
1	**Physical Chemistry** 1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically. 2. To determine the amount of HCl in the given sample potentiometrically. 3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of acid hydrolysis of methyl acetate. 4. Industrial visit/ research institute/ seminar report.
2	**Inorganic Chemistry** 1. Inorganic preparation – Nickel dimethyl glyoxime using microscale method. 2. Complex cation – tris (ethylene diamine) nickel (II) thiosulphate. 3. Complex anion – Sodium hexanitrocobaltate (III) 4. Inorganic salt – Calcium or magnesium oxalate using PFHS technique
3	**Organic Chemistry** Qualitative Analysis of organic compounds on the basis of 1. Preliminary examination. 2. Solubility profile. 3. Detection of elements C, H, (O), N, S, X. 4. Detection of functional groups. 5. Determination of physical constants (M.P/B.P) 6. Confirmatory test for the compound 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. (Minimum 6 compounds to be analyzed)

Unit	Course Code: SIUCHE4P3 (Paper – III)
1	Tools of Analytical Chemistry-II a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus. b. Development chamber for chromatography c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.) d. Conductivity cell (with respect to care and maintenance.) e. Combined Glass electrode (with respect to care and maintenance.) f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell (The learner should draw diagrams and write-ups providing uses of the items mentioned in (a. and b.) and Principle, Construction care and Uses of items (c) to (f) in his journal.)
2	1. Paper chromatography**:** Separation of cations like Fe (III), Ni(II) and Cu(II) in a sample. 2. Determination of acidity of a water sample. 3. Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. 4. Conductometric titration: Estimation of given acid by conductometric titration with strong base and calculation of % error. 5. Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically and calculation of % error. 6. Gravimetric estimation of Sulphate as $BaSO_4$ and calculation of % error.

Suggested Reference for SIUSCHE4P1 and SIUSCHE4P2

1. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M. Saunders, College Publication
2. Quality in the Analytical Chemistry laboratory –Neil T. Crosby, Florence Elizabeth Prichard, Ernest J. Newman – John Wiley & Sons Ltd.
3. Principles and Practice of Analytical Chemistry-Fifield F.W. and Kealey D, Black well Science
4. Chemical Analysis in the laboratory –A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry
5. Textbook of Quantitative Inorganic Analysis -Vogel A.I.
6. Senior Practical Physical Chemistry - Khosla B.D., Garg V.C. and Gulati A., R. Chand and Co., New Delhi (2011).
7. Experiments in Physical Chemistry - Garland C. W., Nibler J.W. and Shoemaker D.P., 8th Ed.,

McGraw-Hill, New York (2003).

8. Experimental Physical Chemistry - Halpern A. M. and McBane G. C., 3rd Ed., W.H. Freeman and Co., New York (2003).
9. Experimental Physical Chemistry - Athawale V.D. and Mathur P., New Age International, New Delhi (2001).
10. Practical Inorganic Chemistry - G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
11. Practical Organic Chemistry - Mann, F.G. & Saunders, B.C., Pearson Education (2009)
12. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis - Ahluwalia, V.K. & Aggarwal, R., University Press (2000).
13. Practical Organic Chemistry - Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R., 5th Ed., Pearson (2012)

Suggested Reference for SIUSCHE4P3

1 D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.
2 A.I. Vogel. “Textbook of Quantitative Inorganic Analysis,” Longman, London (1961).
3 R.V. Dilts. “Analytical Chemistry. Methods of Separation,” van Nostrand, N.Y. (1974).
4 Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B. Baruah, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi

The scheme of examination for the course in Chemistry at the Second Year B.Sc. Semester end examination will be as follows.

MODALITY OF ASSESSMENT

I] THEORY EXAMINATION PATTERN:

(A) Internal Assessment for theory– 40 Marks

Internal Assessment	Marks
Class test	**20**
Assignment / Case Study / Project / Presentation/ etc.)	**15**
Active participation and overall conduct in class	**05**
Total Marks	**40**

(B) Semester End Theory Assessment - 60 Marks

Duration - **Semester End Theory** examinations shall be of **2 Hours** duration.

Semester End Theory question paper pattern:

1. There shall be **four** questions.
2. Each unit will consist of be one question with **15** Marks each and the fourth question will be based on all the three units with 15 Marks.
3. All questions are **compulsory** with internal choices within the questions.

   Question 1 (Unit-1)

   Question 2 (Unit-2)

   Question 3 (Unit-3) &

   Question 4 (combined units) will be of **15** Marks with internal options.
4. All Questions may be sub divided into sub questions of **five** marks each.
5. Please ensure that the allocation of marks depends on the number of lectures allotted for each topic.

Marks distribution pattern for theory examination

Semester End Examination	Paper I	Paper II	Paper III	Grand Total
Internal Assessment	**40**	**40**	**40**	**120**
Theory	**60**	**60**	**60**	**180**
Total Marks	**100**	**100**	**100**	**300**

II] PRACTICAL EXAMINATION PATTERN:

Scheme of examination: There will be no internal assessment for practical.

A candidate will be allowed to appear for the semester end practical examination only if the candidate submits a **certified journal** at the time of practical examination or a certificate from the Head of the Department/Institute to the effect that the candidate has completed the practical course of that semester of S.Y.B.Sc. Chemistry as per the minimum requirement.

The duration of the practical examination will be three and half hours per experiment. The questions on slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of chemistry.

Note: Minimum 75% experiments of prescribed syllabus should be completed in the 3rd and 4th semester. Certified journal is a must to be eligible to appear for the semester end practical examination, failing which they will not be allowed to appear for the examination.

Marks distribution pattern for practical examination

Sr. No.	Practical Examination	Papers			Total
		P1	P2	P3	
1.	Experiment	35	35	35	105
2.	Journal	05	05	05	15
3.	Viva Voce	10	10	10	30
Practical Marks		50	50	50	150

Overall Examination and Marks Distribution Pattern

Semester End Examination	Paper I	Paper II	Paper III	Grand Total
Internal Assessment	40	40	40	120
Theory	60	60	60	180
Practical	50	50	50	150
Total Marks	150	150	150	450

SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Department of Chemistry

Program: B.Sc.

Course: Chemistry (6 Units)

Syllabus for T.Y.B.Sc. Semester V & VI

(Implemented from 2018 – 2019)

Credit Based Semester and Grading System

SEMESTER – V

Contents:		
Paper I	:	**Physical Chemistry**
SIUSCHE51.1	:	Molecular Spectroscopy
SIUSCHE51.2	:	Chemical Thermodynamics and Chemical Kinetics
SIUSCHE51.3	:	Nuclear Chemistry
SIUSCHE51.4	:	Surface Chemistry and Colloidal State
Paper II	:	**Inorganic Chemistry**
SIUSCHE52.1	:	Molecular Symmetry and Chemical Bonding
SIUSCHE52.2	:	Solid State Chemistry
SIUSCHE52.3	:	Chemistry of Inner transition elements
SIUSCHE52.4	:	Some Selected topics
Paper III	:	**Organic Chemistry**
SIUSCHE53.1	:	Mechanism of organic reactions and photochemistry
SIUSCHE53.2	:	Stereochemistry, Agrochemicals and Heterocyclic chemistry
SIUSCHE53.3	:	IUPAC nomenclature & synthesis of organic compounds
SIUSCHE53.4	:	Spectroscopy I and Natural Products
Paper IV	:	**Analytical Chemistry**
SIUSCHE54.1	:	Introduction to quality concepts, chemical calculations and sampling
SIUSCHE54.2	:	Optical methods
SIUSCHE54.3	:	Classical methods of analysis (titrimetry)
SIUSCHE54.4	:	Methods of separation – I
Practical		
SIUSCHE5P1.1	:	Physical Chemistry Practical
SIUSCHE5P1.1	:	Inorganic Chemistry Practical
SIUSCHE5P2.1	:	Organic Chemistry Practical
SIUSCHE5P2.2	:	Elective (Analytical Chemistry) Practical

SEMESTER – VI

T.Y.B.Sc. Chemistry Syllabus

Contents:		
Paper I	:	**Physical Chemistry**
SIUSCHE61.1	:	Electrochemistry
SIUSCHE61.2	:	Polymers
SIUSCHE61.3	:	Basics of Quantum Chemistry and Renewable Energy Resources
SIUSCHE61.4	:	Basics of Quantum Chemistry, Crystalline State
Paper II	:	**Inorganic Chemistry**
SIUSCHE62.1	:	Theories of metal-ligand bond (I)
SIUSCHE62.2	:	Theories of metal-ligand bond (II)
SIUSCHE62.3	:	Organometallic Chemistry
SIUSCHE62.4	:	Some Selected Topics
Paper III	:	**Organic Chemistry**
SIUSCHE63.1	:	Stereochemistry II, Amino acids & Proteins
SIUSCHE63.2	:	Molecular Rearrangement& Carbohydrates
SIUSCHE63.3	:	Spectroscopy & Nucleic acid
SIUSCHE63.4	:	Polymer, Catalysts and Reagents
Paper IV	:	**Analytical Chemistry**
SIUSCHE64.1	:	Electro Analytical Techniques
SIUSCHE64.2	:	Food And Cosmetics Analysis
SIUSCHE64.3	:	Chromatographic Techniques – II
SIUSCHE64.4	:	Thermal Methods And analytical Methods validation
Practical		
SIUSCHE6P1.1	:	Physical Chemistry Practical
SIUSCHE6P1.2	:	Inorganic Chemistry Practical
SIUSCHE6P2.1	:	Organic Chemistry Practical
SIUSCHE6P2.2	:	Elective (Analytical Chemistry) Practical

SEMESTER V

Course Code	Unit	Topics	Credits	L/Week
SIUSCHE51	1	**Molecular Spectroscopy**	2.5	1
		1.1 Molecular Spectroscopy (15L)		
	2	**Chemical Thermodynamics and Chemical kinetics**		1
		2.1 Chemical Thermodynamics (10L)		
		2.2 Chemical kinetics (5L)		
	3	**Nuclear chemistry**		1
		3.1 Nuclear chemistry (15L)		
	4	**Surface Chemistry and Colloidal state**		1
		4.1 Surface chemistry (6L)		
		4.2 Colloidal state (9L)		
SIUSCHE52	1	**Molecular Symmetry and Chemical Bonding**	2.5	1
		1.1 Molecular Symmetry (6L)		
		1.2 Molecular Orbital Theory for heteronuclear diatomic molecules and polyatomic species (9L)		
	2	**Solid State Chemistry**		1
		2.1 Structures of Solids (11L)		
		2.2 Superconductivity (4L)		
	3	**Chemistry of inner transition elements**		1
		3.1 Inner transition elements (5L)		
		3.2 Lanthanide series (10L)		
	4	**Some selected topics**		1
		4.1 Chemistry in Non-aqueous solvents (5L)		

		4.2 Comparative chemistry of Group 16 (5L)		
		4.3 Comparative chemistry of Group 17 (5L)		
SIUSCHE53	**1**	**Mechanism of organic reactions and photochemistry**	**2.5**	**1**
		1.1 Mechanism of organic reactions		
		1.2 Photochemistry		
	2	**Stereochemistry, Agrochemicals & Heterocyclic chemistry**		**1**
		2.1 Stereochemistry I (5 L)		
		2.2 Agrochemicals (4 L)		
		2.3 Heterocyclic chemistry (6 L)		
	3	**IUPAC nomenclature and synthesis of organic compounds**		**1**
		3.1 IUPAC nomenclature (5 L)		
		3.2 Synthesis of organic compounds (10 L)		
	4	**Spectroscopy & Natural Products**		**1**
		4.1 Spectroscopy I (5 L)		
		4.2 Natural Products (10 L)		
SIUSCHE54	**1**	**Introduction to quality concepts, chemical calculations and sampling**	**2.5**	**1**
		1 .1 Quality in Analytical Chemistry (5 L)		
		1.2 Chemical Calculations (4 L)		
		1.3 Sampling (6 L)		
	2	**Optical methods**		**1**
		2.1 Atomic Spectroscopy: Flame Emission spectroscopy (FES) and Atomic Absorption Spectroscopy (AAS) (7L)		

		2.2 Molecular Fluorescence and Phosphorescence Spectroscopy (4L)		
		2.3. Turbidimetry and Nephelometry (4L)		
	3	**Classical methods of analysis (titrimetry)**		**1**
		3.1 Redox Titrations (8L)		
		3.2 Complexometric Titrations (7L)		
	4	**Methods of separation – I**		**1**
		4.1 Solvent Extraction (6L)		
		4.2 High Performance Liquid chromatography(HPLC)(6 L)		
		4.3 High Performance Thin Layer Chromatography (HPTLC) (3 L)		
SIUSCHE5P1.1		**Physical Chemistry Practical**	**3**	**8**
SIUSCHE5P1.2		**Inorganic Chemistry Practical**		
SIUSCHE5P2.1		**Organic Chemistry Practical**	**3**	**8**
SIUSCHE5P2.2		**Elective (Analytical Chemistry) Practical**		

Course Code: SIUSCHE51

Paper I

Credits: 2.5 Credits (60 Lectures)

Unit – 1, 1L/Week		**15L**
Course Code: SIUSCHE51.1 **LEARNING OBJECTIVES** 9. *To study the role of spectroscopy in determining the dipole moment of molecules.* 10. *To study interpret rotational, vibration and IR spectrum of diatomic molecule.* 11. *To interpret Raman spectra considering examples of various molecules.*		
Note : Numericals and Word Problems are Expected from All Units		
1 Molecular Spectroscopy		**15 L**
1.1	**Molecular Spectroscopy** 1.1.1 Rotational Spectrum: Introduction to dipole moment, polarization of a bond, bond moment, molecular structure, 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 internuclear distance and isotopic shift. 1.1.2 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 obtaining vibrational spectrum, selection rule, nature of spectrum. 1.1.3 Vibrational-Rotational spectrum of diatomic molecule: Energy levels, selection rule, nature of spectrum, P and R branch lines. Anharmonic oscillator - energy levels, selection rule, fundamental band, overtones. Application of vibrational-rotational spectrum in determination of force constant and its significance. Infrared spectra of simple molecules like H_2O and CO_2. 1.1.4 Raman Spectroscopy : Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion- CO_2 molecule.	**15 L**
Unit – 2, 1L/Week		**15L**
Course Code: SIUSCHE51.2 **LEARNING OBJECTIVES** 1. *To have a basic understanding of colligative properties with their applications.* 2. *To study the applications of collision theory to unimolecular and bimolecular reactions.* 3. *To classify reactions as slow, fast and ultra-fast, study the kinetics of fast reactions.*		

2 Chemical Thermodynamics and Chemical kinetics		**15L**
2.1	**Chemical Thermodynamics** 2.1.1 Colligative properties: Vapour pressure and relative lowering of vapour pressure. Measurement of lowering of vapour pressure - Static and Dynamic method 2.1.2 Solutions of Solid in Liquid: Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non-volatile solute. Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. Beckmann Method and Rast Method. 2.1.3 Osmotic Pressure : Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff Factor. Measurement of Osmotic Pressure - Berkeley and Hartley's Method, Reverse Osmosis.	**10 L**
2.2	**Chemical kinetics** 2.2.1. Collision theory of reaction rates: Application of collision theory to 1. Unimolecular reaction Lindemann theory and 2. Bimolecular reaction. (derivation expected for both) 2.2.2 Classification of reactions as slow, fast and ultra-fast. Study of kinetics of fast reactions by Stop flow method and Flash photolysis (No derivation expected).	**5 L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE51.3 **LEARNING OBJECTIVES** *1. To study the types of radiations, their effects and measurements.* *2. To study the applications of radioisotopes.* *3. To learn about the various nuclear reactions.*		
3	**Nuclear chemistry**	**15L**
3.1	**Nuclear chemistry** 3.1.1 Introduction: Basic terms-radioactive constants (decay constant, half-life and average life) and units of radioactivity 3.1.2 Detection and Measurement of Radioactivity: Types and characteristics of nuclear radiations, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter. 3.1.3 Application of use of radioisotopes as Tracers: chemical reaction mechanism, age determination - dating by C^{14}.	**15 L**

	3.1.4 Nuclear reactions: Nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy. 3.1.5 Fission Process: Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. Multiplication factor and critical size or mass of fissionable material, nuclear power reactor and breeder reactor. 3.1.6 Fusion Process: Thermonuclear reactions occurring on stellar bodies and earth.	
Unit – 4, 1L/Week		**15 L**
Course Code: SIUSCHE51.4 **LEARNING OBJECTIVES** 1. *To study the various adsorption isotherms in surface chemistry.* 2. *To study the types of catalysis, mechanism of acid, base and enzyme catalysis.* 3. *To study the electrical properties of colloidal particles and role of surfactants in industries.*		
4 Surface chemistry and Colloidal state		**15L**
4.1	**Surface chemistry** 4.1.1 **Adsorption:** Physical and Chemical Adsorption, types of adsorption isotherms. Langmuir's adsorption isotherm (Postulates and derivation expected). 4.1.2 B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation.	**6 L**
4.2	**Colloidal state** 4.2.1 Introduction to colloids - Emulsions, Gels and Sols. 4.2.2 Electrical Properties: Origin of charges on colloidal particles, Concept of electrical double layer, zeta potential, Helmholtz and Stern model. 4.2.3 Electro-kinetic phenomena - Electrophoresis, Electro-osmosis, Streaming potential, Sedimentation potential, Donnan Membrane Equilibrium. 4.2.3 Colloidal electrolytes: Introduction, micelle formation. 4.2.4 Surfactants: Classification and applications of surfactants in detergents and food industry.	**9L**

Course Code: SIUSCHE52

Paper II

Credits: 2.5 Credits (60 Lectures)

<table>
<tr><td colspan="2">Unit – 1, 1L/Week</td><td>15L</td></tr>
<tr><td colspan="2">Course Code: SIUSCHE52.1
LEARNING OBJECTIVES
9. To study the symmetry of inorganic molecules.
10. To learn the concepts of point groups.
11. To study the geometry and structural behavior of polyatomic species on the basis of Walsh correlation diagram, study LCAO and MO, SALC's of heteroatomic molecules.</td><td></td></tr>
<tr><td colspan="2">1 Molecular symmetry, MOT of polyatomic species & metallic bond</td><td></td></tr>
<tr><td>1.1</td><td>Molecular Symmetry:
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 point groups
(i) $C_{\infty v}$ (HCl) (ii) $D_{\infty h}$ (H_2) (iii) C_{2v} (H_2O) (iv) C_{3v} (NH_3) (v) C_{2h} (trans-trichloroethylene) and (vi) D_{3h}(BCl_3)</td><td>6 L</td></tr>
<tr><td>1.2</td><td>Molecular Orbital Theory for heteronuclear diatomic molecules and polyatomic species :
1.2.1 Comparison between homonuclear and heteronuclear diatomic molecules.
1.2.2 Heteronuclear diatomic molecules like CO, NO and HCl, appreciation of modified MO diagram for CO.
1.2.3 Molecular orbital theory for H_3 and H_3^+ (correlation diagram expected)
1.2.4 Molecular shape to molecular orbital approach in AB_2 molecules. Application of symmetry concepts for linear and angular species considering σ-bonding on. Examples like: i) BeH_2 ii) H_2O</td><td>9 L</td></tr>
<tr><td colspan="2">Unit – 2, 1L/Week</td><td>15L</td></tr>
<tr><td colspan="2">Course Code: SIUSCHE52.2
LEARNING OBJECTIVES
1. To study solid state chemistry for selected crystal lattices.
2. To derive the packing density of hcp and ccp systems and study crystal defects.
3. To introduce the concepts of superconductors and its applications in various solid materials.</td><td></td></tr>
<tr><td colspan="2">2 Solid state chemistry</td><td></td></tr>
</table>

2.1	**Structures of Solids :** 2.1.1 Explanation of terms viz. crystal lattice, lattice point, unit cell and lattice constant. 2.1.2 Closest packing of rigid spheres (hcp, ccp), packing density in sc, bcc, fcc and hcp lattices (numerical problems expected). 2.1.4 Relationship between density and edge length of unit cells, lattice parameters. (Numerical problems expected). 2.1.5 Stoichiometric Point defects in solids (Point defects with respect to Frenkel and Schottky defects expected).	**11L**
2.2	**Superconductivity :** **2.2.1** Discovery of superconductivity**.** **2.2.2** Explanation of terms like Superconductivity, Transition temperature, Meissner effect. **2.2.3** Different superconducting materials viz., conventional superconductors, organic superconductors, alkali metal fullerides (A_3C_{60}) and high temperature superconductors. **2.2.4** Brief applications of superconducting materials.	**4 L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE52.3 **LEARNING OBJECTIVES** 1. *To study the position of inner transition elements in periodic table.* 2. *To study the shapes of f-orbitals, discuss the properties of lanthanides and actinides.* 3. *Introduce the elution order with respect to basicity through solvent extraction and ion exchange methods for lanthanides.*		
3 Chemistry of Inner transition elements		
3.1	**Inner transition elements** **3.1.1** Introduction: position of f-block elements, electronic configuration of lanthanides and actinides and comparison between lanthanides and actinides **3.1.2** The shapes of *f*-orbitals.	**5 L**
3.2	**Lanthanides Series** 3.2.1 Chemistry of lanthanides with reference to (i) lanthanide contraction and its consequences (ii) Oxidation states (iii) Ability to form complexes (iv) Magnetic and spectral properties. 3.2.2 Occurrence, extraction and separation of lanthanides by (i) Ion exchange method (ii) Solvent extraction method (Principles and technique). 3.2.3 Applications of lanthanides.	**10 L**

Unit – 4, 1L/Week		15 L
Course Code: SIUSCHE52.4 **LEARNING OBJECTIVES** 1. *To study the chemistry of non-aqueous solvents.* 2. *To study the preparation, reaction, bonding, structure and uses of Group 16, Group 17 and interhalogens compounds.*		
4 Some selected topics		
4.1	**Chemistry in Non-aqueous Solvents:** 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, dinitrogen tetroxide as non-aqueous solvents with respect to: i. Acid base reactions ii. Redox reactions.	**5 L**
4.2	**Comparative Chemistry of Group 16:** 4.2.1 Electronic configurations, trends in physical properties, allotropy. 4.2.2 Manufacture of sulphuric acid by Contact process.	**5L**
4.3	**Comparative Chemistry of Group 17:** 4.3.1 Electronic configuration, General characteristics, anomalous properties of fluorine, comparative study of acidity of oxyacids of chlorine w.r.t. acidity, oxidizing properties and structures (on the basis of VSEPR theory. 4.3.2 Chemistry of interhalogens with reference to preparations, properties and structures (on the basis of VSEPR theory).	**5L**

Course Code: SIUSCHE53

Paper III

Credits: 2.5 Credits (60 Lectures)

Unit – 1, 1L/Week		**15L**
Course Code: SIUSCHE53.1 **LEARNING OBJECTIVES** 1. *Recapitulation of basic concept and terminology with respect to reaction mechanism.* 2. *The evidences, mechanism & stereochemical aspects of substitution and elimination reactions.* 3. *To study the concept of pericyclic reactions.* 4. *To know the difference between thermal and photochemical reactions.* 5. *To study the Jablonski diagram and various types of photochemical reactions.*		
1 Mechanism of organic reactions and photochemistry		
1.1	**Mechanism of organic reactions :** 1.1.1 The basic terms and concepts: bond fission, reaction intermediates, electrophiles & nucleophiles, ligand, base, electrophilicity vs acidity and nucleophilicity vs basicity. 1.1.2 Neighbouring group participation in nucleophilic substitution reactions**:** participation of lone pair of electrons, kinetics and stereochemical outcome. 1.1.3 Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalyzed esterification of carboxylic acids ($A_{AC}2$) and base promoted hydrolysis of esters ($B_{AC}2$). 1.1.4 Pericyclic reactions, classification and nomenclature 1.1.4.1 Electrocyclic reactions (ring opening and ring closing), cycloaddition, sigma tropic Rearrangement, group transfer reactions, cheletropic reaction (definition and one example of each type) 1.1.4.2 Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates.	**10L**
1.2	**Photochemistry :** 1.2.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, photosensitization. 1.2.2 Photochemical reactions of olefins: photoisomerization, photochemical rearrangement of 1,4-dienes (di- π methane) 1.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photo reduction (e.g. benzophenone to benzopinacol)	**5L**
Unit – 2, 1L/Week		**15L**

Course Code: SIUSCHE53.2 **LEARNING OBJECTIVES** 1. *To identify the elements of symmetry in organic compounds and predict their chirality.* 2. *To specify the spatial information necessary to identify chirality in a molecule without a stereogenic centre.* 3. *To learn the concept, synthesis and applications of agrochemicals.* 4. *To rationalize the reactivity of heterocyclic compounds.* 5. *To study synthesis and reactions of quinoline, iso-quionoline and pyridine-N-oxide.*		
2 Stereochemistry, Agrochemicals & Heterocyclic chemistry		
2.1	**Stereochemistry I:** 2.1.1 Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center, rotation-reflection (alternating) axis. 2.1.2 Chirality of compounds without a stereogenic center: cummulenes and biphenyls.	**5 L**
2.2	**Agrochemicals:** 2.2.1 General introduction and scope, meaning and examples of insecticides, herbicides, fungicide, rodenticide, pesticides, plant growth regulators. 2.2.2 Advantages and disadvantages of agrochemicals. 2.2.3 Synthesis and application of IAA (Indole Acetic Acid) and Endosulphan. 2.2.4 Bio pesticides – Neem oil and Karanj oil.	**4 L**
2.3	**Heterocyclic chemistry:** 2.3.1 Reactivity of pyridine-N-oxide, quinoline and iso-quionoline. 2.3.2 Preparation of pyridine-N-oxide, quinoline and iso-quinoline. 2.3.3 Reactions of pyridine-N-oxide: halogenation, nitration and reaction with $NaNH_2$/liq.NH_3, n-BuLi. 2.3.2 Reactions of quinoline and isoquinoline; oxidation, reduction, nitration, halogenation and reaction with $NaNH_2$/liq. NH_3, n-BuLi.	**6L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE53.3 **LEARNING OBJECTIVES** 1. *To know the rules for converting names of organic compounds into their structures and vice versa.* 2. *To conceptualize the idea of ideal organic synthesis.* 3. *To study the important role of the green chemistry in organic synthesis and how to deal with it in our practical life.*		

3 IUPAC nomenclature and synthesis of organic compounds		**15 L**
3.1	**IUPAC nomenclature:** IUPAC Systematic nomenclature of the following classes of compounds (including compounds up to two substituents / functional groups): 3.1.1 Bicyclic compounds – spiro, fused and bridged (up to 11 carbon atoms) – saturated and unsaturated compounds. 3.1.2 Biphenyls. 3.1.3 Cummulenes with upto 3 double bonds. 3.1.4 Quinolines and isoquinolines.	**5 L**
3.2	**Synthesis of organic compounds:** 3.2.1 Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemo selectivity and region selectivity with examples, calculation of yields. 3.2.2 Multicomponent Synthesis: Mannich reaction and Biginelli reaction. Synthesis with examples (no mechanism). 3.2.3 Green chemistry and synthesis: Introduction: Twelve principles of green chemistry, concept of atom economy and E-factor, calculations and their significance, numerical examples. i) Green reagents: dimethyl carbonate. ii) Green starting materials : D-glucose. iii) Green solvents : supercritical CO_2. iv) Green catalysts: Bio catalysts. 3.2.4 Planning of organic synthesis i) synthesis of nitroanilines. (*o* and *p*) ii) synthesis of halobenzoic acid.(*o* and *p*) iii) Alcohols (primary / secondary / tertiary) using Grignard reagents. iv) Alkanes (using organolithium compounds)	**10 L**
Unit – 4, 1L/Week		**15 L**
Course Code: SIUSCHE53.4 **LEARNING OBJECTIVES** 1. *To study the interaction of radiation with matter.* 2. *To learn the principles and application of UV-Visible and mass spectrometry.* 3. *To figure out the significance of natural products in terms of their biosynthesis, biological activity and chemical synthesis and combining organic and biological chemistry.*		

4 Spectroscopy I & Natural Products:		
4.1	**Spectroscopy I:** 4.1.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency. 4.1.2 UV – Visible spectroscopy: Basic theory, solvents, nature of UV-Visible spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, chromophore-chromophore and chromophore-auxochrome interactions. 4.1.3 Mass spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula. Fragmentation of alkanes and aliphatic carbonyl compounds.	**5L**
4.2	**Natural Products:** 4.2.1. Terpenoids: Introduction, Isoprene rule, special isoprene rule and the gem-dialkyl rule. 4.2.2 Citral: a) Structural determination of citral. b) Synthesis of citral from methyl heptenone. c) Isomerism in citral. (cis and trans form). 4.2.3. Alkaloids: Introduction and occurrence. Hofmann's exhaustive methylation and degradation in**:** simple open chain and N – substituted monocyclic amines. 4.2.4 Nicotine: a) Structural determination of nicotine. (Pinner's work included). b) Synthesis of nicotine from nicotinic acid. c) Harmful effects of nicotine. 4.2.5 Hormones: Introduction, structure of adrenaline (epinephrine) physiological action of adrenaline. Synthesis of adrenaline from a) Catechol. b) *3,4*-dihydroxy benzaldehyde (Ott's synthesis).	**10L**

Course Code: SIUSCHE54

Paper IV

Credits: 2.5 Credits (60 Lectures)

Unit – 1, 1L/Week		15L
Course Code: SIUSCHE54.1 **LEARNING OBJECTIVES** 1. *To introduce the learner with various treatments on analytical data for accurate analysis* 2. *To make the learner capable of solving problems.* 3. *To give the learner an opportunity to get hands on experience in sampling of solid, liquid and gaseous samples*		
1 Introduction to Quality Concepts, Chemical Calculations and Sampling		**15 L**
1 .1	**Quality in Analytical Chemistry** 1.1.1 Concepts of Quality, Quality Control and Quality Assurance. 1.1.2 Importance of Quality concepts in Industry. 1.1.3 Chemical Standards and Certified Reference Materials; Importance in chemical analysis. Quality of material: Various grades of laboratory reagents.	**5 L**
1.2	**Chemical Calculations** (Numericals and word problems are expected) 1.2.1 Inter conversion of various concentration units. (Conversion of concentration from one unit to another unit with examples) 1.2.2 Percent composition of elements in chemical compounds.	**4 L**
1.3	**Sampling** 1.3.1 Purpose, significance and difficulties encountered in sampling. 1.3.2 Sampling of solids: Sample size – bulk ratio, size to weight ratio, multistage and sequential sampling, size reduction methods, sampling of compact solids, equipments and methods of sampling of compact solids, sampling of particulate solids, methods and equipments used for sampling of particulate solids. 1.3.3 Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids. 1.3.4 Sampling of gases: Ambient and stack sampling: Apparatus and methods for sampling of gases. 1.3.5 Collection, preservation and dissolution of the sample.	**6 L**

Unit – 2, 1L/Week		15 L
Course Code: SIUSCHE54.2 **LEARNING OBJECTIVES** 1. *To introduce learner with various optical methods of analysis.* 2. *To study Fluorescence and Phosphorescence phenomenon and its applications.* 3. *To study the Nephelometry and Turbidimetry and its applications.*		
2 Optical methods		**15 L**
2.1	**Atomic Spectroscopy: Flame Emission spectroscopy(FES) and Atomic Absorption Spectroscopy(AAS)** 2.1.1 Introduction, Energy level diagrams, Atomic spectra, Absorption and Emission Spectra. 2.1.2 Flame Photometry – Principle, Instrumentation (Flame atomizers, types of Burners, Wavelength selectors, Detectors). 3.1.3 Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electrothermal Atomiser). 2.1.4 Quantification methods of FES and AAS – Calibration curve method, Standard addition method and Internal standard method. 2.1.5 Comparison between FES and AAS. 2.1.6 Applications, Advantages and Limitations.	**7 L**
2.2	**Molecular Fluorescence and Phosphorescence Spectroscopy** 2.1.2 Introduction and Principle. 2.2.2 Relationship of Fluorescence intensity with concentration. 2.2.3 Factors affecting Fluorescence and Phosphorescence. 2.2.4 Instrumentation and applications. 2.2.5 Comparison of Fluorimetry and Phosphorimetry. 2.2.6 Comparison with Absorption methods.	**4L**
2.3	**Turbidimetry and Nephelometry** 2.3.1 Introduction and Principle. 2.3.2 Factors affecting scattering of Radiation: Concentration, particle size, wavelength, refractive index. 2.3.3 Instrumentation and Applications.	**4L**

Unit – 3, 1L/Week		**15L**
Course Code:SIUSCHE54.3 **LEARNING OBJECTIVES** 1. *To learn about redox and complexometry titraions.* 2. *Study the construction of the titration curves.* 3. *To learn about the selection of indicator.*		
3 Classical Methods of Analysis (Titrimetry)		**15L**
3.1	**Redox Titrations (Numerical and word Problems are expected)** 3.1.1 Introduction. 3.1.2 Construction of the titration curves and calculation of E_{system} in aqueous medium in case of: (1) One electron system, (2) Multielectron system. 3.1.3 Theory of redox indicators, Criteria for selection of an indicator. Use of diphenyl amine and ferroin as redox indicators.	**8L**
3.2	**Complexometric Titrations** 3.2.1 Introduction, construction of titration curve. 3.2.2 Use of EDTA as titrant and its standardisation, absolute and conditional formation constants of metal EDTA complexes, Selectivity of EDTA as a titrant. Factors enhancing selectivity with examples. Advantages and limitations of EDTA as a titrant. 3.2.3 Types of EDTA titrations. 3.2.4 Metallochromic indicators, theory, examples and applications.	**7L**
Unit – 4, 1L/Week		**15 L**
Course Code: SIUSCHE54.4 **LEARNING OBJECTIVES** 1. *To introduce learner with separation techniques.* 2. *To introduce the learner with Solvent Extraction* 3. *To introduce learner with chromatographic techniques and its applications.* 4. *To study the HPLC and its applications.* 5. *To study the HPTLC and its applications.*		
4 METHODS OF SEPARATION – I		**15L**

4.1	**Solvent Extraction** 4.1.1 Factors affecting extraction: Chelation, Ion pair formation and Solvation. 4.1.2 Graph of percent extraction versus pH. Concept of $[pH]_{\frac{1}{2}}$ and its significance (derivation not expected). 4.1.3 Craig's counter current extraction: Principle, apparatus and applications. 4.1.4 Solid phase extraction: Principle, process and applications with special reference to water and industrial effluent analysis. 4.1.5 Comparison of solid phase extraction and solvent extraction.	**6L**
4.2	**High Performance Liquid chromatography (HPLC)** 4.2.1 Introduction and Principle: Instrumentation - components with their significance: Solvent Reservoir, Degassing system, Pumps-(reciprocating pumps, screw driven- syringe type pumps, pneumatic pumps, advantages and disadvantages of each pump), Precolumn, Sample injection system, HPLC Columns, Detectors (UV – Visible detector, Refractive index detector). 4.2.2 Qualitative and Quantitative Applications of HPLC.	**6L**
4.3	**High Performance Thin Layer Chromatography (HPTLC)** 4.3.1 Introduction and Principle Stationary phase, Sample application and mobile phase. 4.3.2 Detectors. a) Scanning densitometer- Components. Types of densitometer- Single beam and Double beam. b) Fluorometric Detector. 4.3.3 Advantages, disadvantages and applications. 4.3.4 Comparison of TLC and HPTLC.	**3L**

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Course Code: SIUSCHE5P1

Paper I

Credits: 3 Credits (8 Lectures/ week)

PRACTICAL COURSE CHEMISTRY LABORATORY:

Course Code: SIUSCHE5P1

LEARNING OBJECTIVES

1. *To establish a correlation between the theory and practical, so that the student can apply their theoretical knowledge and correlate it with hands on experience.*
2. *To learn the importance of various instrumentation methods in quantitative analysis.*
3. *To know the importance of various parameters during preparation of transition metal complexes.*

Course Code: SIUSCHE5P1 (Paper – I) 8L/Week	
P1.1	**Physical Chemistry** 1. Chemical Kinetics: To determine the effect of addition of KCl for reaction between $K_2S_2O_8$ and KI and hence to determine the rate constant. 2. Colligative properties: To determine the molecular weight of compound by Rast Method. 3. Potentiometry: To determine the solubility product and solubility of AgCl potentiometrically using chemical cell. 4. Surface phenomena: To investigate the adsorption acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm. 5. Conductometry: To determine the velocity constant of alkaline hydrolysis of ethyl acetate by conductometric method. 6. pH-metry: To determine acidic and basic dissociation constants of amino acid and hence to calculate isoelectric point.

P1.2	**Inorganic Chemistry** Inorganic preparations: 1. Preparation of Potassium diaquo bis(oxalato) cuprate (II) 2. Preparation of Ferrous ethylene diammonium sulphate 3. Preparation of bis(acetylacetonato)copper(II). Determination of percentage purity: Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t. added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ion).

Course Code: SIUSCHE5P2

Paper II

Credits: 3 Credits (8 Lectures/ week)

PRACTICAL COURSE CHEMISTRY LABORATORY:

Course Code: SIUSCHE5P2

LEARNING OBJECTIVES

1. *To learn the importance of reagents in binary separation of organic mixture.*
2. *To develop skills of observation, recording and analyzing data.*
3. *To study the solubility and precipitation criteria of various organic compounds.*

Course Code: SIUSCHE5P2 (Paper – II) 8L/Week	
P2.1	**Organic Chemistry** 1. Separation of Binary solid-solid mixture (2.0 g mixture given). Minimum Six mixtures to be completed by the students. 2. Components of the mixture should include water soluble and water insoluble acids (carboxylic acid), water insoluble phenols (2-naphthol, 1-naphthol), water insoluble bases (nitroanilines), water soluble (urea, thiourea) and water insoluble neutral compounds (anilides, amides, m-DNB, hydrocarbons) 3. A sample of the binary mixture to be given (< 1.0 g) to the student for detection of the chemical type of the mixture. After correct determination of chemical type, the fixing reagent should be decided by the student for separation. 4. Follow separation scheme with the bulk sample of binary mixture. 5. After separation into component A and component B,

	a) One component (decided by the examiner) is to be analyzed and melting point is to be determined. This component is not to be weighed. b) The other component is dried, weighted and the melting point is to be determined.
P2.2	**Elective (Analytical Chemistry)** 1. Spectrophotometric estimation of fluoride. 2 Estimation of magnesium content in talcum powder by complexometry, using standardized solution of EDTA. 3 Determination of COD of water sample. 4 To determine potassium content of a common salt by Flame Photometry (Calibration curve method). 5 To determine the amount of persulphate in the given sample solution by back titration with standard Fe (II) ammonium sulphate solution. 6 To determine the amount of sulphate in given water sample turbidimetrically.

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T.Y.B.Sc. Chemistry Syllabus

SEMESTER VI

Course Code	Unit	Topics	Credits	L/Week
SIUSCHE61	1	**Electrochemistry**	2.5	1
		1.1 Electrochemistry (15 L)		
	2	**Polymers**		1
		2.1 Polymers (15 L)		
	3	**Basics of Quantum Chemistry and Renewable Energy Resources**		1
		3.1 Basics of Quantum Chemistry (10 L)		
		3.2 Renewable Energy Resources (5 L)		
	4	**Nuclear magnetic resonance spectroscopy and Electron spin resonance spectroscopy**		1
		4.1 Nuclear magnetic resonance spectroscopy		
		4.2 Electron spin resonance spectroscopy		
SIUSCHE62	1	**Theories of metal-ligand bond (I)**	2.5	1
		1.1Application of CFT to Coordination Compounds (15L)		
	2	**Theories of metal-ligand bond (II)**		1
		2.1 Molecular orbital theory for coordination compounds (4L)		
		2.2 Stability of metal complexes (4L)		
		2.2 Reactivity of metal complexes (4L)		
		2.3 Electronic spectra (3L)		
	3	**Organometallic Chemistry (15L)**		1
		3.1 Organometallic Compounds of main group metals (6L)		
		3.2 Metallocenes (5L)		
		3.3 Catalysis (4L)		

	4	**Some Selected Topics (15L)**		**1**
		4.1 Metallurgy (7L)		
		4.2 Chemistry of Group 18 (5L)		
		4.3 Introduction to Bio-inorganic Chemistry (3L)		
SIUSCHE63	**1**	**Stereochemistry, Amino acids and Proteins**	**2.5**	**1**
		1.1 Stereochemistry II (10 L)		
		1.2 Amino acids & Proteins (5 L)		
	2	**Molecular Rearrangement and Carbohydrates**		**1**
		2.1 Molecular Rearrangement (5 L)		
		2.2 Carbohydrates (10 L)		
	3	**Spectroscopy and Nucleic acid**		**1**
		3.1 Spectroscopy II (10 L)		
		3.2 Nucleic acids (15 L)		
	4	**Polymers, Catalysts and Reagents**		**1**
		4.1 Polymers (8 L)		
		4.2 Catalysts and Reagents (7 L)		
SIUSCHE64	**1**	**Electro Analytical Techniques**	**2.5**	**1**
		1.1 Polarography (11 L)		
		1.2 Amperometric titrations (4L)		
	2	**Food And Cosmetics Analysis**		**1**
		2.1 Introduction to food chemistry (10L)		
		2.2 Cosmetics (5L)		
	3	**Chromatographic Techniques – II**		**1**
		3.1 Gas Chromatography (GC) (9 L)		
		3.2 Ion Exchange Chromatography (6 L)		

	4	**Thermal Methods And analytical Methods validation**		**1**
		4.1 Thermal Methods (12L)		
		4.2 Analytical Method Validation (3L)		
SIUSCHE6P1.1		**Physical Chemistry Practical**	**3**	**8**
SIUSCHE6P1.2		**Inorganic Chemistry Practical**		
SIUSCHE6P2.1		**Organic Chemistry Practical**	**3**	**8**
SIUSCHE6P2.2		**Elective (Analytical Chemistry) Practical**		

Course Code: SIUSCHE61

Paper I

Credits: 2.5 Credits (60 Lectures)

Unit – 1, 1L/Week		15L
Course Code: SIUSCHE 61.1 **LEARNING OBJECTIVES** 1. *To study the different types of cells used in electrochemistry and their applications.* 2. *To have a broad idea about EMF series and its detailed applications in day to day activities.* 3. *To have a proper knowledge of the applications of pH, ion selective electrodes in diverse field of analysis.* 4. *To study the various applications of electrochemistry.*		
Note : Numericals and word Problems are Expected from All Units		
1 Electrochemistry		**15 L**
1.1	**Electrochemistry** **1.1.1 Activity and Activity Coefficient:** Lewis concept, ionic strength, Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye-Huckel limiting law (No derivation). **1.1.2 Classification of cells:** Chemical cells and Concentration cells. Chemical cells with and without transference, Electrode Concentration cells, Electrolyte concentration cells with and without transference. (derivations are expected)	**7 L**
1.2	**Applied electrochemistry** **1.2.1 Polarization**: concentration polarization and it's elimination. **1.2.2 Decomposition Potential and Overvoltage**: Introduction, experimental determination of decomposition potential, factors affecting decomposition potential. Tafel's equation for hydrogen overvoltage, experimental determination of over-voltage.	**8L**
Unit – 2, 1L/Week		**15L**
Course Code: SIUSCHE 61.2 **LEARNING OBJECTIVES** 8. *To study the classification of polymers, determination of molar mass, light emitting polymers, antioxidants and stabilizers.*		
2 Polymers		**15 L**

2.1	**Polymers** 2.1.1 Basic terms: macromolecule, monomer, repeat unit, degree of polymerization. 2.1.2 Classification of polymers: Classification based on source, structure, thermal response and physical properties. 2.1.3 Molar masses of polymers: Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity. 2.1.4 Method of determining molar masses of polymers: Viscosity method using Ostwald Viscometer. (derivation expected). 2.1.5 Light Emitting Polymers : Introduction, Characteristics, Method of preparation and applications. 2.1.6 Antioxidants and Stabilizers : Antioxidants, Ultraviolet stabilizers, Colourants, Antistatic agents and Curing agents.	**15 L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE 61.3 **LEARNING OBJECTIVES** *1. To study the basics of quantum chemistry, postulates, eigen value and eigen function.* *2. To enhance the knowledge about the renewable energy sources.*		
3 Basics of Quantum Chemistry and Renewable Energy Resources		**15 L**
3.1	**Basics of Quantum Chemistry** 3.1.1 Classical mechanics: Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect. 3.1.2 Quantum mechanics: Introduction, Planck's theory of quantization, wave particle duality, de –Broglie's equation, Heisenberg's uncertainty principle. 3.1.3 Progressive and standing waves- Introduction, boundary conditions, Schrodinger's time independent wave equation (No derivation expected), interpretation and properties of wave function. 3.1.4 Quantum mechanics: State function and its significance, Concept of operators - definition, addition, subtraction and multiplication of operators, commutative and non - commutative operators, linear operator, Hamiltonian operator, Eigen function and Eigen value.	**10 L**
3.2	**Renewable Energy Resources** 3.2.1. Renewable energy resources: Introduction. 3.2.2 Solar energy: Solar cells, Photovoltaic effect, Differences between conductors, semiconductors ,insulators and its band gap, Semiconductors as solar energy converters, Silicon solar cell 3.2.3. Hydrogen: Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.	**5L**

Unit – 4, 1L/Week		15 L
Course Code: SSIUSCHE 61.4 **LEARNING OBJECTIVES** 1. *To study the basics of NMR and ESR spectroscopy.*		
4 Nuclear magnetic resonance spectroscopy and Electron spin resonance spectroscopy		**15 L**
4.1	**NMR -Nuclear magnetic resonance spectroscopy** 4.1.1 Principle: Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in NMR (spin -spin relaxation and spin - lattice relaxation). 4.1.2 Instrumentation: NMR Spectrometer.	**7L**
4.2	**Electron spin resonance spectroscopy** 4.2.1. Principle: fundamental equation, g-value -dimensionless constant or electron g-factor, hyperfine splitting. 4.2.2. Instrumentation: ESR spectrometer, ESR spectrum of hydrogen and deuterium.	**8L**

Course Code: SIUSCHE62

Paper II

Credits: 2.5 Credits (60 Lectures)

Unit – 1, 1L/Week		15L
Course Code: SIUSCHE62.1 **LEARNING OBJECTIVES** 1. *To study the theories of metal ligand bond by applying Crystal field theory.* 2. *To learn about the crystal field splitting in octahedral, tetrahedral and square planar complexes, distortion, ligand field strength and calculate CFSE.*		
1 Theories of Metal Ligand bond (I)		**15 L**
1.1	**Application of crystal field theory to coordination compounds** **1.1.1** Limitations of Valance Bond theory. **1.1.2** Crystal field theory and effect of crystal field on central metal valence orbitals in various geometries from linear to octahedral (from coordination number 2 to coordination number 6). **1.1.3** Splitting of *d* orbitals in octahedral, tetrahedral and square planar crystal fields.	**15 L**

	1.1.4 Distortion from the octahedral geometry: (i) effect of ligand field and (ii) Jahn-Teller distortions **1.1.5** Crystal field splitting parameter (10Dq /Δ_o) its calculation and factors affecting it in octahedral complexes, Spectrochemical series. **1.1.6** Crystal field stabilization energy (CFSE), calculation of CFSE, for octahedral complexes with $d^0$to d^{10}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 of the first transition series. **1.1.8** Limitations of CFT: Evidences for covalence in metal complexes: (i) Intensities of d-d transitions, (ii) ESR spectrum of $[IrCl_6]^{2-}$ and (iii) Nephelauxetic effect.	
Unit – 2, 1L/Week		**15L**
Course Code: SIUSCHE62.2 **LEARNING OBJECTIVES** 1. *To discuss MOT of coordination compounds involving σ and Π bonding* 2. *To study electronic transition involved in coordination compounds, types of electronic transition.* 3. *To study the concept of term, term symbol, spectroscopic state and selection rules.* 4. *To interpret transition in metal complexes using Orgel diagram for term D.* 5. *To learn about stability, factors affecting stability and reactivity of metal complexes.*		
2 Theories of Metal Ligand bond (II)		**15 L**
2.1	**Molecular Orbital Theory (MOT) of Coordination Compounds** 2.1.1 Identification of the central metal orbitals and their symmetry suitable for formation of σ-bonds with ligand orbitals. 2.1.2 Construction of ligand group orbitals. 2.1.3 Construction of σ-molecular orbitals for ML_6 complex. 2.1.4 Effect of Π-bonding on complexes. 2.1.5 Examples like $[FeF_6]^{-4}$, $[Fe(CN)_6]^{-4}$, $[FeF6]^{-3}$, $[Fe(CN)_6]^{-3}$, $[CoF_6]^{-3}$, $[Co(NH_3)_6]^{+3}$.	**4 L**
2.2	**Stability of Metal Complexes** 2.2.1Thermodynamic and kinetic perspectives of metal complexes with examples. 2.2.2 Stability constants: Stepwise and overall stability constants and their interrelationship. 2.2.3 Factors affecting thermodynamic stability.	**4 L**
2.3	**Reactivity of Metal Complexes** 2.3.1 Comparison between Inorganic and Organic reactions 2.3.2 Types of reactions in metal complexes.	**4 L**

	2.3.3 Inert and Labile complexes: Correlation between electronic configuration and lability of complexes. 2.3.4 Ligand substitution reactions: Associative and Dissociative mechanism. 2.3.5 Acid hydrolysis, base hydrolysis and anation reactions.	
2.4	**Electronic spectra** 2.1.1 Origin of electronic spectra. 2.1.2 Types of electronic transitions in coordination compounds like intra−ligand, charge transfer and intra-metal transitions. 2.1.3 Selection rules for electronic transitions. 2.1.4 Electronic configuration and electronic micro states, Terms and Term symbols, for transition metal ions, rules for determination of ground state term. 2.1.5 Determination of Terms for p^2 electronic configuration. Orgel diagrams for D term in octahedral field.	**3 L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE62.3 **LEARNING OBJECTIVES** 1. *To know the orientation of organic molecules to bond with metal to form ligands.* 2. *To understand the various synthetic methods and chemical reactions of organometallic compounds.* 3. *To study the structure and bonding nature of metallocenes on the basis of VBT.* 4. *To introduce various catalytic reaction of organometallic compounds.*		
3 Organometallic compounds		**15 L**
3.1	**Organometallic Compounds of main group metals** 3.1.1 General characteristics of various types of organometallic compounds, viz., ionic, σ-bonded and electron deficient compounds. 3.1.2 General synthetic methods: (i) Oxidative addition, (ii) Metal-Metal exchange (Transmetallation) Carbanion-Halide exchange, (iv) Metal Hydrogen exchange and (v) Methylene insertion reactions. 3.1.3 Some Chemical reactions of organometallic compounds (i) Reactions with oxygen and halogens, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents and (iv) Complex formation reactions.	**6L**
3.2	**Metallocenes** 3.2.1 Introduction, Ferrocene: Synthesis, properties, structure and bonding on the basis of VBT.	**5L**

3.3	**Catalysis (4L)** 3.3.1 Comparison of homogeneous and heterogeneous catalysis 3.3.2 Basic steps involved in homogeneous catalysis. 3.3.3 Mechanism of Ziegler-Natta in polymerization of alkenes and Mechanism of Wilkinson's catalyst in hydrogenation of alkene.	**4L**
Unit – 4, 1L/Week		**15 L**
Course Code: SIUSCHE62.4 **LEARNING OBJECTIVES** 1. *To learn basic principles of metallurgy, extraction and refining process.* 2. *To learn the physical and chemical properties of Group 18 elements.* 3. *To study the preparation and structure of compounds of Xenon.* 4. *To study the role of inorganic elements in biological systems.*		
4 Some selected topics		**15 L**
4.1	**Metallurgy** 4.1.1 Types of metallurgies. 4.1.2 General steps of metallurgy; concentration of ore, calcination, roasting, reduction and refining. 4.1.3 Metallurgy of iron: occurrence, physicochemical principles, extraction of iron from hematite.	**7L**
4.2	**Chemistry of Group 18** 4.2.1 Historical perspectives. 4.2.2 General characteristics and trends in physical and chemical properties. 4.2.3 Isolation of noble gases. 4.2.4 Compounds of Xenon (oxides and fluorides) with respect to preparation and structure (VSEPR). 4.2.5 Uses of noble gases.	**5L**
4.3	**Introduction to Bioinorganic Chemistry** 4.3.1 Essential and non-essential elements in biological systems. 4.3.2 Biological importance of metal ions such as Na^+, K^+, Fe^{+2}/Fe^{+3} and Cu^{+2} (Role of Na^+ and K^+ w.r.t. ion pump).	**3L**

Course Code: SIUSCHE63

Paper III

Credits: 2.5 Credits (60 Lectures)

Unit – 1, 1L/Week		15L
Course Code: SIUSCHE63.1 **LEARNING OBJECTIVES** *1. To study the concept selectivity and topicity.* *2. To study the stereochemical aspects of various organic reactions* *3. To learn the basic chemical and structural features of amino acids and proteins.*		
1 Stereochemistry, Amino acids & Proteins:		**15L**
1.1	**Stereochemistry II** 1.1.1 Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and diastereoselectivity (de), Topicity : enantiotopic and diasterotopic atoms, groups and faces. 1.1.2 Stereochemistry of – i) Substitution reactions :S_Ni (reaction of alcohol with thionyl chloride) ii) Elimination reactions: E_2–Base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane. iii) Addition reactions to olefins: a) bromination (electrophilic anti addition) b) syn hydroxylation with O_sO_4 and $KMnO_4$ c) epoxidation followed by hydrolysis.	**10 L**
1.2	**Amino acids & Proteins** **1.2.1** α-Amino acids: General structure, configuration, and classification based on structure and nutrition. Properties: pH dependency of ionic structure, isoelectric point and zwitter ion. Methods of preparations: Strecker synthesis, Gabriel Phthalimide synthesis. **1.2.2** Polypeptides and Proteins: nature of peptide bond. Nomenclature and representation of polypeptides (di-and tri-peptides) with examples. Merrifield solid phase polypeptide synthesis, proteins: general idea of primary, secondary, tertiary & quaternary structure.	**5L**
Unit – 2, 1L/Week		**15L**
Course Code: SIUSCHE63.2 **LEARNING OBJECTIVES** *2. To predict and write the mechanism and stereochemistry of various molecular rearrangement reactions and also apply it to prepare some important class of organic molecules.* *3. To represent the carbohydrates in various spatial arrangements and interconvert them.* *4. To identify the basic chemical and structural features of carbohydrate.* *5. To write various reactions pertaining to different functional group transformations in carbohydrates.*		

2 Molecular Rearrangement & Carbohydrates:		**15 L**
2.1	**Molecular Rearrangement** Mechanism of the following rearrangements with examples and stereochemistry wherever applicable. 2.1.1 Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement. 2.1.2 Migration to the electron deficient nitrogen: Beckmann rearrangement. 2.1.3 Migration involving a carbanion: Favorski rearrangement. 2.1.4 Name reactions: Michael addition, Wittig reaction.	**5 L**
2.2	**Carbohydrates** 2.2.1 Introduction: classification, reducing and non-reducing sugars, DL notation 2.2.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses) Interconversion: open chain and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with stereochemistry of D-glucose, Stability of chair form of D-glucose 2.2.3 Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers. 2.2.4 Mutarotation in D-glucose with mechanism 2.2.5 Chain lengthening & shortening reactions: Modified Kiliani-Fischer synthesis (D-arabinose to D-glucose and D-mannose), Wohlmethod (D-glucose to D-arabinose) 2.2.6 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 2.2.7 Glycosides: general structure.	**10 L**
Unit – 3, 1L/Week		**15 L**
Course Code: SIUSCHE63.3 **LEARNING OBJECTIVES** 1. *Brief idea about the advantages of spectroscopic methods.* 2. *Various terminology used and basic concept of IR and PMR.* 3. *Application of UV, IR, Mass and PMR spectroscopy in structural determination of organic molecules.*		
3 Spectroscopy & Nucleic acid:		**15 L**
3.1	**3.1 Spectroscopy II** **3.1.1** IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region.	**10L**

	3.1.2 PMR Spectroscopy: Basic theory of PMR, nature of PMR spectrum, chemical shift (δunit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) 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 PMR in structure determination. **3.1.3** Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to IR and PMR: (1) alkanes (2) alkenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) amines (broad regions characteristic of different groups are expected). Problems of structure elucidation of simple organic compounds using individual or combined use of UV-Vis, IR, Mass and NMR spectroscopic technique are expected. (Index of hydrogen deficiency should be the first step in solving the problems).	
3.2	**Nucleic Acids** **3.2.1** Controlled hydrolysis of nucleic acids, sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing.	**5L**
Unit – 4, 1L/Week		**15 L**
Course Code: SIUSCHE63.4 **LEARNING OBJECTIVES** 1. *To study step-growth and polymerization, with respect to mechanism, stereochemistry and applications.* 2. *To figure out the role of various reagents in synthetic organic chemistry.*		
4 Polymer, Catalysts and Reagents		**15 L**
4.1	**Polymer Chemistry** 4.1.1 Introduction: terms monomer, polymer, homopolymer, copolymer, thermoplastics and thermosets. 4.1.2 Addition polymers: polyethylene, polypropylene, teflon, polystyrene, PVC, Uses. 4.1.3 Condensation polymers: polyesters, polyamides, polyurethanes, polycarbonates, phenol formaldehyde resins. Uses 4.1.4 Stereochemistry of polymers: Tacticity, mechanism of stereochemical control of poly merization using Ziegler Natta catalysts. Natural and synthetic rubbers: Polymerisation of isoprene: 1,2 and 1,4 addition (cis and trans), Styrene-butadiene copolymer. 4.1.5 Additives to polymers: Plasticisers, stabilizers and fillers. 4.1.6 Biodegradable polymers: Classification and uses. Polylactic acid structure, properties and use for packaging and medical purposes. (Note : Identification of monomer in a given polymer & structure of polymer for a given monomer is expected. condition for polymerization is not expected).	**8 L**

4.2	**Catalysts and Reagents** Study of following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism). 4.2.1 Catalysts: Catalysts for hydrogenation: a. Raney Nickel b. Pt and PtO_2 (C=C, CN, NO_2, aromatic ring) c. Pd/C: C=C, COCl → CHO (Rosenmund) d. Lindlar catalyst: alkynes 4.2.2 Reagents: a. $LiAlH_4$ (reduction of CO, COOR, CN, NO_2). b. $NaBH_4$ (reduction of CO). c. SeO_2 (Oxidation of CH_2 alpha to CO). d. mCPBA (epoxidation of C=C). e. NBS (allylic and benzylic bromination).	**7 L**

Course Code: SIUSCHE64

Paper IV

Credits: 2.5 Credits (60 Lectures)

Unit – 1, 1L/Week	**15L**
Course Code: SIUSCHE64.1 **LEARNING OBJECTIVES** 1. *To study the various electroanalytical techniques and its applications.* 2. *To make the learner capable of solving problems.*	
1 Electro Analytical Techniques	

1.1	**Polarography** (**Numerical and word problems are expected)** 1.1.1 Difference between potentiometry and voltammetry, Polarizable and non-polarizable electrodes 1.1.2 Basic principle of polarography H shaped polarographic cell, DME (construction, working, advantages and limitations) 1.1.3 DC polarogram: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential Role and selection of supporting electrolyte, Interference of oxygen and its removal, polarographic Maxima and Maxima Suppressors Qualitative aspects of Polarography: Half wave potential $E_{1/2}$, Factors affecting $E_{1/2}$ Quantitative aspects of polarography: Ilkovic equations*: various terms involved in it (No derivation) 1.1.4 Quantification 1) Wave height – Concentration plots (working plots/calibration) 2) Internal standard (pilot ion) method 3) Standard addition method 1.1.5 Applications, advantages and limitations	**11 L**
1.2	**Amperometric Titrations** 1.2.1 Principle, Rotating Platinum Electrode(Construction, advantages and limitations) 1.2.2 Titration curves with example 1.2.3 Advantages and limitations	**4 L**
Unit – 2, 1L/Week		**15 L**
Course Code: SIUSCHE64.2 **LEARNING OBJECTIVES** 1. *To introduce the learner with food and cosmetics through analytical chemistry view.* 2. *To study the analysis of various essential ingredients of food and cosmetics*		
2 Food and Cosmetics Analysis		

2.1	**Introduction to food chemistry** 2.1.1 Food processing and preservation: Introduction, need, chemical methods, action of chemicals(sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar) and pH control. Physical methods (Pasteurization and Irradiation) 2.1.2 Determination of boric acid by titrimetry and sodium benzoate by HPLC. 2.1.3 Study and analysis of food products and detection of adulterants 1) Milk: Composition & nutrients, types of milk (fat free, organic and lactose milk) Analysis of milk for lactose by Lane Eynon's Method 2) Honey: Composition Analysis of reducing sugars in honey by Coles Ferricyanide method 3) Tea: Composition, types (green tea and mixed tea) Analysis of Tannin by Lowenthal's method 4) Coffee: Constituents and composition, Role of Chicory Analysis of caffeine by Bailey Andrew method	**10L**
2.2	**Cosmetics** 2.2.1 Introduction and sensory properties 2.2.2 Study of cosmetic products – 1) Face powder: Composition, Estimation of calcium and magnesium by complexometric titration 2) Lipstick: Constituents, Ash analysis for water soluble salts: borates, carbonates and zinc oxide. 3) Deodorants and Antiperspirants: Constituents, properties, Estimation of Zinc by gravimetry.	**5L**
Unit – 3, 1L/Week		**15L**
Course Code: SIUSCHE64.3 **LEARNING OBJECTIVES** 1. *To introduce learner with separation techniques.*		

2. *To introduce learner with chromatographic techniques and its applications.* 3. *To make the learner capable of solving problems.*		
3 METHODS OF SEPARATION - II		
3.1	**Gas Chromatography (Numerical and word problems are expected)** 3.1.1 Introduction, Principle, Theory and terms involved 3.1.2 Instrumentation: Block diagram and components,types of columns, stationary phases in GSC and GLC, Detectors: TCD, FID, ECD 3.1.3 Qualitative, Quantitative analysis and applications 3.1.4 Comparison between GSC and GLC	**9L**
3.1	**Ion Exchange Chromatography** 3.2.1 Introduction, Principle. 3.2.2 Types of Ion Exchangers , Ideal properties of resin. 3.2.3 Ion Exchange equilibria and mechanism, selectivity coefficient and separation factor Factors affecting separation of ions. 3.2.4 Ion exchange capacity and its determination for cation and anion exchangers. 3.2.5 Applications of Ion Exchange Chromatography with reference to Preparation of demineralised water, Separation of amino acids.	**6L**
Unit – 4, 1L/Week		**15 L**
Course Code: SIUSCHE64.4 **LEARNING OBJECTIVES** 1. *To study the various thermal methods of analysis and applications.* 2. *To study the Radioanalytical Techniques and its applications*		
4 Thermal Methods and Analytical Method Validation		**15 L**
4.1	**Thermal Methods** 4.1.1 Introduction to various thermal methods (TGA, DTA and Thermometric titration)	**12L**
	4.1.2 **Thermogravimetric Analysis(TGA)** Instrumentation-block diagram, thermobalance (Basic components: balance, furnace, temperature measurement and control, recorder) Thermogram (TG curve) for $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ Factors affecting thermogram-Instrumental factors and sample characteristics Applications:	

	Determination of drying and ignition temperature range Determination of percent composition of binary mixtures (Estimation of Calcium and Magnesium oxalate)	
	4.1.3 **Differential Thermal Analysis (DTA):** Principle**,** Instrumentation, and Reference material used Differential thermogram (DTA curve) $CaC_2O_4 .H_2O$ and $CuSO_4.5H_2O$ Applications Comparison between TGA and DTA. 4.1.4 **Thermometric Titrations –** Principle and Instrumentation Thermometric titrations of : 1) HCl v/s NaOH 2) Boric acid v/s NaOH 3) Mixture of Ca^{+2} and Mg^{+2} v/s EDTA 4) Zn^{+2} with Disodium tartarate**.**	
4.2	**Analytical Method Validation** 4.2.1 Introduction and need for validation of a method. 4.2.2 Validation Parameters: Specificity, Selectivity, Precision, Linearity, Accuracy and Robustness.	**3L**

Note: Concept of sensitivity is to be discussed for all techniques and instruments mentioned in the syllabus.

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23. Polymer chemistry by M.G. Arora, K.Singh.
24. Polymer science – a text book by Ahluwalia and Mishra
25. Introduction to polymer chemistry - R. Seymour, Wiley Interscience.

26. Organic chemistry by Francis Carey – Mc GrawHill.

27. Organic chemistry by Carey and Sundberg, Part A & B

SUGGESTED REFERENCE SIUSCHE64

1. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M. Saunders, College Publication
2. Introduction to Instrumental Analysis, R. D. Brown, McGraw Hill.
3. Instrumental Methods of Analysis, H. H. Willard, L. L. Meritt and J. A. Dean, Affiliated East-West Press.
4. Quality in the Analytical Chemistry laboratory –Neil T. Crosby, Florence Elizabeth Prichard, Ernest J. Newman – John Wiley & Sons Ltd.
5. Principles and Practice of Analytical Chemistry-Fifield F.W. and Kealey D, Black well Science
6. Analytical Chemistry, Christian, WSE / Wiley
7. Basic concepts of Analytical Chemistry, S. M. Khopkar, New Age International (P) Ltd
8. Quantitative Analysis, R.A Day &A.L Underwood, Prentice Hall Publication
9. Chemical Analysis in the laboratory –A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry
10. Analytical Chemistry for Technicians – John Kenkel, 3rd Edition.
11. Textbook of Quantitative Inorganic Analysis -Vogel A.I. 5th Edition.

Course Code: SIUSCHE6P1

Paper I

Credits: 3 Credits (8 Lectures/ week)

PRACTICAL COURSE CHEMISTRY LABORATORY:

Course Code: SIUSCHE6P1	
LEARNING OBJECTIVES 1. *To learn the importance of various instrumentation methods in quantitative analysis.* 2. *To know the importance of various parameters during preparation of metal complexes.*	
Course Code: SIUSCHE6P1 (Paper – I) 8L/Week	
1	**Physical Chemistry** 1. Chemical Kinetics: To interpret the order of reaction graphically from the given experimental data and calculate the specific rate constant. (No fractional order). 2. Viscosity: To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement. 3. Potentiometry: To determine the amount of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate. 4. To determine the number of electrons in the redox reaction between ferrous ammonium sulphate and cerric ammonium sulphate potentiometrically. 5. Conductometry: To titrate a mixture of weak acid and strong acid against strong base and estimate the amount of each acid in the mixture conductometrically. 6. Colorimetry: To estimate the amount of Fe (III) in the complex formation with salicylic acid by Static Method.
2	**Inorganic Chemistry** **2.1 Inorganic preparations** 1. Preparation of tris(acetylacetonato)iron(III). 2. Preparation of bis(dimethylglyoximato)nickel(II). 3. Preparation of potassium tris(oxalato)aluminate(III). **2.2 Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t. added cation and/or anion (qualitative analysis only by wet tests).** (Any three salts of main group metal ions).

Course Code: SIUSCHE6P2

Paper II

Credits: 3 Credits (8 Lectures/ week)

PRACTICAL COURSE CHEMISTRY LABORATORY:

Course Code: SIUSCHE6P2

LEARNING OBJECTIVES

1. *To learn the importance of reagents in binary separation of liquid organic mixture.*
2. *To understand miscibility concept of various organic compounds.*
3. *To learn the importance of various instrumentation methods in quantitative analysis.*

Course Code: SIUSCHE6P2 (Paper – II) 8L/Week	
1	**Organic Chemistry** **A)** Separation of Binary liquid-liquid and liquid- solid mixture. 1. Minimum **six** mixtures to be completed by the students. 2. Components of the liquid-liquid mixture should include volatile liquids like acetone, methylacetate, ethylacetate, isopropylalcohol, ethyl alcohol, ethyl methyl ketone and nonvolatile liquids like chlorobenzene, bromobenzene, aniline, N,N-dimethylaniline, acetophenone, nitrobenzene, ethyl benzoate. 3. Components of the liquid-solid mixture should include volatile liquids like acetone, methylacetate, ethylacetate, ethyl alcohol, iso propyl alcohol, ethyl methyl ketone or non-volatile liquid like nitrobenzene, aniline etc. and solids such as water insoluble acids, phenols, bases, neutral. 4. 1 mL of the mixture to be given to the student for detection of the physical type. 5. After correct determination of physical type, separation of the binary mixture to be carried out by distillation method using micro scale technique. 6. After separation into component A and component B: a) In case of a liquid-liquid mixture, the volatile component is to be analysed and detected. For the non-volatile component the boiling point has to be reported. (non-volatile component not to be analysed) b) In case of a liquid-solid mixture, the volatile component is to be analysed and detected. The solid component is to be dried, weighted and the melting point is to be determined. c) The component to be identified can be decided by examiner.
2	**Elective (Analytical Chemistry)** 1 Estimation of Chromium in water sample spectrophotometrically by using Diphenyl carbazide. 2 Estimation of reducing sugar in honey by Willstatter method.

	3 Separation and estimation of Mg(II) and Zn(II) from given sample solution using an anion exchange resin 4 Estimation of acetic acid in Vinegar sample by using Quinhydrone electrode potentiometrically. 5 Determination of phosphoric acid in cola sample pH metrically.

SUGGESTED REFERENCE SIUSCHE6P

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H.Middleton.
3. Practical organic chemistry – O.P.Aggarwal.
4. Practical Physical Chemistry 3rd edition A.M.James and F.E. Prichard , Longman publication
5. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
6. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
7. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.
8. Experimental Physical Chemistry By V. D. Athawale.
9. Senior Practical Physical Chemistry By: B. D. Khosla, V. C. Garg and A. Gulati, R Chand and Co.. 2011
10. Fundamental of Analytical Chemistry-Skoog D.A. and West D.M. Saunders, College Publication
11. Introduction to Instrumental Analysis, R. D. Brown, McGraw Hill.
12. Instrumental Methods of Analysis, H. H. Willard, L. L. Meritt and J. A. Dean, Affiliated East-West Press.
13. Quality in the Analytical Chemistry laboratory –Neil T. Crosby, Florence Elizabeth Prichard, Ernest J. Newman – John Wiley & Sons Ltd.
14. Principles and Practice of Analytical Chemistry-Fifield F.W. and Kealey D, Black well Science
15. Analytical Chemistry, Christian, WSE / Wiley
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17. Quantitative Analysis, R.A Day &A.L Underwood, Prentice Hall Publication
18. Chemical Analysis in the laboratory –A Basic guide by Irene Muller-Harvey, Richard M. Baker, Royal Society of Chemistry
19. Textbook of Quantitative Inorganic Analysis -Vogel A.I. 5th Edition

MODALITY OF ASSESSMENT

THEORY EXAMINATION PATTERN:

(A) Semester End Theory Internal Assessment - 40 Marks

Internal Assessment	Marks
Class test	**20**
Assignment / Case Study / Project / Presentation/ etc.)	**15**
Active participation and overall conduct in class	**05**
Total Marks	**40**

(B) Semester End Theory Assessment - 60 Marks (Duration - These examinations shall be of **2 hours** duration).

Theory question paper pattern:

1. There shall be **four** questions.
2. Each unit there will be one question with **15** Marks each.
3. All questions shall be **compulsory** with internal choices within the questions.

   Question 1 (Unit-1),

   Question 2 (Unit-2),

   Question 3 (Unit-3) &

   Question 4 (Unit-4).
4. All Questions may be sub divided into sub questions of **five** marks each.
5. Please ensure that the allocation of marks depends on the number of lectures allotted for each topic.

Marks distribution pattern for theory examination

Theory Examination	Paper I	Paper II	Paper III	Paper IV	Grand Total
Internal Assessment	**40**	**40**	**40**	**40**	**160**
Theory	**60**	**60**	**60**	**60**	**240**
Total Marks	**100**	**100**	**100**	**100**	**400**

II] PRACTICAL EXAMINATION PATTERN:

Scheme of examination: There will be no internal assessment for practical.

A candidate will be allowed to appear for the semester end practical examination only if the candidate submits a **certified journal** at the time of practical examination or a certificate from the Head of the Department/Institute to the effect that the candidate has completed the practical course of that semester of T.Y.B.Sc. Chemistry as per the minimum requirement.

The duration of the practical examination will be **three and half hours** per experiment. The questions on slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of chemistry.

Note: Minimum 75% experiments of prescribed syllabus should be completed in the 5th and 6th semester. Certified journal is a must to be eligible to appear for the semester end practical examination, failing which they will not be allowed to appear for the examination.

Marks distribution pattern for practical examination

Sr. No.	Practical Examination	Marks Distribution				Grand Total
		Paper I		Paper II		
		P1.1	P1.2	P2.1	P2.2	
1.	Experimental work	40	40	40	40	160
2.	Journal	05	05	05	05	20
3.	Viva – Voce	05	05	05	05	20
Practical Marks		50	50	50	50	200

Overall Examination and Marks Distribution Pattern

Semester End Examination	Paper I	Paper II	Paper III	Paper IV	Grand Total
Theory Internal Assessment	40	40	40	40	160
Theory	60	60	60	60	240
Practical	50	50	50	50	200
Total Marks	150	150	150	150	600