Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: B. Sc. in Chemistry

SYLLABUS

(Approved in the Academic Council Meeting held on 27/ 06 /2023)

F.Y.B.Sc. Chemistry

According to National Education Policy -2020

w.e.f. Academic Year 2023-24

NEP-2020

BACHELOR'S IN SCIENCE (B. Sc.)

Programme Outcomes

S. N.	After completion of B.Sc. program students will acquire	Graduate Attribute
PO1	The knowledge of the disciplines and in-depth and extensive knowledge, understanding and skills in a specific field of interest.	Disciplinary knowledge
PO2	An ability to develop and conduct experiments, analyze, and interpret data and use scientific judgment to draw conclusions	Scientific reasoning
PO3	An ability to use current technology, and modern tools necessary for creation, analysis, dissemination of information.	Digital literacy
PO4	Innovative, professional, and entrepreneurial skills needed in various disciplines of science.	Life-long learning
PO5	An ability to achieve high order communication skills.	Communication skills
PO6	An ability to collect, analyze and evaluate information and ideas and apply them in problem solving using conventional as well as modern approaches	Problem solving
PO7	A sense of social responsibility; intellectual and practical skills and demonstration of ability to apply it in real-world settings.	Reflective thinking
PO8	An ability to engage in independent and life-long learning through openness, curiosity, and a desire to meet new challenges.	Life-long learning
PO9	A capacity to relate, collaborate, and lead others, and to exchange views and ideas to work in a team to achieve desired outcomes	Teamwork
PO10	An ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	Leadership
PO11	An ability to understanding values, ethics, and morality in a multidisciplinary context.	Moral and ethical awareness

Preamble:

Bachelor of Science (B.Sc.) in Chemistry is an undergraduate course of Department of Chemistry, Changu Kana Thakur Arts, Commerce & Science College, New Panvel (Autonomous). The Choice Based Credit System to be implemented through this curriculum would help the students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

This syllabus is prepared to give the sound knowledge and understanding of chemistry to undergraduate students at first year of the B.Sc. degree course. The goal of the syllabus is to make the study of Chemistry as stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make students capable of studying Chemistry in academic and industrial courses. Also to expose the students and to develop interest in them in various fields of Chemistry.

The new and updated syllabus is based on disciplinary approach with vigour and depth taking care of the syllabus is not heavy at the same time it is comparable to the syllabi of other universities at the same level. The students pursuing this course would have to develop understanding of various aspects of the chemistry. The conceptual understanding, development of experimental skills, developing the aptitude for academic and professional skills, obtaining basic ideas and understanding of hyphenated techniques, understanding the fundamental chemical processes and rationale towards application of knowledgeare among such important aspects.

Course Description (Theory)	Major Chemistry
Semester	I
Course Name	General Chemistry – I
Course Code	USC1GCH1
Eligibility for Course	12^{th} Science of all recognized Board
Credit	02
Hours	30

Course Objectives

- To construct and apply knowledge of chemistry, and appreciate the relationship between Chemistry and other disciplines.
- To promote understanding of basic facts and concepts in Chemistry while retaining the excitement of Chemistry.
- To enable students to understand Chemistry and its Industrial and Social Context.

Course Outcomes:

COs.	**After completing course, Students will able to**	**Bloom Taxonomy Level (BTL)**
CO1	Recall thermodynamics terms, the first law of thermodynamics and terms like normality, molarity.	Remember
CO2	Solve the Numerical problems based on the Concentration of solutions	Apply
CO3	Classify the elements according to electronic configuration and explain details of periodic trends and atomic structure.	Understand
CO 4	Explain the name, bonding , structure and bond fission of organic compounds.	Evaluating

Unit	Course Description	Hrs
1.	**1.1 Thermodynamics [10 L]** Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. First law: Concept of heat, q, work, w, internal energy, U and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Second Law of thermodynamics Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules. **1.2 Atomic Structure [5 L]** Hydrogenic atoms: 1. Simple principles of quantum mechanics; 2. Atomic orbitals i) Hydrogenic energy levels ii) Shells, subshells and orbitals iii) Electron spin iv) Radial shapes of orbitals v) Radial distribution function vi) Angular shapes of orbitals 3. Many Electron Atoms i) Penetration and shielding ii) Effective nuclear charge 4. Electrons filling rules in various orbitals: a) Aufbau principle b) Hund's rule of maximum multiplicity c) Pauli's exclusion principle	15
2	**2.1 Basics of Organic Chemistry (10 L)** 2.1.1 Introduction, General properties and applications of organic compounds in every days life (1L) 2.1.2 Classification and Nomenclature of organic compounds: (4L) Review of basic rules of IUPAC nomenclature. Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of	15

	the following classes of compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines; including their cyclic analogues 2.1.3 Bonding and Structure of Organic compounds(2L) Hybridization: sp3, sp2, sp hybridization of carbon and nitrogen; Shapes of molecules; Influence of hybridization on bond properties (as applicable to ethane, ethene, ethyne) 2.1.4 Fundamentals of organic reaction mechanism: (3L) Electronic Effects: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment, Bond fission: Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles. **2.2 Periodic Table and Periodicity [5 L]** 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 Alred Rochow electronegativities (Numerical problems expected, wherever applicable.).	

Course Description (Theory)	Major Chemistry
Semester	I
Course Name	General Chemistry – II
Course Code	USC1GCH2
Eligibility for Course	12^{th} Science of all recognizedBoard
Credit	02
Hours	30

Course Objectives

- To expose the students to various emerging new areas of Chemistry and apprise them with their prevalent in their future studies and their applications in various spheres of chemical sciences.
- To familiar students with chemistry of main group elements.

- To do the comparative study of carbides, nitrides, oxides and hydrides of group 1 and group 2 elements and some important compounds.
- To aware the students with important class of organic compounds with applications.

Course Outcomes:

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO 1	Explain enantiomer, optical activity, diastereomers, projection formulas, isomerism.	Apply
CO 2	Outline the metallic and non-metallic nature, oxidation states, electronegativity, Anomalous behaviour and allotropy of main group elements.	Understand
CO 3	Explain the reactivity of group 1 and group 2 elements and the effects of Oxides of carbon, sulphur and nitrogen on the environment.	Understand
CO 4	Define surface tension, Viscosity, Refractive index of Liquid, Order of reaction.	Remember

Unit	Course Description	Hrs
1.	**1.1 Gaseous State: (7L)** 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) **1.2 Chemical Equilibria: (3L)** 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 **1.3 Comparative chemistry of Main Group Elements: (5 L)** Metallic and non-metallic nature, oxidation states, electronegativity,	15

	anomalous behaviour of second period elements, allotropy, catenation, diagonal relationship.	
2	**2.1 Stereochemistry: [10L]** Classification of isomer, IUPAC nomenclature of stereoisomers. Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3 dichlorobutane) and their interconversions; Geometrical isomerism in alkene and cycloalkanes: cis–trans and syn-anti isomerism E/Z notations with C.I.P. rules. 15h 2 1 8 Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two similar and dissimilar chiral centres, Distereoisomers, meso structures, racemic mixture and resolution (methods of resolution not expected). Relative and absolute configuration: D/L and R/S designations. **2.2 Comparative Chemistry of Compounds of Group I and Group II Elements: 5L]** Comparative chemistry of carbides, nitrides, oxides and hydroxides of group I and group II elements. Some important compounds- $NaHCO_3$, Na_2CO_3, NaCl, NaOH, CaO, $CaCO_3$ **[**	15

Course Description (Theory)	Major Chemistry
Semester	I
Course Name	Chemistry Practical
Course Code	USC1CHP
Eligibility for Course	12^{th} Science of all recognizedBoard
Credit	02
Hours	30

Course Objectives

- To develop the practical skills in the students regarding the preparation of chemical solutions.
- To build the knowledge of important reagents, practical techniques in the students.
- To develop the knowledge of handlings chemical instruments used in the laboratory.

COs.	**After completing course, Students will able to**	**Bloom Taxonomy Level (BTL)**
CO 1	Find exact concentrations of the solutions and enthalpy of dissolution.	Remember
CO 2	Apply chemical kinetics law to calculate the rate constant of the	Apply

	reaction.	
CO 3	Find the normality of the acids and bases and purity of the samples gravimetrically.	Remember
CO 4	Apply Thin Layer Chromatography (TLC) ,Distillation, Recrystallization, sublimation methods for separation of mixtures.	Apply

	Course Description	Hrs
	Physical chemistry 1. Standardization of solutions of two different concentration of KOH by using 0.1 N oxalic acid solution. 2 To determine the rate constant for the hydrolysis of ester using HCl as catalyst 3 To determine enthalpy of dissolution of salt (like KNO3) 4 Preparation of different normal and molar solutions (at least two). **Inorganic chemistry** **1.** Commercial analysis of a) Mineral acid–Sulphuric acid b) Organic acid 2. Titration using double indicator: analysis of solution of Na2CO3 and NaHCO3. 3. To determine the percent purity of sample of BaSO4 containing NH4Cl by gravimetrically. 4) To determine the percentage purity of given sample of ascorbic acid . **Organic Chemistry** Purification of Organic Compound compounds by 1. Recrystallization (02) (Benzoic acid, Acetanilide) 2. Sublimation (01) Phthalic anhydride to Phthalic acid 3. Distillation. (01) (Recording of M.P. & B.P.) Learners are expected to report a) Solvent for recrystallization. b) Mass and the M.P. & B.P. of purified compound.	30

	Learners should calibrate thermometer before determining melting point 2. Chromatography-- Separation of a mixture of o-and p-nitrophenols by thin layer chromatography (TLC)	

Course Description (Theory)	Indian Knowledge System (IKS)
Semester	I
Course Name	Chemistry in Ancient India
Course Code	UIKS1CAI
Eligibility for Course	12^{th} Science of all recognized Board
Credit	02
Hours	30

Course Objective

The objective of the course is to develop the understanding of Chemistry of Ancient India.

Course Outcomes:

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO 1	Explain the ancient Indian Science and Technology.	Understand
CO 2	Apply the knowledge of Rasayan Shastra used during ancient period and Charaka Samhita.	Apply
CO 3	Tell the history of Metals and Metallurgy in Ancient India.	Remember
CO 4	Explain the knowledge of extraction and smelting of metals in ancient India.	Understand

Unit	Course Description	Hrs
1	**1.1 History of Ancient Indian Science and Technology.** **(8 Lectures)** Chronology of ancient Indian science and technological developments. Features of Science and Technology, Development of Science in different branches, Technology in Ancient India, Significant Science and Technology discovery in Ancient India. **(8 Lectures)** **2. 2 Rasayan Shastra during Ancient Period.** Introduction, Constitution and properties of matter, Traditional Chemicals in India, Atomism in Vaisesika, Classification, early chemical techniques. Minerals and Metals: Mercury, major alkemic product .Fermentation technology. **(7 Lectures)**	15
2	**Material technology: Metals and Metallurgy in Ancient India.** **2.1 Introduction to Metals and Metallurgy in Ancient India.** History of Ancient Indian materials being used in ancient times, history of the Indian Metallurgy, Archaeological Metallurgy of ancient India, ancient India for processing of pure metals from the respective ores. Study of Metals - Gold Silver, Lead and Copper during ancient times**. (8 Lectures)** **2.2 Extraction and smelting of metals in Ancient India** Extraction and Smelting of Zinc, Introduction to metal casting, Metal Casting in Ancient India, Different methods involved in metal casting, Glass Technology in Ancient India.(**7 Lectures)**	15

Reference :

1. History of Technology by A. G. Bag. published by INSA, Indian National Science, New Delhi.
2. Forays into Ancient Indian Science and Technology, by D. P. Mishra Department of Aerospace Engineering Indian Institute of Technology.

Course Description (Theory)	Open Elective-I
Semester	I
Course Name	Chemistry in Everyday Life-I
Course Code	UOE1CEL1
Eligibility for Course	12^{th} Science of all recognized Board
Credit	02
Hours	30

Course Objectives

- To construct and apply knowledge of chemistry, and appreciate the relationship between Chemistry and other disciplines.
- To promote understanding of basic facts and concepts in Chemistry in everyday life.
- To enable students to understand Chemistry and its Industrial and Social Context.

Course Outcomes:

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Student understand the role of chemistry in every day life.	Remember
CO2	Analyse the connection between chemistry and nutrition and life	Analyse
CO3	Describe the impact of chemistry in areas of human activity	Describe
CO 4	Find the various chemicals used in the daily human life	Find

Unit	Course Description	Hrs
1	**1.1 Introduction to the Chemistry [8 L]** History of Chemistry, Relevance of Chemistry, Chemistry of Life Introduction to Chemistry, Branches of Chemistry, Atoms and Molecules, Classifying matters: mixtures, elements and compounds, Periodic Table.Elements in human body, essential elements and non-essential elements, criteria of essentiality.General Survey of chemicals used in everyday life, Tools and Equipment's for Chemistry**.** **1.2 The World of Plastics and Polymers [7 L]** Introduction to polymers, Definition, classification, polymers all around us, Plastic in daily use: Polyethylene (HDPE and LDPE), PVC, PP, PET and PS., Environmental hazards of plastic, Biodegradable plastics, Recycling of Plastics, International universal recycling codes and symbol for identification, Natural Rubbers, Synthetic rubber, Vulcanization of Rubber, Biomedical uses of Polymers**.**	**15**
2	**Medicinal Chemistry in Daily Life (15 L)** Contribution of chemistry to human health and historical developments in medicine, **Drugs:** Introduction, definition, classification and nomenclature . **Drug Discovery and Development:** Stages in life of a Drug, Discovery, Chemical Development, Good Manufacturing Practices (GMP). Brand name and generic prescriptions, some common drugs used in our daily	15

	life. **Over-the counter drugs:** Analgesics and anti-inflammatory drugs, Antacids and indigestion aids, Cough remedies, cold remedies, decongestants, sleep aids, motion sickness drugs, agents to block acid formation. **Herbal Medicines:**History and Scope, traditional system of medicine, Major herbs used as herbal medicines- their botanical names, plant parts used, major chemical constituents and uses (Examples- Indian gooseberry (Amla),Haritaki (Hirada), Pippalimoolaetc.) **Drugs of Abuse:** Drug schedule, heroin, cocaine, marijuana	

REFERENCES:

1. Traditional Herbal Remedies for Primary Health Care, World Health Organization.
2. Chemistry in Context Applying Chemistry to Society, Fifth Edition, McGraw-Hill International Edition
3. Arber, Agnes (1999). Herbal Plants and Drugs. Mangal Deep Publications, Jaipur.Sivaranjan, V.V. and India, B. (1994). Ayurvedic Drugs and their plant Sources., Oxford and IBH Publishing Compony, 1994
4. Polymer Science, V.R. Gowarikar, N.V. Viswanathan, J. Sreedhar, New Age International
5. Aburjai, TandNatsheh, F.M. (2003). Plants in cosmetics. Phytotherapy Research 17: 987-1000.
6. Patri, F. and Silano, V. (2002). Plants in cosmetics: plants and plants preparations used as ingredients for cosmetic products- Volume 1 ISBN 978-92-871-8474-0, PP 218.

Course Description (Theory)	Skill Enhancement Course-I
Semester	I
Course Name	Techniques in Environmental Analysis-I
Course Code	USEC1TEA
Eligibility for Course	12^{th} Science
Credit	01
Hours	15

Course Objectives :

The objective of the course is to develop a basic understanding of water qualities and ability to use principles of water chemistry for water treatment and water quality control in the natural systems.

Course Outcomes :

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Categorise the various parameters for determining the water quality such as alkalinity, hardness, total dissolved solids etc.	Analysing
CO2	Apply knowledge of basic water chemistry to solve problems associated with water/ waste-water treatment and water quality.	Apply
CO3	Understand various water treatment processes.	Understand
CO4	Apply the basic practical knowledge for sample of water analyses.	Apply

Unit	Course Description	Hr
1	**Analysis of Water** **1.1** Need of analysis of water, water pollution & its types, career in water analysis, industries employing water analysis techniques. [**2 L**] **1.2 Water Quality Parameters. [8L]** Types of water, Physical and Chemical parameters of water. Physical parameter: color. Odour, taste, turbidity, total solids, dissolved solids, electrical conductivity, Chemical parameters: pH, acidity, alkalinity, salinity, hardness of water & its type, dissolved oxygen (DO), Chemical oxygen demand (C.O.D.), Bochemical Oxygen demand (B.O.D), Heavy metals. Rules & Regulations of water quality, name of agencies, Permissible limits of water quality parameters. **1.3 Water analysis & treatment [5L]** Various water quality monitoring instruments used for the analysis of water, sampling procedure for analysis of water, Coagulation, sedimentation, filtration, sterilization disinfection of water, Clark's process for softening of hard water, determination of hardness of water: titration method, complexometric method by EDTA.	15

References:

Theory:

1. Sharma, B. K., Industrial Chemistry (including Chemical Engineering), Goel Publishing House, Meerut (2000).
2. Varashney, C. K., Water Pollution and Management, 2nd Ed, New Age International (2018).
3. Srivastava, A., Waste Water Treatment and Water Management: Water Treatment and Management, Notion Press (2018).

Course Description (Theory)	Skill Enhancement Course-I
Semester	I
Course Name	Practical's in Techniques in Environmental Analysis-I
Course Code	USEC1TEP
Eligibility for Course	12th Science of all recognized Board
Credit	02
Hours	30

Course Outcomes :

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Find the p^H, Acidity, Alkalinity of the given water samples.	Find
CO2	Analyse the solid pollutant present in the water samples.	Analysing
CO3	Determine the total hardness and purity of the given water samples.	Evaluating

	Course Description	Hrs
	Analysis of Water 1 Water analysis: Sampling techniques for water analysis. 2. Determination of conductivity using Conductometer. 3. Determination of pH of Water using pH meter (electrometrically) 4. Determination of the acidity and alkalinity of water sample titrimetrically. 5. Determination of carbonate and bicarbonate of water sample. 6. Determination of chloride, nitrate, sulphate present in water sample. 7. Determination of dissolved oxygen (DO) in water sample using Winkler's (azide modification) method. 8. Analysis of solids present in water: suspended solids and dissolved solids. 9. Analysis of metals present in water: Fe and Mn spectrophotometrically. **10.** Determine the total hardness of given water samples (concentrations of Ca^{2+} and Mg^{2+})	30

References :

Practicals:

1. APHA, Standard Methods for the Examination of Water, Sewage and Industrial Wastes. 20th Ed., American Public Health Association: Washington, USA (1995).

Course Description (Theory)	Vocational Skill Course (VSC)
Semester	I
Course Name	Good Laboratory Practices-I
Course Code	UVSC1GLP
Eligibility for Course	12th Science of all recognizedBoard
Credit	02
Hours	30

Course Objective

1. To help learners in acquiring knowledge and skills necessary for performing the tasks of handling and maintaining the apparatus and equipment required for practical work.
2. To develop laboratory experiment related skill.
3. To understand about different aspects of good laboratory practices.
4. Competency in handling instruments and techniques in chemistry with Good Laboratory Practices.

5 . Competency in adoption of safety measures while working in the laboratory

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Apply practical skills in science courses with the understanding of laboratory practices	Apply
CO2	Understand the different aspects and laboratory techniques in Chemistry	Understanding
CO3	Make use of safety measures while working in the laboratory.	Apply

Scheme of examination of Vocational Skill Course (VSC)

1. Theory examination (40 Marks)
2. Practical Examination (60 Marks)

There will not be any internal examination

Unit	Course Description	Hrs
1	**Laboratory Practices in Chemistry [15 L]** **1.1 General Laboratory Practices:** Code of behaviour and practice in a laboratory, understanding the details on the label of reagent bottles, handling of hazardous chemicals, knowledge of common toxic chemicals and their handling, use and care of electronic balance, cleaning and drying of glassware. **1.2 Safety Measures in Laboratory** **1.2.1 Personal Safety:** Obligation from the teachers towards maintaining laboratory safety, personal protective equipment in laboratory, Disposal of chemical wastes. **1.2.2 Chemical Hazards:** Classification of hazardous chemicals, handling of chemicals, storage of chemicals, transport of bulk chemicals, transfer from large containers. **1.3 Laboratory Techniques :** Heating, Refluxing, filtration, Drying, recrystallization, determination of melting point, distillation, determination of boiling point	15

2	**Practical's –** 1. Introduction to common laboratory apparatus. 2. Preparation of standard and stock solutions, dilution, preparation of water based and alcohol based reagents (Fehling A and B, Starch solution) 3. Purification of organic compounds by crystallization from water, alcohol and alcohol-water. (minimum three compounds) 4. Purification of organic compounds by distillation. 5. Criteria of purity: Determination of melting and boiling points. 6. Supply of Gas, Electricity and Water in Laboratory. 7. Safe disposal of Laboratory waste. 8 Classification and handling of hazardous chemicals.	30

Reference:

1. Garner, W.Y., Barge M.S., Ussary P.J. (1992). Good Laboratory Practice Standards: Application for field and Laboratory studies. Wiley VCH.
2. Seiler J.P. (2005). Good Laboratory Practices: the why and how. Springer-Verlag Berlin and Heidelberg GmbH & Co. K; 2nd Edition
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Edition, Pearson (2012)
5. Mendham, J., A.I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.

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Program: B. Sc. in Chemistry

SYLLABUS

(Approved in the Academic Council Meeting held on 27/ 06 /2023)

F.Y.B.Sc. Chemistry

According to National Education Policy -2020

w.e.f. Academic Year 2023-24

NEP-2020

BACHELOR'S IN SCIENCE (B. Sc.)

Course Description (Theory)	Major Chemistry
Semester	II
Course Name	General Chemistry – III
Course Code	USC2GCH3
Eligibility for Course	12th Science of all recognizedBoard
Credit	02
Hours	30

Course Objectives

- To develop problem solving skills in students.
- To make students capable of studying Chemistry in academic and Industrial courses.
- To develop analytical skills and critical thinking through application of theory knowledge into practical course
- To acquaint students with the fundamental Organic, Inorganic, Physical & Analytical Chemistry.

Course Outcomes:

COs.	**After completing course, Students will able to**	**Bloom Taxonomy Level (BTL)**
CO 1	Explain deviations from ideal gas laws , Joule-Thomson effect and nanotechnology with the experimental setup.	Understand
CO 2	Define the equilibrium constant, Le-Chatelier Principle and the second law of thermodynamics.	Remember
CO 3	Discuss basic terms of co-ordination chemistry, qualitative analysis and acid-base theories	Understand
CO 4	Identify the products of reactions of alkanes, alkenes and alkynes.	Apply

Unit	**Course Description**	Hrs
1	**1.1 Chemical Kinetics : (6 L)** Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, integrated rate equation of first and second order reactions (with equal initial concentration of reactants) (Numericals	15

	expected) Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method (Numericals expected) **1.2 Chemical Calculations: (4L)** Expressing concentration of solutions: Normality, molality, molarity, formality, mole fractions, weight ratio, volume ratio, weight to volume ratio, ppm, ppb, millimoles, milliequivalents (Numericals expected) **1.3 Concept of Qualitative Analysis: (3 L)** 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.) **1.4 Coordination chemistry: (2 L)** 1. Introduction to coordination compound 2. Terminology in coordination compound 3. Types of ligand.	
2	**2.1 Chemistry of Aliphatic Hydrocarbons** 2.1.1 Physical and chemical properties of alkane, alkene and alkynes : **(1L)** 2.1.2 Carbon-Carbon sigma bonds: **(3L)** Chemistry of alkanes: Formation of alkanes by Corey-House reaction, Sabatier-Sanderens reaction, and Reaction of alkanes- , Chlorination, Iodination, Nitration, Sulphonation, 2.1.3 Carbon-Carbon pi bonds: **(6 L)** Formation of alkenes and alkynes by elimination reactions: Mechanism of E1, E2, E1cb, Saytzeff and Hofmann eliminations Reactions of alkenes: Electrophilic additions ,their mechanisms (Markownikoff/ Anti Markownikoff addition), Mechanism of oxymercuration-demercuration, ozonolysis, Reduction (catalytic and chemical), 1, 2-and 1, 4- addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination using N-bromosuccinimide and	15

	mechanism, e.g. propene, 1-butene, toluene, ethylbenzene. **2.2 Acid Base Theories [5 L]** Arrhenius, Lowry- Bronsted, Lewis, Lux-Flood acid –base concept, Usanovich acid –base concept, Solvent – Solute concept of acids and bases, Hard and Soft acids and bases, Applications of HSAB in understanding organic reactions like Friedel Craft's reaction.	

Course Description (Theory)	Major Chemistry
Semester	II
Course Name	General Chemistry – IV
Course Code	USC2GCH4
Eligibility for Course	12^{th} Science of all recognizedBoard
Credit	02
Hours	30

Course Objectives

- To construct the problem solving approach in the students.
- To build the skills in the students to apply their theory and practical knowledge in real life.
- To produce knowledge of various chemical reagents and their reactivity in industrial fields.

Course Outcomes

COs.	**After completing course, Students will able to**	**Bloom Taxonomy Level (BTL)**
CO 1	Identify the shapes of molecules with and without lone pair of electrons and the oxidation number of elements to balance the redox equations.	Apply
CO 2	Explain Law of crystallography, Different types of interaction of electromagnetic radiation with matter, Degree of ionization and Henderson equation for acidic and basic buffers.	Understand
CO 3	Classify between aromatic, anti-aromatic, and non-aromatic compounds	Understand
CO 4	Write the mechanism of the Electrophilic aromatic substitution reaction.	Apply

Unit	Course Description	Hrs
1	**1.1 Ionic Equilibria : (6L)** 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, dissociation constants of mono-, di- and triprotic acid (exact treatment for monoprotic acid) **Buffers:** Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected) **1.2 Liquid State: (4L)** Surface tension: Introduction, methods of determination of surface tension by drop number method (Numericals expected) Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer (Numericals expected) Refractive index: Introduction, molar refraction and polarizability, determination of refractive index by Abbe's refractometer (Numerical expected) **1.3 Chemical Bond and Reactivity: (5 L)** Types of chemical bond, comparison between ionic and covalent bonds, polarizability (Fajan's Rule), shapes of molecules, Lewis dot structure, Sidgwick Powell Theory, basic VSEPR theory for ABn type molecules with and without lone pair of electrons, isoelectronic principles, applications and limitations of VSEPR theory **[5 L]**	15
2	**2.1 Aromatic Hydrocarbons: (10L)** Aromaticity: Hückel's rule anti-aromaticity, 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. Hammond's postulate, directing effects of the groups. Disadvantages of F&C acylation and alkylation reaction. Name reaction Involving Electrophilic aromatic substitution. Activating and deactivating groups Mono and Disubstituted compounds and their orienting effects the groups. Activating and deactivating groups Mono and Disubstituted compounds and their orienting effects. **2.2 General Principles of Metallurgy: (5L)** i) Introduction, occurrence of metals, ores and minerals, types of ores. ii) operations involved in metallurgy:- crushing, methods of concentration such	15

	as hand picking, gravity separation, Froth floatation, Calcinations, Roasting etc. iii) Reduction:- Auto reduction, Aluminothermic process and electrolytic reduction. iv) Refining of metals:- poling, liquation, electrolytic and vapour phase refining. i) Extraction of elements: (example: isolation of copper by auto reduction)	

Course Description (Theory)	Major Chemistry
Semester	II
Course Name	Chemistry Practical
Course Code	USC2CHP
Eligibility for Course	12th Science of all recognizedBoard
Credit	02
Hours	30

Course Objectives

- To develop practical skills of identification of organic compounds.
- To identify the compounds by performing chemical tests.
- To develop the skills of titrations in the students.

Course Outcomes

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO 1	Apply chemical kinetics law to calculate the rate constant of reaction.	Apply
CO 2	Make use of colorimeter and pH meter.	Apply
CO 3	Identify organic compound containing C,H (O) N, S, X elements.	Apply
CO 4	Identify cations and anions from the given mixture of compounds and percentage of metal present in the sample by titration.	Apply

Course Description		Hrs
	Physical Chemistry 1. Determination of viscosity of given liquid by viscometer. 2. To determine dissociation constant of weak acid (Ka) using Henderson's equation and the method of incomplete titration pH metrically.	30

	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. **Inorganic Chemistry** **1. Qualitative analysis: (at least 3 mixtures to be analyzed)** Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions. Cations (from amongst): Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}, K^{+},$NH4^{+}$ Anions (From amongst): CO_3^{2-}, S^{2-}, SO_3^{2-}, NO_2^{-}, NO_3^{-} , Cl^{-}, Br^{-}, I^{-}, SO_4^{2-}, PO_4^{3-}. (Scheme of analysis should avoid use of sulphide ion in any form for Precipitation / separation of cations.) **2. Redox Titration:** 1 . To determine the percentage of copper(II) present in a given sample by titration against a standard aqueous solution of sodium thiosulfate (iodometry titration) 2 Estimation of available chlorine in bleaching powder iodometrically. **Organic Chemistry** Characterization of monofunctional organic compound (solid, liquid) containing C, H, (O), N, S, X elements. (minimum 6 compounds) **Characteristic Reactions of following Test** 1. Test for unsaturation (KMnO4 and bromine water) 2. Test for acid 3) Test for phenol 4) Test for base 5) Test for nitrogen 6) Test for sulphur 7) Test for halogens 8. Functional groups test A) Alcohols B) Aldehyde and ketone C) Esters D) Primary aromatic amines F) Phenol E) Nitro/Dinitro G) Amide	

References:

Theory-

1. Atkins P.W. and Paula J.de, Atkin's Physical Chemistry, 10th Ed., OxfordUniversity 12 Press (2014).
2. Ball D.W., Physical Chemistry, Thomson Press, India (2007).

3. Castellan G.W., Physical Chemistry, 4th Ed., Narosa (2004).
4. Mortimer R.G., Physical Chemistry, 3rd Ed., Elsevier: NOIDA, UP (2009).
5. Engel T. and Reid P., Physical Chemistry, 3rd Ed., Pearson (2013).
6. Peter A. and Paula J. de., Physical Chemistry, 10th Ed., Oxford University Press(2014).
7. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt.Ltd.,New Delhi (2004).
8. Levine I.N., Physical Chemistry, 6th Ed., Tata Mc Graw Hill (2010).
9. Metz C.R., 2000 Solved Problems in Chemistry, Schaum Series (2006).
10. Mortimer R.G., Physical Chemistry, 3rd Ed., Elsevier: NOIDA, UP (2009).
11. Banwell C.N., Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGrawHill (1994).
12. K.L. Kapoor, A Textbook of Physical Chemistry, Macmillan (2000).
13. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
14. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970
15. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.
16. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
17. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
18. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
19. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
20. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
21. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
22. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

Practical's :

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R.Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in PhysicalChemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New AgeInternational, New Delhi (2001).
5. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, PearsonEducation (2009)
7. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. PracticalOrganic Chemistry, 5th Ed., Pearson (2012)
8. 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.

Course Description (Theory)	Open Elective-III
Semester	II
Course Name	Chemistry in Everyday Life-II
Course Code	UOE2CEL2
Eligibility for Course	12^{th} Science of all recognized Board
Credit	02
Hours	30

Course Objectives

- To provide an overview and familiarize the students with the importance of chemistry in everyday life.
- To impart the introductory knowledge of chemistry among the learners to improve the quality of life.
- To create awareness among the learners about the chemicals and materials used in daily life.
- To acquire the ability of identifying the importance and hazards of chemicals to the

society.

- Develop the learners understanding and ability to evaluate food adulteration and herbal medicines.

Course Outcomes:

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Know the various compounds used in the everyday life.	Find
CO2	Analyse the role of chemistry in the different compounds utilised in the daily life.	Analyse
CO3	Understand the importance of chemistry in the everyday life	Understand

Unit	Course Description	Hrs
1	**Cosmetics, Perfumery, Soaps and Detergents [15 L]** **Cosmetics:** **Skin care: -** Moisturizing cream, cold cream, sun screen, lotions, vanishing cream and their relative skin sensory, Role of Aloe and Turmeric in skin care **Decorative: -**Talcum powder, Lipsticks, face creams, dental cosmetics, nail polish, foundation, primer etc., **Hair care: -**Hair dyes, conditioning shampoo, antidandruff shampoo, hair conditioner, hair oil, Role of Heena and Amla in hair care **Perfumery:** Raw material: natural and synthetic, Floral accord, deodorants **Soaps and Detergents:** **Soaps:** Basic chemical composition of soaps, surface active agents, builders, additives, fillers and fragrance, bathing bars, washing soaps, toilet soaps. **Detergents:** Introduction, detergent action, significance of acidity and alkalinity, common detergent chemicals, Environmental hazards Side effects of cosmetics, perfumes, soaps and detergents	15
2	**Food-Nutrients, Preservatives ,Adulteration. [15 L]** **Food Nutrients:** Introduction to nutrition - Food as a source of nutrients. Types of nutrients: Essential nutrients and non-essential nutrients. Functions of	15

	food and nutrients. **Food Preservatives**: Introduction to food preservation. Objectives and principles of food preservation. Food preservatives like benzoates, propionates, sorbates, disulphites. Common methods used for food preservation. Methods of food handling and storage. **Food Adulteration:** Introduction. Methods of Food Adulteration. Adulterants in Milk, Ghee, Oil, grain, pulses, Sugar, Spices, Processed food. Food Additives and Sweetening agents, Harmful Effects of adulteration.(Demonstration of Adulteration detection methods for a minimum of 2 common foods (one method each).	

References :

1. Traditional Herbal Remedies for Primary Health Care, World Health Organization.
2. Chemistry in Context Applying Chemistry to Society, Fifth Edition, McGraw-Hill International Edition
3. Heterocyclic Chemistry, Fifth Edition, J.A. Joule and K. Mills, Wiley
4. RodaySS (2012): Food Science and Nutrition, 2nd Ed. Oxford University Press.
5. Mann J and Truswell S (2017): Essential of Human Nutrition, 5th Ed. Oxford University Press.
6. Subalakshmi, G and Udipi, SA (2006): Food processing and preservation. 1st Ed. New Age International (P) Ltd.
7. Srilakshmi B (2018): Food Science, 7thColour Ed. New Age International (P) Ltd

Course Description (Theory)	Skill Enhancement Course-II
Semester	II
Course Name	Techniques in Environmental Analysis-II
Course Code	USEC2TEA
Eligibility for Course	12th Science
Credit	01
Hours	15

Course Objectives:

The objective of course is to enhance skills, knowledge and develop research aptitude in the students.

Course Outcomes:

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Understanding the sources and causes of soil pollution.	Understand
CO2	Study the soil pollution to understand the various health impacts.	Understand
CO3	List the various control measure of soil pollution.	Analysis
CO4	Determine the quality of soil of the surrounding.	Evaluate

Unit	Course Description	Hrs
1.	**1.1 Soil Chemistry** [5 L] Components of soil, soil profile, physical properties of soil , soil texture, particle size analysis, soil structure, classification, Inorganic and organic components, various physicochemical parameters to be study for the collected samples of soil, soil colour, elementary knowledge of soil classification of Indian soil, soil moisture constants, soil colloids, Soil as a source of plant nutrients, essential and beneficial elements **1.2 Soil Pollution & Control: [10 L]** Definition, Sources, Types of soil pollution. Physicochemical and microbial Characteristics of soil pollutants. Causes of soil pollution, Soil pollution from Industrial Waste, Domestic Waste, Agricultural Waste and Agrochemical residues. Fertilizers, insecticides, and their effect on soil, soil fertility, different approaches for soil fertility evaluation. Different effects of soil pollutants. Remedial measures of soil pollution, and degradation; effect of soil pollution on environment, vegetation and other life forms , Soil Pollution control measures, Soil micro-organisms and their functions - degradation of pesticides and synthetic fertilizers. Soil conservation.	15

References :

1) Environmental Pollution Control Engineering: C. S. Rao
2) Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications,2nd Edition, McGraw-Hill, 2000.
3) Environmental Chemistry : B.K. Sharma, and H. Kaur
4) J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.
5) Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.
6) Air pollution and Environmental Protection – Legislative policies, Judicial trend and Social perceptions: N. Kumar; Mittal Publication
7) Ecology and Environment – P.D. Sharma
8) Environmental Chemistry – V.P. Khudesia
9) Environmental Chemistry – A.K. De, Wiley Eastern ltd. New Delhi

Course Description (Theory)	Skill Enhancement Course-I
Semester	II
Course Name	Practical's in Techniques in Environmental Analysis-II
Course Code	USEC2TEP
Eligibility for Course	12^{th} Science of all recognizedBoard
Credit	02
Hours	30

Course Objectives:

The course objective is to train the students to acquire various practical skills required for soil analysis.

Course Outcomes :

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Identify the quality of soil of the surroundings.	Apply
CO2	Develop the environmental control plan for environment pollution problem.	Apply
CO3	Classify the various samples of soil according to their purity.	Understanding
CO4	Discover the various components of soil.	Analyse

Unit	Course Description	Hrs
1.	1. Determination of total organic matter and moisture content of soil. 2. Determination of pH value of different types of soil. 3. Determination of water holding capacity of soil. 4. Determination of mechanical composition of soil by Pipette method. 5. Determination of SAR value of soil.(Sodium Absorption Ratio.) 6. Determination of available phosphorous from the soil sample. 7. Determination of available Calcium carbonate from the soil sample. 8. Determination of electrical conductivity of the soil sample by using Electrical conductivity meter. 9) Preparation of soil health card. 10) Determination of Gypsum requirement of the soil. 11) Estimation of Calcium and Magnesium ions by complexometric titration. 12) Determination of bulk density and particle density of the soil sample.	30

References :

1. Soil and air analysis by S.K. Maiti.
2. A comprehensive laboratory manual for Environmental Sciences and Engineering By P.R. Sreemahadevan Pillai. New Age International Publishers.
3. Chemical and biological methods for water pollution studies By R.K. Trivedi.
4. Introduction to soil laboratory manual-J.J.Harset stipes.
5. Introduction to soil science laboratory manual, Palmer and troch-Lowa state.
6. Sarkar, D.; Haldar, A. Physical and Chemical Methods in Soil Analysis, 2nd Ed., New Age International (2010).
7. Saha, A. K. Methods of Physical and Chemical Analysis of Soil, Kalyani Publishers (2008).

Course Description (Theory)	Vocational Skill Course (VSC)
Semester	II
Course Name	Good Laboratory Practices -II
Course Code	UVSC2GLP
Eligibility for Course	12^{th} Science of all recognizedBoard
Credit	02
Hours	30

Course Objectives:

The course objective is to train the students to acquire various practical skills required for soil analysis.

Course Outcomes :

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Apply the skills of laboratory techniques in performing laboratory work.	Applying
CO2	Make use of safety measures while working in the laboratory.	Applying

Unit	Course Description	Hrs
1	**Laboratory Practices in Chemistry [15 L]** **1.1 General Laboratory Practices:** Preparation of solutions, Molarity and normality of common acids and bases. Dilutions. Technique of handling micropipettes. **1.2 Safety Measures in Laboratory** **1.2.1 Fire Hazards:** Fire hazards in in the laboratory- The Fire Triangle, causes of fires, classification of fires, Precautions of fire prevention-Fire alarms, fire escapes, fire barriers, Extinguishing a Fire- Fire Extinguishers, Use of Fire Extinguishers **1.2.2 Accidents and First Aid:** Accident Reporting- The need for reporting accident, accident reporting procedure First Aid Box- Placement of First Aid Box, Contents of First Aid Box, General features of First Aid Procedure, Scope of First Aid. **1.3 Laboratory Techniques :** Laboratory centrifuge, rotary evaporator, use of micropipette, pH meter, conductivity meter, common calculations in chemistry laboratories,	15

	general guidelines for preparation of solutions, methods of preparing solutions, molar and normal solutions.	
2	**Practical : [30L]** 1. Preparation of solutions of different molarity/ normality of titrants. 2. Preparation of standard oxalic acid solution and determination of strength of NaOH. 3. Fire safety measures in a Laboratory. 4. Attending of Emergency Situations. 5. Preparation of crystals from given salt. 6. Preparation of dyes. 7. Preparation of aspirin and its comparison with an aspirin tablet by TLC. 8. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps using pH meter. 9. Conductometric titration of strong acid vs strong base. 10. Preparation of Buffer solution and determination of pH using pH paper and pH meter	30

Reference:

1. Garner, W.Y., Barge M.S., Ussary P.J. (1992). Good Laboratory Practice Standards: Application for field and Laboratory studies. Wiley VCH.
2. Seiler J.P. (2005). Good Laboratory Practices: the why and how. Springer-Verlag Berlin and Heidelberg GmbH & Co. K; 2nd Edition
3. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Edition, Pearson (2012)
5. Mendham, J., A.I. Vogel's Quantitative Chemical Analysis Sixth Edition, Pearson, 2009.

Course Description (Theory)	Minor Chemistry-I
Semester	II
Course Name	Fundamentals of Chemistry
Course Code	USC2CHM
Eligibility for Course	12^{th} Science of all recognized Board
Credit	01
Hours	30

Course Objectives:

The objectives of the course to develop the basic concepts, fundamental knowledge of the chemistry subject among the students.

Course Outcomes :

COs.	After completing course, Students will able to	Bloom Taxonomy Level (BTL)
CO1	Explain study chemical equilibrium	Understand
CO2	Explain the basics of acids and bases.	Understand
CO3	Understand the fundamentals of chemistry	Understand

Unit	Course Description	Hrs
1	**Fundamentals of Chemistry.** **Ionic Equilibria: (05 L)** 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, degree of hydrolysis and pH for different salts. Buffer solutions, Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. **Acids and Bases: (05 L)** Arrhenius concept, Bronsted-Lowry concept, Lux-Flood and Lewis concept of acids and bases; Hard and Soft Acid-Base Theory: Classification of acids and bases as hard and soft. Pearson's hard and soft acid base concept, acid base strength and hardness and softness. **Fundamentals of Organic Chemistry : (5L)** Physical Effects, Electronic Displacements: Inductive Effect, Electrometric	15

	Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles.	

Course Description (Theory)	Minor Chemistry-I
Semester	II
Course Name	Practical's in Minor Chemistry-I
Course Code	USC2CHMP
Eligibility for Course	12^{th} Science of all recognized Board
Credit	01
Hours	30

Course Objectives:

The objectives of the course to develop the practical skills in chemistry subject, knowledge of laboratory chemicals, basic chemical tests .

Course Outcomes :

COs.	**After completing course, Students will able to**	**Bloom Taxonomy Level (BTL)**
CO1	prepare solutions of different Molarity/Normality.	Apply
CO2	determine quality of substance.	Analyse
CO3	perform the estimation of fruit juices, shampoos etc.	Analyse
CO4	Separate the mixtures by Chromatography.	Analyse

	Course Description	Hrs
	1) Determination of Hardness of water 2) Determination of pH, acidity and alkalinity of a water sample. 3) Purification of organic compounds by crystallization (from water and alcohol) and distillation. 4) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH- meter.	30

	5) Preparation of solutions of different Molarity/Normality of titrants. 6) Estimation of oxalic acid by titrating it with KMnO4. 7) Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 8) Determination of the melting points of the compounds and unknown organic compounds. 9) Determination of boiling point of liquid compounds. (boiling point lower than and more than 100°C by distillation and capillary method. 10) Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements) 11) . Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given) (Any Two) a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography. b) Identify and separate the sugars present in the given mixture by paper chromatography. 12) Organic Qualitative Analysis (Any Four) a) Type determination b) Physical constants b) d) Preliminary tests Functional group tests.	

References :

1. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt. Ltd.,New Delhi (2004).
2. Levine I.N., Physical Chemistry, 6th Ed., Tata Mc Graw Hill (2010).
3. Metz C.R., 2000 Solved Problems in Chemistry, Schaum Series (2006).
4. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
5. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
6. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
8. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).

UNIVERSITY OF MUMBAI

Janardan Bhagat shikshan Prasarak Sanstha's

Changu Kana Thakur
Arts, Commerce and Science College, New Panvel (Autonomous)

Re-accredited A+ Grade by NAAC

'College with Potential for Excellence 'Status Awarded by University Grants Commission 'Best College Award' by University of Mumbai

Programme: S.Y.B.Sc. (Choice Based Credit System)

Course: Chemistry

Syllabus for Semester III and IV

To be implemented from the Academic year 2020-2021

JanardanBhagatshikshanPrasarakSanstha's

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AC_ 2020-2021

Item No._____

Syllabus for Approval

Sr. No.	Heading	Particulars
1	**Title of Course**	**S. Y. B. Sc. Chemistry**
2	**Eligibility for Admission**	F. Y. B. Sc. Passed from this autonomous college or university of mumbai (or with ATKT in any three courses at the F. Y. B. Sc. Level) or equivalent qualification from other universities as may have been allowed by the relevant ordinances of this autonomous college or university of mumbai
3	**Passing marks**	**40%**
4	**Ordinances/Regulations (if any)**	
5	**No. of Semesters**	**Two**
6	**Level**	**U.G.**
7	**Pattern**	**Semester**
8	**Status**	**New**
9	**To be implemented from Academic year**	**2020-2021**

Date : 20-6-2021

Dr.S.K.Patil
BOS Chairperson:
Vice Principal & Head
Department of Chemistry

Signature:

Prin. Dr. Bahrate V.D.

JanardanBhagatshikshanPrasarakSanstha's

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Essentials Elements of The Syllabus

1	**Title of Course**	Syllabus for two semester S. Y. B. Sc. course in chemistry
2	**Couse Code**	USC3CH1, USC3CH2, USC3CH3 USC4CH1, USC4CH2, USC4CH3, USC3CHP ,USC4CHP
3	**Preamble**	Attached
4	**Objective**	• To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry. • To make the learner proficient in analysing the various observations and chemical phenomena presented to him during the course. • To make the learner capable of solving problems in the various units of this course • To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry • To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling • To make the learner capable of analysing and interpreting results of the experiments he conducts or performs
5	**Eligibility**	Pass F. Y. B. Sc.
6	**Fee Structure**	As Per Guidelines issued from the autonomous college or university of Mumbai
7	**No. of Lectures**	9 lectures per week (three lectures per paper)
8	**No. of Practicals**	9 periods per week (three periods per paper)
9	**Duration of Course**	Two Semester

10	**Notional Hours**	72 hours per paper per semester Theory and 36 hours per paper per semester for laboratory sessions
11	**No of students per batch**	120 students per division (20 Students for laboratory sessions)
12	**Selection**	As per merit.
13	**Assessment**	**End of semester examination of 75 marks per paper for theory and 50 marks per paper for laboratory sessions**
14	**Syllabus Detail**	**Attached**
15	**Title of the Unit**	**As given in the Syllabus text**
16	**Title of the Sub-unit**	**As given in the syllabus text.**
17	**Semester wise Theory**	**As prescribed in the syllabus text**
18	**Semester wise Practicals**	**As prescribed in the syllabus text.**
19	**Question Paper Pattern**	**As prescribed by the Faculty of Science**
20	**Scheme of evaluation of Project**	**N.A.**
21	**List of suggested reading**	**As Attached**
22	**List of websites**	**As Attached**
23	**List of You Tube videos**	**As attached**
24	**List of MOOCs**	**As Attached**

Examination Scheme

Choice Based Credit System (CBCS)

The performance of the learners shall be evaluated into two components. The learner's Performance shall be assessed by Internal Assessment with 40% marks in the first component and by conducting the Semester End Examinations with 60% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinationsare as shown below –

A) Internal Assessment: 40 % 40 Marks
B) Semester End Examination: 60 % 60 Marks

A) Internal Assessment: 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20
02	Any one tool out of these (15 Marks each) 1. Group/ Individual Project 2. Presentation and write up on the selected topics of the subjects 3. Test on Practical Skills 4. Open Book Test	15
03	Overall Conduct and Attendance	05

Question Paper Pattern for Periodical Class Test/ online examination--

- Maximum marks : 20
- Duration : 30 Minutes

Particular	Marks
Match the Column / Fill in the Blanks / Multiple Choice Questions/ True/False/Answer in One or Two Lines (Concept based Questions) (1 Marks each)	20 Marks

B. Question Paper Pattern for Semester End Examination:

Semester End Examination: 60% (60 Marks)

Undergraduate Programmes of T.Y.B.Sc. (Sem. V & VI)

Duration: The examination shall be of 2 hours duration.

Theory question paper pattern
1. There shall be FOUR questions of 15 marks each.
2. On each unit there will be one question and fourth question will be based on entire syllabus.
3. Question Number 1-3 shall be compulsory with 100 % internal options and question number four is compulsory which having 30% options.
4. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

Question Paper Pattern for Practical Examination

Semester End Practical Examination practical course

(150 Marks)

- Laboratory Work (105 Marks)
- Journal (30 Marks)
- Viva (15 Marks)

- The practical examination will be held for 9.0 hrs.
- The candidates will be examined practically and orally.

REGULATIONS

1. Preamble and objectives of the Course :

In the first two semseters of the six semester graduation program of B. Sc.(Chemistry) the learner was introduced to some basic aspects in the various core branches of chemistry like Physical Chemistry, Organic chemistry and Inorganic chemistry. Concepts about the structure of atom, distribution of electrons, Thermodynamics, Formation of organic compounds and basic ideas in reactivity of molecules in general and organic compounds in particular were introduced to the learner. He was made inquisitive about why and how should atoms combine to give molecules or ions. The non-orbital approach to appreciating the shapes of polyatomic species in general and molecules in particular.

The story of chemistry is taken further in the coming two semesters of the second year of the B. Sc. (Chemistry) Program. However it is also realised that some students opting for the course on Chemistry may not continue with the subject subsequently as such the syllabus is designed to retain the interest of the serious learner of chemistry as well as be helpful to non-chemistry learners. With such students who would want to pursue other branches of science but would want to acquire a basic appreciation and experience of chemistry a separate paper (Paper-III) is designed. This paper along with the laboratory session unit that goes with it deals with the basics of chemical analysis, separating components from a given sample, basic concepts like pH, experimental techniques like Titrimetry, Gravimetry, using instruments to carry out analysis, the various techniques like chromatography, electrophoresis, Instrumentation in general is felt to be of interest to learners of various branches like physics, botany, zoology, and microbiology.

The major objectives of B.Sc. Chemistry course are

- To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.

- To make the learner proficient in analysing the various observations and chemical phenomena presented to him during the course.
- To make the learner capable of solving problems in the various units of this course
- To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry
- To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling
- To make the learner capable of analysing and interpreting results of the experiments he conducts or performs
- To make the learner capable of acquiring or pursuing a source of livelihood like jobs in chemical industry
- To arouse the interest to pursue higher levels of learning in chemistry,

2. Condition for Admission

A candidate who has passed the F.Y.B.Sc. of Mumbai University or an examination of some other university accepted by the syndicate as equivalent there to with Chemistry, Physics, Maths, Botany, Zoology or Life Science shall be eligible for admission into S.Y.B.Sc., course in Chemistry.

To

3. Duration of the Course: one year

4. Course of study:

JanardanBhagatshikshanPrasarakSanstha's

Changu Kana Thakur

Arts, Commerce and Science College, New Panvel (Autonomous)

Re-accredited A+ Grade by NAAC
'College with Potential for Excellence 'Status Awarded by University Grants Commission
'Best College Award' by University of Mumbai

Draft of the proposed revised syllabus for
Choice Based Credit System
S.Y.B.Sc. Chemistry
To be implemented from the Academic year 2020-2021

For the subject of chemistry there shall be three papers for 45 lectures each comprising of three units of 15 L each.

Semester-III

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
3. Paper III Basics of Analytical Chemistry
   Unit-I Intorduction to Analytical Chemistry and Statistical Treatment of analytical data-
   Unit-II Classical Methods of Analysis
   Unit-III Instrumental Methods-I

Semester-IV

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
   Unit-II Inorganic Chemistry
   Unit-III Organic Chemistry.
   Basics of Analytical Chemistry

4. Paper III Basics of Analytical Chemistry
   Unit-I Separation Techniques in Analytical Chemistry -
   Unit-II Instrumental Methods-II
   Unit-III Statistical Treatment of analytical data --II

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Choice Based Credit System

S. Y. B. Sc.

Chemistry Syllabus

To be implemented from the Academic year 2020-2021

Course Content

Semester III

Course Code	Unit	Topics	Credits	L/Week
USC3CH1	I	Chemical Thermodynamics-II, Electrochemistry	2	1
	II	Chemical Bonding		1
	III	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides		1
USC3CH2	I	Chemical Kinetics-II, Solutions	2	1
	II	Selected topics on p block elements		1
	III	Carbonyl Compounds		1
USC3CH3	I	Introduction to Analytical Chemistry and Statistical Treatment of analytical data-I	2	1
	II	Classical Methods of Analysis .		1
	III	Instrumental Methods-I		1
USC3CHP		Chemistry Practicals I	1	3
		Chemistry Practicals II	1	3
		Chemistry Practicals III	1	3

Semester IV

Course Code	Unit	Topics	Credits	L/Week
USC4CH1	I	Electrochemistry-II, Phase Equilibria	2	1
	II	Comparative Chemistry of the transition metals & Coordination Chemistry		1
	III	Carboxylic acids and their derivatives, Stereochemistry		1
USC4CH2	I	Solid state,Catalysis	2	1
	II	Ions in aqeous medium & Uses and Environmental Chemistry of volatile Oxides and oxo-acids		1
	III	Compounds, Stereochemistry		1
USC4CH3	I	Separation Techniques in Analytical Chemistry	2	1
	II	Instrumental Methods-II		1
	III	Statistical Treatment of analytical data --II		1
USC4CHP		Chemistry Practicals I	1	3
		Chemistry Practicals II	1	3
		Chemistry Practicals III	1	3

Semester III
Paper I
Theory: 45 Lectures

Unit I:Physical Chemistry

1.1 Chemical Thermodynamics-II(8L)

1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's
free energy with Pressure and Temperature.
1.1.2 Gibbs-Helmholtz equation, van't Hoff reaction isotherm and van't Hoff reaction isochore.
(Numericals expected).
1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation.
1.1.4 Concept of Fugacity and Activity

1.2 Electrochemistry: (7L)

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.

Unit-II
Chemical Bonding

2.1 Non-Directional Bonding (4L)

2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond.
2.1.2 Types of Ionic Crystals
2.1.3 Radius Ratio Rules
2.1.4 Lattice Energy, Borne-Lande Equation
2.1.5 Kapustinski Equation
2.1.6 Born-Haber Cycle and its Application

2.2. Directional Bonding: Orbital Approach. (6L)

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 Homonuclear diatomic molecules from He_2 to Ne_2

2.2.4 Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures.

2.2.5 Bonding in Polyatomic Species: The role of Hybridization. And types of hybrid orbitals-*sp, sp^2, sp^3, sp^3d, $sp^2d^2$and sp^2d sp^3d^2*.

2.2.6 Equivalent and Non-Equivalent hybrid orbitals

2.2.7 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)

2.3 Molecular Orbital Theory (5L)

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 Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2,O_{2+} O_{2-},O_{22-}

(Problems and numerical problems expected wherever possible)

Unit III: Organic Chemistry

3.1.1. Reactions and reactivity of halogenated hydrocarbons: [4L]

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.

3.1.3. Organomagnesium and organolithium compounds: [3L]

Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl / aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO2, cyanides and epoxides.

3.2 Alcohols, phenols and epoxides: [8L]

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.

3.2.3. **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.

Semester III

Paper II

Unit I: Physical Chemistry

1.1 Chemical Kinetics-II (7L)

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 (Ea). (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)

1.2 Solutions: (8 L)

1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature -composition curves of ideal and non-ideal solutions. 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 , Triethanolamine – 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.

Unit-II

2. Selected topics on p block elements (15L)

2.1 Chemistry of Boron compounds

2.1.1 Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications.

2.1.2 Preparation of simple boranes like diborane and tetraborane.

2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds)

2.1.4 Synthesis of Borax.

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 and Germanium

2.3 Chemistry of Nitrogen family

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.

Unit III: Organic Chemistry

Carbonyl Compounds: [15L]

3.1 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

3.2 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions.

3.3 Reactions of aldehydes and ketones with $NaHSO_3$, HCN, RMgX, alcohol, amine, , 2,4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$.

3.4 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, and Cannizzaro reaction.

3.5 Keto-enol tautomerism: Mechanism of acid and base catalysed enolization

3.6 Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols.

3.7 Stereochemistry: (5 L)

Regioselective, chemoselective, stereoselective and stereospecific reactions.

Stereochemistry of: i) Substitution reaction (SN^1, SN^2 and SN^i)

ii) Addition reaction (catalytic hydrogenation) (5L)

Semester III
Paper III
Basics in analytical Chemistry

1. Introduction to Analytical Chemistry (15 L)

1.1 Introduction (6L)

1.1.1 General introd-uction of analytical chemistry

1.1.2 Chemical Analysis: Qualitative and Quantitative analysis. Common Analytical Problems, Important terms associated with chemical analysis, Steps in chemical analysis, 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 Classification of analytical methods (Classical & instrumental methods)

Importance of analytical chemistry in various fields (Pharmaceutical, Clinical, agriculture, environmental studies and research).

1.2 Errors in Analysis (3L)

1.2.1 Concepts of Accuracy and Precision: terms,

1.2.2 Types of Errors: Determinate and Indeterminate error

1.2.3 Expression of error: Absolute and Relative Error &Constant and proportionate error

1.2.4 Minimization of Determinate error

1.3 Interpretation of Results of Analysis (6L)

1.3.1 Concept of true and acceptable value

1.3.2 Measures of central tendency: Mean, median, mode

1.3.3 Measures of Dispersion: Absolute Deviation, Relative Deviation, Relative average deviation, standard deviation, variance, coefficient of variation.

1.4 Significant Figure

(*Problemsincluding Numericals expected*)

2. Classical methods of Analysis –I (15L)

2.1 Titrimetric Analysis -I(1L)

2.1.1 Terms involved in Titrimetric Analysis

2.1.2 Types of Titrations

2.2 Tools of titrimetry: Graduated glassware and their Calibration (3L)

i) Volumetric Flask

ii) Burette

iii) Pipette

2.3 Standardization (4L)

2.3.1 Introduction, Concept of standard solution, primary standard, secondary standard

2.3.2 Requirements for primary and secondary standard

2.3.3 Preparation of standard solutions: (Molarity, Formality Normality W/W W/V, ppm)dilution of solution. (Numerical Problems expected)

2.4 Neutralization Titrations (6L)

2.4.1. Concept of pH and its importance in Neutralisation Titrations

2.4.2 End point and Equivalence point of Neutralisation titrations

2.4.3 Construction of titration curve (on the basis of change in pH) and choice of indicator of a titration of

i. Strong acid-strong base

ii.Strong acid-weak base

iii.Strong base-weak acid

2.4.4 Theory of Acid base indicators; Illustrate Acid base indicators with examples (1L)

3. Basic Concepts in Instrumental methods (15L)

3.1 Relation between the Analyte, Stimulus and measurement of change in the observable property.
3.2 Block Diagram of an Analytical instrument.
3.3 Types of Analytical Instrumental methods based on
i. Optical interactions (eg. Spectrometry: uv-visible, Polarimetry)
ii. Electrochemical interactions (eg. Potentiometry, Conductometry,)
iii. Thermal interactions (eg. Thermogravimetry) (3L)

3.4. Absorption Spectroscopy(12 L)

3.4.1. Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy

3.4.2. Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorbtivity

3.4.3. 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)

3.4.4. Instrumentation for absorption spectroscopy: Colorimeters

3.4.5. Block Diagrams for Single beam and double beam Colorimeter

3.4.6. quantitative applications of colorimetry: Calibration curve method

Semester IV
Paper I

Unit I: Physical Chemistry

1.1Electrochemistry-II: (8 L)

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)

1.2 Phase Equilibria: (7L)

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 eutectics, congruent and incongruent melting points (lead-silver system).

Unit-II

2.1 Comparative Chemistry of the transition metals (9 L)

2.1.1 Position in the periodic table; Natural occurrence principal 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 magnetons (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)

2.2 Coordination Chemistry : (6 L)

2.2.1 Introduction to Chemistry of Coordination Compounds

i. Isomerism :General Types with special reference to stereoisomerism of coordination compounds (C.N=6)

ii. Evidence for the formation of coordination compounds,

2.2.2. Theories of coordination compounds

i. Effective atomic number rule.

ii. Eighteen electron Rule

2.2.3. Nature of the Metal-Ligand Bond:

i. Valence Bond Theory; Hybridisation 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 of .(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 III: Organic Chemistry

3.1 Carboxylic Acids and their Derivatives :(11 Lectures)

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 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 chlorides, esters, amides and acid anhydrides 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.

3.2 Stereochemistry (4L) Stability of cycloalkane: Strain in cycloalkanes, angle, eclipsing, trans annular (3 to 6membered). Conformations of cyclohexane, mono and di-alkyl cyclohexane and their relative stability.(4L)

Semester IV
Paper II

Unit I: Physical Chemistry

1.1 Solid State: (7L)

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)

1.2 Catalysis: (8 L)

1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation

1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH.

1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation)

1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst.

Unit-II

2 Ions in aqeous medium

2.1. Acidity of Cations and Basicity of Anions

i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radious.

ii. Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation

iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples

iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions-concept, diagram classification on the basis of basicity

2.2. Uses and Environmental Chemistry of volatile Oxides and oxo-acids

i. Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid

ii. Uses and environments aspects of these acids

Unit III: Organic Chemistry

Nitrogen containing compounds and heterocyclic compounds:

3.1 Amines: Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines;

3.1.1. Preparation: Reduction ofaromaticnitro compounds using catalytic hydrogenation,chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination , Hofmann bromamide reaction.

3.1.2. 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.

3.2 Diazonium Salts: **(7 Lectures)**

Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H,-OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine

3.3 Heterocyclic Compounds: (8 Lectures)

3.3.1. Classification, nomenclature, electronic structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom;

3.3.2. Synthesis of Furan, Pyrrole (Paal-Knorr synthesis and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis),

3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine towards nucleophilic substitution on the basis of electron distribution.

3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine.

3.3.5. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).

Semester IV

Paper III

Basics in analytical Chemistry

1. **Methods of Separation in Analytical Chemistry (15L)**

1.1 An Introduction to Analytical Separations and its importance in analysis. (2L)

1.2 Estimation of an analyte without effecting separation.

1.3 Types of separation methods

1.3.1 Based on Solubilities (Precipitation, Filtration 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;

1.4 Chromatography:(2L)

1.4.1 Introduction to Chromatography

1.4.2 Classification of chromatographic methods based on stationary and mobile phase

1.5 Planar Chromatography (7L)

Principle, techniques and applications of

1.5.1 Paper chromatography

1.5.2 Thin layer chromatography

1.6 Electrophoresis (4L)

Introduction, Principle and theory of electrophoresis, Different types of electrophoresis techniques, Moving Boundary Electrophoresis, Zone electrophoresis- Paper, Cellulose acetate and Gel electrophoresis, Applications of electrophoresis

2. Instrumental Methods – II (15L)

Instrumental techniques based **on the electrochemical properties of the analytes**

2.1 Potentiometry: (5 L)

2.1.1 Principle.Selection of indicator electrode system for various types of titrimetric reactionAcid base titrations

2.1.2. Role of Reference and indicator electrodes

2.1.3. Applications, advantages and limitations

2.1.4. detection of equivalence points Graphically

2.2. pHmetry: **(4 L)**

2.2.1. Principle

2.2.2. Types of pH meters.

2.2.3. Principle, Construction Working and Care of Combined Glass electrode

2.2.4. Applications in Titrimetry (Strong acid-Strong Base) biological and environmental analysis.

2.3. Conductometry(6 L)

2.3.1. Principle

2.3.2. Conductivity cell its construction and care

2.3.3. conductometric titration curves for following titrations

i. Strong Acid-Strong Base

ii. Strong Acid-Weak Base

iii. Strong Base-weak Acid

iv. Weak Acid- Weak Base**.**

2.3.4. Advantages & limitations of conductometric titrations.

3. A] Classical Methods of Analysis -II (10L)

3.1. Titrimetric Analysis-II

3.2. Precipitation Titration (4L)

3.1.1. Argentimetric titration

3.1.2 Construction of titration curve(numerical problems expected)

3.2.3 Selecting and evaluating the end point: Volhard method, Mohr's method, using adsorption indicator

3.2 GravimetricAnalysis (6 L)

3.2.1. General Introduction to Gravimetry.

3.2.2. Types of Gravimetric Methods

3.2.3 Steps involved in gravimetry analysis

3.2.4 Isolation of ion of interest

3.2.5. Precipitation: Nucleation (homogeneous and herogeneous)& crystal growth, Super solubility curve, significance of metastable region

i. Factors affecting precipitation: Common ion effect and solubility product

ii. Colloidal precipitates (coagulation of colloids, peptization of colloids, treatment of colloidalprecipitates).Crystalline precipitates (particle size and filterability).

iii. Conditions for precipitation

iv. Completion of precipitation,

v. Role of Digestion, Filteration, Washing : Choice of washing liquid, Drying Ignition of precipitate.

3.2.6 Co-precipitation (surface adsorption, mixed-crystal formation, occlusion,and mechanical entrapment,co precipitation errors).

B] Introduction to environmental analysis (5 L)

3.3.1 Environmental pollution from industrial effluents.

i. sources and types of pollutants

ii. Causes and consequences

iii. Role of EPA and central pollution control board.

3.3.2 Analysis of soil: Composition of soil, Sampling of soil, Industrial effluents and their interactions with soil components.

i. Determination of pH of soil samples.

ii. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

3.3.3 Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

i. Physical Parameters: Colour, Temperature, Taste and Odour, Turbidity, Conductivity, Hydrogen Ion Concentration (pH), Total Solids, Suspended and Dissolved Solids.

ii. Chemical Parameters: Acidity, Alkalinity, Hardness, Chlorides, Fluorides, Dissolved Oxygen,

iii. Determination of pH, acidity and alkalinity of a water sample.

iv. Determination of dissolved oxygen (DO) of a water sample.

(Semester 4 is not having any numerical based unit; however semester 3 is having all 3 units with numericals)

Semester III Chemistry
Practicals:

Unit I: Physical Chemistry

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine dissociation constant of weak acid conductometrically.
3. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.
4. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants
5. To determine solubility of sparingly soluble salts (anytwo) conductometrically.

Unit II: Inorganic Chemistry

1. 1) Identification of two cations and two anions in a given mixture containing following: cations Pb^{2+}(II), Ba^{2+}(II), Ca^{2+}(II), Sr^{2+}(II), Cu^{2+}(II), Cd^{2+}(II), Mg^{2+}(II), Zn^{2+}(II), Fe^{2+}(II), Fe^{3+}(III), Ni^{2+}(II), Co^{2+}(II) Al^{3+}(III), Cr^{3+}(III)] and Anions : Cl^-, Br^-, I^-,, NO_{3-}, SO_{4-2}, and CO_{3-2}
2. Crystallisation of potassium iodate and to estimate its purity before and after the separation.
3. Estimation of total hardness
4. Investigation of the raction between Copper supfate and Sodium Hydroxide (Standard EDTA solution to be provided to the learner).

Unit III: 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.

Preparation of:

1. Cyclohexanone oxime from cyclohexanone.
2. Glucosazone from dextrose or fructose
3. Tribromoaniline from aniline.
4. β-Naphthylbenzoate
5. m-Dinitrobenzene from nitrobenzene

6. Phthalic anhydride from phthalic acid by sublimation
7. Acetanilide from aniline
8. p-Bromoacetanilide from acetanilide
9. Iodoform from acetone

(Any eight preparations)

Semester IV Chemistry
Practicals:

Unit I: 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.
6. Industrial visit report.

Unit II: 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) The aim of this experiment is to understand the preparation of a soluble cation (sodium)and a large anion hexanitrocobaltate(III) and its use to precipitate a large cation (potassium)

Unit III: Organic Chemistry

Qualitative Analysis of bi-functional organic compounds on the basis of

1. **Prelimenary 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)**

Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysisto be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides.

Students are expected to write balanced chemical reactions wherever necessary. (Minimum 6 compounds to be analyzed)

Reference Books for Practicals:

Unit I:

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)

Unit III:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry,5th Ed., Pearson (2012)
4. 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

Reference Books:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
3. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
4. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
5. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
6. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
7. Chemistry of Transition Elements Pg.- 608 – 679 .
8. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.
9. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
10. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
11. CNR Rao edited, University General Chemistry, 513-578.
12. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,
13. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
14. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
15. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
16. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
17. Bruce H. Mahan, University Chemistry, Narosa publishing house.
18. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
19. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS
20. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999)
21. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
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24. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry
26.Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
27.Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
28. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry

Unit III:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton ,W. David Ollis.
8. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
9. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

II □□□□□□ □□□□□□ □□□□□ II

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE AND SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A^{+}' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: Bachelor's in Science (B. Sc.)

SYLLABUS

(Approved in the Academic council meeting held on 27th June 2023)

T.Y.B.Sc. Chemistry

Revised as per
Choice Based Credit System (60:40)
w. e. f. Academic Year 2023-24

BACHELOR'S IN SCIENCE (B.Sc.)

Programme Outcomes

S. N.	After completion of B.Sc. program students will acquire	Graduate Attribute
PO1	The knowledge of the disciplines and in-depth and extensive knowledge, understanding and skills in a specific field of interest.	Disciplinary knowledge
PO2	An ability to develop and conduct experiments, analyze, and interpret data and use scientific judgment to draw conclusions	Scientific reasoning
PO3	An ability to use current technology, and modern tools necessary for creation, analysis, dissemination of information.	Digital literacy
PO4	Innovative, professional, and entrepreneurial skills needed in various disciplines of science.	Life-long learning
PO5	An ability to achieve high order communication skills.	Communication skills
PO6	An ability to collect, analyze and evaluate information and ideas and apply them in problem solving using conventional as well as modern approaches	Problem solving
PO7	A sense of social responsibility; intellectual and practical skills and demonstration of ability to apply it in real-world settings.	Reflective thinking
PO8	An ability to engage in independent and life-long learning through openness, curiosity, and a desire to meet new challenges.	Life-long learning
PO9	A capacity to relate, collaborate, and lead others, and to exchange views and ideas to work in a team to achieve desired outcomes	Teamwork
PO10	An ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	Leadership

PO11	An ability to understanding values, ethics, and morality in a multidisciplinary context.	Moral and ethical awareness

Preamble:

Bachelor of Science (B.Sc.) in Chemistry is an undergraduate course of Department of Chemistry, Changu Kana Thakur Arts, Commerce & Science College, New Panvel (Autonomous). The Choice Based Credit System to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. This syllabus is prepared to give the sound knowledge and understanding of chemistry to undergraduate students at third year of the B.Sc. degree course. The goal of the syllabus is to make the study of Chemistry as stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make students capable of studying Chemistry in academic and industrial courses. Also to expose the students and to develop interest in them in various fields of Chemistry. The new and updated syllabus is based on disciplinary approach with vigour and depth taking care of the syllabus is not heavy at the same time it is comparable to the syllabi of other universities at the same level. The students pursuing this course would have to develop understanding of various aspects of the chemistry. The conceptual understanding, development of experimental skills, developing the aptitude for academic and professional skills, obtaining basic ideas and understanding of hyphenated techniques, understanding the fundamental chemical processes and rationale towards application of knowledge are among such important aspects

Semester - V

[Under CBCS Scheme]

Course	Course Type	Course code	Hrs/ week	Internal assessment	Semester-end examination	Total	Credits
Physical Chemistry	Core	USC5CH1	3	40	60	100	3
Inorganic Chemistry	Core	USC5CH2	3	40	60	100	3
Organic Chemistry	Core	USC5CH3	3	40	60	100	3
Analytical Chemistry	Core	USC5CH4	3	40	60	100	3
Drugs and dyes	Core	USC5CH5	3	40	60	100	3
Practical I	Core	USC5CP1	3	40	60	100	4
Practical II	Core	USC5CP2	3	40	60	100	4
Practical III	Core	USC5CP3	3	40	60	100	4

Semester - VI

[Under CBCS Scheme]

Course	Course Type	Course code	Hrs/ week	Internal assessment	Semester-end examination	Total	Credits

Physical Chemistry	Core	USC6CH1	3	40	60	100	3
Inorganic Chemistry	Core	USC6CH2	3	40	60	100	3
Organic Chemistry	Core	USC6CH3	3	40	60	100	3
Analytical Chemistry	Core	USC6CH4	3	40	60	100	3
Drugs and dyes	Core	USC6CH5	3	40	60	100	3
Practical I	Core	USC6CP1	3	40	60	100	4
Practical II	Core	USC6CP2	3	40	60	100	4
Practical III	Core	USC6CP3	3	40	60	100	4

Examination Scheme

- **Internal Theory examination (40 Marks)**
    1. One Class Test: **20 Marks.**
    2. Continuous Internal Assessment (one tool): **15 Marks**
    3. Active participation: **05 Marks**
- **External Theory Examination (60 Marks)**
- **Semester End Practical Examination (50 Marks)**

Question Paper Pattern for Semester End Examination

It is recommended that a total of five questions be set, based on the syllabus with due weightage to the number of lectures allotted per topic. The candidates are expected to answer all five questions. Question 5 will be based on all four units and the remaining questions will be based on the units as indicated below.

Question No.	Semester- V	Semester- VI
01	Unit I	Unit I
02	Unit II	Unit II
03	Unit III	Unit III
04	Unit IV	Unit IV
05	From all four units	From all four units

Duration of Examination: 2 hrs.

Question Paper Pattern for Continuous Assessment (Total Marks 20 to be converted in 10 marks)

Marks	Group Project*/ Individual Project	Presentation and write-up	Practical Skills	Open book test	Quiz
5	Hypothesis/Topic of the project	Presentation skill	Demonstration of skill	**High order thinking questions (HOTS)**	**Quiz on application of subject in real life**
5	Actual laboratory work/Field work	Knowledge	Viva		
5	Result/output	Quality of ppt	Report		
5	Dissertation/Report	Writing skill	Problem solving ability		

Note

Group Project*

1) Define number of students

2) Every student will get equal marks if the same contribution

3) if any student without any kind of involvement in the project, guide will take the decision on his share

Question Paper Pattern for Practical Examination

End Practical Examination per practical course (100 Marks)

- Laboratory Work (80 Marks)
- Journal (10 Marks)
- Viva (10 Marks)
- The practical examination will be held for 6.0 hrs.
- The candidates will be examined practically and orally

There will not be any internal examination for practical

Physical Chemistry

Course Description	
Semester	**V**
Course Name	**Physical Chemistry**
Course Code	**USC5CH1**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Course Objectives

- To provide a comprehensive understanding of rotational, vibrational, and Raman spectroscopy, enabling students to apply these techniques effectively in the analysis of molecular structure and behaviour.
- To develop a deep comprehension of thermodynamics and their applications in predicting chemical reactions.
- To study the crystalline and amorphous structures of solids.
- To understand the relationship between the structure of solids and their properties, including electrical conductivity and mechanical properties.
- To learn the principles of nuclear reactions, radioactivity, and nuclear decay processes.
- To comprehend the applications of nuclear chemistry, such as radioisotope dating and nuclear medicine.
- To examine the properties and behaviour of interfaces, including adsorption and catalysis.
- To explore the role of surface chemistry in various industries, such as catalysis in chemical processes.
- To understand the fundamental processes involved in photochemistry, including photoexcitation and photodecomposition.
- To develop problem-solving skills, especially in the context of thermodynamics and spectroscopy.
- To connect the concepts of molecular spectroscopy, chemical thermodynamics, solid-state chemistry, nuclear chemistry, surface chemistry, and photochemistry to analyse real-world chemical systems.

Course Outcomes

COs	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Memorize concept of dipole moment, polar and non- polar molecules, examples of colligative properties, basic terms of radioactivity and Surface tension.	I
CO2	Differentiate Rotational Spectroscopy and Vibrational Spectroscopy Raman Spectroscopy, Freundlich Adsorption Isotherm and Langmuir Adsorption Isotherm	III
CO3	Explain first and second law of photochemistry Raoult's law, Clapeyron equation, van't Hoff Factor.	II
CO4	Apply spectroscopic data for solving different numerical, lattice space information for determination structure of unit cell and Carbon Dating method	IV

Module / Unit	**Topics** **MOLECULAR SPECTROSCOPY**	**(15L)**
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.	
1.2	**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.	
1.3	**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.	

1.4	**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.	
II **2.1**	**CHEMICAL THERMODYNAMICS**	**(9L)**
2.1.1	**Colligative properties:** Vapour pressure, Raoult's law and relativelowering of vapour pressure.	
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 asolution and the molar mass of the non-volatile solute.	
2.1.3	**Osmotic Pressure:** Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff Factor, Reverse Osmosis.	
2.2	**THE SOLID STATE**	**(6L)**
2.2.1	Introduction Space lattice, lattice sites, Lattice planes, Unit cell. Laws of crystallography: (i) Law of constancy of interfacial angles (ii) Law of rational indices (iii) Law of crystal symmetry. Weiss indices and Miller indices.	
2.2.2	Cubic lattice and types of cubic lattice, planes or faces of a simple cubic system, spacing of lattice planes. Diffraction of X-rays, Derivation of Bragg's equation.	
2.2.3	Determination of crystal structure of NaCl and KCl on the basis of Bragg's equation. Numerical problems.	
III **3.0**	**NUCLEAR CHEMISTRY**	**(15L)**
3.1	**Introduction**: Nuclear disintegration/ Nuclear radioactivity, Types of nuclear radiations (α-particle, β- particle and γ-ray). Basic terms-radioactive constants (decay constant, half-life and average life) and units of radioactivity.	
3.2	**Detection and Measurement of Radioactivity:**	

	Types and characteristics of nuclear radiations, behavior of ion pairs in electric field, detection and measurement of nuclear radiations using G.M. Counter and Scintillation Counter.	
3.3	**Application of use of radioisotopes as Tracers:** Chemical reaction mechanism, age determination - dating by C^{14}.	
3.4	**Nuclear reactions**: Nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy.	
3.5	**Fission Process:** Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. multiplication factor and critical size or mass of fissionablematerial, nuclear power reactor and breeder reactor.	
3.6	**Fusion Process:** Thermonuclear reactions occurring on stellar bodies and earth.	
IV **4.1**	**SURFACE CHEMISTRY**	**(07 L)**
4.1.1	**Adsorption:** Physical and Chemical Adsorption, types of adsorption isotherms. Langmuir's adsorption isotherm (Postulatesand derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation.	
4.2	**PHOTOCHEMISTRY**	**(08 L)**
4.2.1	Introduction Difference between thermal and photochemical processes.	
4.2.2	Laws of photochemistry: Grotthus - Draper law, Lambert's law, Lambert Beer's law (with derivation), Stark - Einstein law.	
4.2.3	Quantum yield, Reasons for high and low quantum yield.	
4.2.4	Photosensitized reactions – Dissociation of H_2, Photosynthesis	
4.2.5	Photodimerization of anthracene, decomposition of HI and HBr	
4.2.6	Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence	
4.2.7	Chemiluminescence	
4.2.8	Numerical problems	

References

- **Physical Chemistry**, Ira Levine, 5th Edition, 2002 Tata McGrawHill Publishing Co.Ltd.
- **Physical Chemistry**, P.C. Rakshit, 6th Edition, 2001, Sarat BookDistributors, Kolkata.

- **Physical Chemistry**, R.J. Silbey, & R.A. Alberty, 3rd edition, John Wiley & Sons, Inc [part 1]
- **Physical Chemistry**, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.
- **Modern Electrochemistry**, J.O.M Bockris & A.K.N. Reddy Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer
- **Fundamental of Molecular Spectroscopy**, 4th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
- **Physical Chemistry**, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- **The Elements of Physical Chemistry**, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.
- **Physical Chemistry**, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.
- **Principles of Physical Chemistry** B.R. Puri, L.R. Sharma, M.S. Pathania, VISHAL PUBLISHING Company, 2008.
- **Textbook of Polymer Science**, Fred W Bilmeyer, John Wiley & Sons (Asia) Ple. Ltd., Singapore, 2007.
- **Polymer Science**, V.R. Gowariker, N.V. Viswanathan, Jayadevan Sreedhar, New Age International (P) Ltd., Publishers, 2005.
- **Essentials of Nuclear Chemistry**, Arnikar, Hari Jeevan, New Age International (P) Ltd., Publishers, 2011.
- **Chemical Kinetics**, K. Laidler, Pearson Education India, 1987.

P-I Physical (SEM-V)-Practical's

COs	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Handle and Understand principles of different instruments like Colorimetry, Potentiometry, Conductometry.	I
CO2	Determine molecular weight of any high polymer polyvinyl alcohols by viscosity measurement.	III
CO3	Interpret the order of reaction graphically from given experimental data and to calculate the specific rate constant.	III

Sr. No.	TYPE	PRINCIPLE	TITLE
1	**Non-Instruments**	**Colligative properties**	To determine the molecular weight of compound by Rast Method
2		**Chemical Kinetics**	To determine the order between $K_2S_2O_8$ and KI by fractional change method.
3		**Surface phenomena**	To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm.
4	**Instruments**	**Potentiometry**	To determine the solubility product and solubility of AgCl potentiometrically using chemical cell.
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.

Reference books

- **Practical Physical Chemistry** 3rd edition A.M. James and F.E. Prichard, Longman publication
- **Experiments in Physical Chemistry** R.C. Das and B. Behra, Tata Mc Graw Hill
- **Advanced Practical Physical Chemistry** J.B. Yadav, Goel Publishing House
- **Advanced Experimental Chemistry** Vol-I J.N. Gurtu and R Kapoor, S. Chand and Co.
- **Experimental Physical Chemistry** by V.D. Athawale.
- **Senior Practical Physical Chemistry** by B.D. Khosla, V.C. Garg and A. Gulati, R Chand and Co.

Inorganic Chemistry

Semester V (Theory)

Course Description	
Semester	**V**
Course Name	**Inorganic Chemistry**
Course Code	**USC5CH2**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Course Objectives:

1. To encourage students to analyze and integrate concepts relevant to graduate level Inorganic chemistry.
2. To understand concept of molecular symmetry and assign the point group to given molecule.
3. To understand the bond formation in heteronuclear diatomic molecules and poly atomic species with special reference to MOT.
4. To study the structures of solids and concept of superconductivity.
5. To know the chemistry of inner transition elements with reference to its position in periodic table, Properties, extraction, separation and applications.
6. To know the various methods of classifications of inorganic polymers, chemistry of borazine and silicones.
7. To study the Chemistry of non-aqueous solvents, interhalogens and pseudohalogens.

Course Outcomes:

COs.	After completing the course, students will be able to:	**Bloom Taxonomy Level (BTL)**
CO 1	Explain concept of Superconductivity, types of super conductors and its applications, imperfections in solids and their effect on properties, chemistry of inner transition elements, extraction and applications, chemistry of non-aqueous solvents	Understand
CO 2	Explain electrical properties of conductors, insulators and semiconductors on the basis of Band theory. Explain Inorganic Polymers, Chemistry of interhalogens and Pseudo halogens.	Understand
CO 3	Assign the point group for given molecules using basic concepts of molecular symmetry and construct molecular orbital diagrams for heteronuclear diatomic molecules and polyatomic species.	Apply
CO 4	Determine packing density of different types of cubic unit cells	Evaluate

Unit		Topics	
I	**1.0**	**MOLECULAR SYMMETRY AND CHEMICAL BONDING**	**(6L)**
	1.1	**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 pointgroups :(i) C□V (ii) D□h (iii) C2V (iv) C3v (v)C2h and (vi)D3h	
	1.2	**MOLECULAR ORBITAL THEORY FOR HETERONUCLEAR DIATOMIC MOLECULES AND POLYATOMIC SPECIES**	**(9L)**
	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 only. (Examples like: i) BeH_2, ii) H_2O).	
II	**2.0**	**SOLID STATE CHEMISTRY**	
	2.1	**STRUCTURES OF SOLIDS**	**(11L)**
	2.1.1	Explanation of terms viz. crystal lattice, lattice point, unit cell and lattice constants.	
	2.1.2	Closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc and fcc lattices. Relationship between density, radius of unit cell and lattice parameters.	
	2.1.3	Stoichiometric Point defects in solids (discussion on Frenkel and Schottky defects expected).	
	2.1.4	Metallic Bond: Band theory, Explanation of electrical properties of conductors, insulators and semiconductors (n- and p- types) on the basis of Band theory.	
	2.2	**SUPERCONDUCTIVITY**	**(4L)**
	2.2.1	Discovery of superconductivity.	
	2.2.2	Explanation of terms like superconductivity, transition temperature, Meissner effect.	
	2.2.3	Different types of superconductors' viz. conventional superconductors, Organic superconductors, alkali metal fullerides, high temperature superconductors.	
	2.2.4	Brief application of superconductors.	

III	**3.0**	**CHEMISTRY OF INNER TRANSITION ELEMENTS**	**(15L)**
	3.1	Introduction: Position in periodic table and electronic configuration of Lanthanides and actinides.	
	3.2	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	
	3.3	Occurrence, extraction and separation of lanthanides by (i) Ion Exchange method and (ii) Solvent extraction method (Principles and technique)	
	3.4	Applications of lanthanides	
	3.5	Chemistry of Uranium with reference to occurrence, extraction (solvent extraction method), properties and applications.	
IV	**4.0**	**SOME SELECTED TOPICS**	
	4.1	**CHEMISTRY OF NON-AQUEOUS SOLVENTS**	**(5L)**
	4.1.1	Classification of solvents and importance of non-aqueous solvents.	
	4.1.2	Characteristics and study of liquid ammonia, dinitrogen tetra oxide as non-aqueous solvents with respect to: (i) acid-base reactions and (ii) redox reactions.	
	4.2	**Inorganic Polymers**	**(5L)**
	4.2.1	Introduction, Various methods of classifications with examples.	
	4.2.2	Chemistry of borazine and silicones with reference to preparations, properties, structure, bonding and applications.	
	4.3	**Chemistry of interhalogens**	**(3L)**
	4.3.1	Introduction, Preparation, Uses, Bonding.	
	4.4	**Chemistry of Pseudohalogens:**	**(2L)**
	4.3.2	Introduction, Preparation, reactions and structures.	

REFERENCES:

Unit-I

1. Per Jensen and Philip R. Bunker, Fundamentals of Molecular Symmetry, Series in Chemical Physics,Taylor & Francis Group
2. J. S. Ogden, Introduction to Molecular Symmetry, Oxford University Press
3. Derek W. Smith, Molecular orbital theory in inorganic chemistry Publisher: Cambridge

University Press

4. C. J. Ballhausen, Carl Johan Ballhausen, Harry B. Gray, Molecular Orbital Theory: An Introductory LectureNote and Reprint Volume Frontiers in chemistry Publisher W.A. Benjamin, 1965
5. Jack Barrett and Mounir A Malati, Fundamentals of Inorganic Chemistry, Affiliated East west PressPvt. Ltd., New Delhi.
6. Satya Prakash, G.D.Tuli, R.D. Madan, Advanced Inorganic Chemistry. S. Chand & Co. Ltd

Unit-II

1. C. N. R. Rao, Advances in Solid State Chemistry
2. R.G. Sharma, Superconductivity: Basics and Applications to Magnets
3. Michael Tinkham ,Introduction to Superconductivity: Vol I (Dover Books on Physics)
4. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.
5. Richard Harwood, Chemistry, Cambridge University Press,
6. Satya Prakash, G.D. Tuli, R.D. Madan, Advanced Inorganic Chemistry. S. Chand & Co Ltd.
7. Lesley E. Smart, Elaine A. Moore Solid State Chemistry: An Introduction, 2nd Edition CRC Press,

Unit-III

1. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.
2. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
3. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
4. G. Singh, Chemistry of Lanthanides and Actinides, Discovery Publishing House
5. Simon Cotton, Lanthanide and Actinide Chemistry Publisher: Wiley-Blackwell

Unit-IV

1. B. H. Mahan, University Chemistry, Narosa publishing.
2. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.
3. J. D. Lee, Concise Inorganic Chemistry, 4thEdn., ELBS,
4. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press
5. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.
6. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt, Ltd. (2002).
7. Richard Harwood, Chemistry, chapter 10 Industrial inorganic chemistry
8. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
9. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993
10. Satya Prakash, G.D. Tuli, R.D. Madan, Advanced Inorganic Chemistry.S. Chand & Co Ltd 2004
11. James E. Mark, R. West, H. Allcock, Inorganic Polymers prentice hall advanced reference series physical and life sciences, 1992.
12. Ronald D. Archer, Inorganic and Organometallic Polymers Special Topics in Inorganic Chemistry, 2001.

Course Description	
Semester	**V**
Course Name	**Inorganic Chemistry Practical's**
Course Code	**USC5CP1**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**1.50**
Hours	**48 h (60L)**

Course Outcomes:

COs.	After completing the course, students will be able to:	Bloom Taxonomy Level (BTL)
CO 1	Develop the practical skills for preparation of different inorganic metalcomplexes	Understand
CO 2	Examine the percentage purity of the inorganic compounds qualitativelyand quantitively and impurity identification.	Analyse

I- Inorganic Preparations:

1. Preparation of Potassium diaquobis-(oxalato)cuprate (II)
2. Preparation of hexamminenickel (II) chloride, $[Ni(NH_3)_6]Cl_2$.
3. Preparation of bis-acetylacetonato copper (II)

II- Percentage Purity:

Determination of percentage purity of the given water-soluble saltand qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests).

(Any three salts of transition metal ions)

References

1. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
2. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N. Dhur & Sons Pvt Ltd.
3. Vogel's. Textbook of. Macro and Semi micro *qualitative* inorganic *analysis*. Fifth edition.

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Organic Chemistry

Course Description	
Semester	**V**
Course Name	**Organic Chemistry**
Course Code	**USC5CH3**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Course Objectives

- To bring organic chemistry to students in the most thought-provoking and comprehensible way possible.
- Develop analytical thinking and apply the same for understanding principles, proposing mechanism and logical conclusions.
- Understanding of the interdisciplinary nature of organic chemistry and emerging trends in organic chemistry.
- To provide an overview and familiarize the students with the basic principles of organic reactions and its stereochemistry.
- Comprehensive and accessible overview of spectroscopy to build the necessary competency among the students for interpretation of spectral data in structure determination of organic compounds.
- To know the structure, elucidation and reactivity of the number of natural products and synthetic polymers.
- Competency in design and planning of synthesis and carry out with Good Laboratory Practices.
- Competency in handling instruments and techniques of separation of mixtures of organic compounds.

Course Outcomes

COs	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Explain the fate of the excited molecule in photochemistry and systematic study of photochemical reactions.	II
CO2	Apply the concepts in writing and predicting the mechanism of organic reactions.	III
CO3	Examine the spectral data of UV-Visible, IR, NMR and Mass spectroscopy for structure elucidation of organic compounds.	IV
CO4	Construct the structures of carbohydrates and its inter-conversion, describe the structures of proteins, nucleic acids and its components.	III

Module / Unit	**Topics** **1.1 MECHANISM OF ORGANIC REACTIONS**	**(10L)**
I		
1.1.1.	Concept and definitions: Nucleophiles: Hard and soft nucleophiles, ambient nucleophiles Electrophiles: Hard and Soft electrophiles, ambient electrophiles Types of mechanism, Types of reactions	
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** Electro cyclic reactions (ring opening and ring closing), cycloaddition, sigmatropic rearrangement, group transfer reactions, cheletropic reaction (definition and one example of each type) **1.1.4.2** Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates	
1.2	**PHOTOCHEMISTRY**	**(5L)**
1.2.1	Introduction: Difference between thermal and photochemical reactions. Singlet and triplet states, allowed and forbidden transitions, Jablonski diagram, 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.	

	Photoreduction (e.g. benzophenone to benzpinacol)	
II		**(15L)**
2.1	**STEREOCHEMISTRY-I**	**(5L)**
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: cumulenes and biphenyls.	
2.2	**CARBOHYDRATES**	**(10L)**
2.2.1	Introduction: classification, reducing and non-reducing sugars, DL notation	
2.2.2	Structures of monosaccharaides: Fischer projection (4-6 carbon monosaccharaides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses) Interconversion: open chain and Haworth forms of monosaccharaides with 5 and 6 carbons. Chair conformation with stereochemistry of D-glucose, Stability of chair form of D-glucose	
2.2.3	Stereoisomers of monosaccharide: epimers, anomers	
2.2.4	Mutarotation and its mechanism	
2.2.5	Chain lengthening & shortening reactions: Modified Kiliani-Fischer synthesis (D-arabinose to D-glucose and D-mannose), Ruff Degradation (D-glucose to D-arabinose)	
2.2.6	Reactions of D-glucose and D-fructose: (a) Osazone formation (b) reduction: H_2/Ni, NaBH4 (c) oxidation: bromine water, HNO_3, HIO_4 (d) acetylation (e) methylation: (d) and (e) with cyclic pyranose forms	
2.2.7	Biologically important sugar: 2DG	

III **3.0**		**(15L)**
3.1	**IUPAC NOMENCLATURE**	**(4L)**
	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	Cumulenes with up to 3 double bonds	
3.2	**HETEROCYCLIC CHEMISTRY**	**(8L)**
3.2.1	Introduction, Nomenclature of monocyclic (5-6 membered) heterocycles (up to two hetero atoms) (Hantzsch-Widman)	
3.2.2	Reactivity and reactions of pyridine-N-oxide: halogenation, nitration and	

	reaction with $NaNH_2$/liq.NH_3, n-BuLi.	
3.2.3	Reactivity and reactions of pyrazole: nitration, halogenation and acylation	
3.2.4	Reactivity and reactions of imidazole: nitration, halogenation and C-metallation	
3.2.5	Reactivity and reactions of thiazole: nitration, halogenation and C-metallation	
3.2.6	Preparation of pyridine-N-oxide, pryazole (from 1,3-dicarbonyl compound) imidazole (from α-halo carbonyl compounds) thiazole (Hantzsch synthesis and Gabriel synthesis)	
3.3	**AGROCHEMICALS**	**(3L)**
3.3.1	General introduction & scope, meaning & examples of insecticides, herbicides, fungicide, rodenticide, pesticides, plant growth regulators.	
3.3.2	Advantages & disadvantages of agrochemicals	
3.3.3	Synthesis & application of IAA (Indole Acetic Acid) & Endosulphan	
3.3.4	Bio pesticides – Neem oil & Karanj oil.	
IV	**4.0 SPECTROSCOPY**	**(15L)**
4.1	Introduction: Electromagnetic spectrum, units of wavelength and frequency	
4.2	**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.	
4.3	**IR spectroscopy**: Basic theory, selection rule, fingerprint region and functional group region, characteristic IR peaks for different functional groups.	
4.4	**PMR spectroscopy:** Basic theory of PMR, Nature of PMR spectrum, reference standard, solvents, chemical shift, factors affecting chemical shift: Inductive effect and anisotropic effect (with reference to acetylene, benzene and aldehyde), spin-sin coupling and coupling constant, D2O exchange technique. Application of PMR in structure determination	
4.5	**Mass spectrometry:** Basic theory, Nature of mass spectrum, Importance of molecular ion peak, base peak and isotopic peaks. Nitrogen rule. General rules for fragmentation. Fragmentation of alkanes and aliphatic carbonyl compounds	
4.6	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) Carboxylic acid, esters and amides (8) amines (broad regions characteristic of different groups are expected).	

4.7	Problems of structure elucidation of simple organic compounds using individual or combined use of UV-VIS, IR, PMR and Mass spectral data. (Index of Hydrogen Deficiency should be the first step in solving the problems)	

REFERENCES:

1. A guide to mechanism in Organic Chemistry, 6th edition, 2009, Peter Sykes, Pearson education, New Delhi.
2. Advanced Organic Chemistry by J. March, 6th Edition.
3. Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K. Parashar, Narosa Publication.
4. Organic Chemistry, Part A and B, Fifth edition, 2007, Francis A. Carey and Richard J. Sundberg, Springer.
5. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press (2001)
6. Organic Chemistry, Seventh Edition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.
7. Organic reactions & their mechanisms, third revised edition, P.S. Kalsi, New Age International Publishers.
8. Organic Chemistry, W. G. Solomons, C. B. Fryhle, 8th Edition, Wiley India Pvt. Ltd.
9. Pericyclic Reactions, S. Sankararaman, Wiley VCH, 2005.
10. Advanced organic chemistry, Jagdamba Singh L. D. S. Yadav, Pragati Prakashan, 2011
11. Pericyclic reactions, Ian Fleming, Oxford University press, 1999.
12. Organic chemistry, 8th edition, John McMurry.
13. Modern methods of Organic Synthesis, 4th Edition W. Carruthers and Iain Coldham, Cambridge University Press 2004.
14. Stereochemistry of Carbon Compounds: Principles and Applications, D, Nasipuri, 3rd edition, New Age International Ltd.
15. Stereochemistry of Organic Compounds, Ernest L. Eliel and Samuel H. Wilen, Wiley-India edition
16. Stereochemistry, P. S. Kalsi, 4th edition, New Age International Ltd
17. Organic Chemistry volume-I & II – I L Finar.
18. Heterocyclic Chemistry, 5th Edition, John A. Joule and Keith Mills, Wiley publication, 2010.
19. Nomenclature of Organic Chemistry: IUPAC recommendations and preferred Names 2013, RSC publication.
20. IUPAC nomenclature by S.C. Pal
21. Insecticides & pesticides: Saxena A. B., Anmol publication.
22. Growth regulators in Agriculture & Horticulture: Amarjit Basra, CRC press 2000.
23. Agrochemicals and pesticides: A. Jadhav and T.V. Sathe.
24. Spectroscopy of Organic Compounds, P.S. Kalsi, Fourth Edition, New Age International Ltd.
25. Spectroscopy, Pavia, Lampman, Kriz, Vyvyan
26. Organic spectroscopy (Second edition), Jag Mohan, Narosa publication.
27. Spectral identification of organic molecules by Silverstein.

P-III Organic (SEM-V)-Practical's

Course code: USC5CP2

COs	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Identify chemical type of components present in binary mixture of solid-solid mixture and unknown organic compound by micro-scale technique.	III
CO2	Apply skills in the separation and qualitative analysis of organic compounds of solid-solid mixtures by microscale technique	III

Separation of Binary solid-solid mixture of organic compounds and identification using micro-scale technique. (2.0 gm mixture to be given)

1. 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 (nitro anilines), water soluble neutral (thiourea) and water insoluble neutral compounds (anilides, amides, m-DNB, hydrocarbons)
3. After correct determination of chemical type, the separating 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, one component (decided by the examiner) is to be analyzed and identified with m.p.

References for Practical's:

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H. Middleton
3. Practical organic chemistry – O.P. Agarwal
4. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.

Important Note:

1. The candidate is expected to submit a journal certified by the Head of the Department /institution at the time of the practical examination.
2. A candidate will not be allowed to appear for the practical examination unless he/she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such certificate.
3. Use of non-programmable calculator is allowed both at the theory and the practical examination.

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Course Description	
Semester	**V**
Course Name	**Analytical Chemistry**
Course Code	**USC5CH4**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Course Objectives

- To provide a basic knowledge and understanding of essential chemical and physical principles for analytical chemistry.
- To introduce basic and advanced analytical techniques and practical aspects of classical and instrumental analysis.
- To solve problems related to chemical analysis and interpret analytical results.

Course Outcomes

After completion of this course student will be able to

CO1: Define, and explain the concepts of quality control, quality assurance, grades of chemicals, concentrations and importance of sampling at a basic level

CO2: Explain the theoretical principals of titrations and apply them for end point detection and selection of suitable indicators

CO3: Apply the Nernst law to the solvent extraction and describe the principles and processes of solvent extraction and solid phase extraction.

CO4: Describe the role of analytical instruments in science and allied fields and explain the principles, instrumentation, working of Spectroscopic techniques.

Module/ Unit	Course Description	Lectures
1.	**Introduction to Quality Concepts in Industry, Chemical Calculations, and Sampling**	15L
1.1	**Quality in Analytical Chemistry**	03L
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; Importancein chemical analysis Quality of material: Various grades of laboratory reagents	

1.2	**Chemical Calculations (Numerical and word problems are expected)**	06L
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	
1.3	**Sampling**	06L
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, equipment and methods of samplingof compact solids, sampling of particulate solids, methods and equipment 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.	
2.	**Classical Methods of Analysis (Titrimetry)**	**15L**
2.1	**Redox Titrations (Numerical and word Problems are expected)**	08L
2.1.1	Introduction	
2.1.2	Construction of the titration curves and calculation of E_{system} inaqueous medium in case of: (1) One electron system **(2)** Multielectron system	
2.1.3	Theory of redox indicators, Criteria for selection of an indicatorUse of diphenyl amine and ferroin as redox indicators	
2.2	**Complexometric Titration**	07L
2.2.1	Introduction, construction of titration curve	
2.2.2	Use of EDTA as titrant and its standardization, 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.	
2.2.3	Types of EDTA titrations.	
2.2.4	Metallochromic indicators, theory, examples and applications	
3.	**Separation Methods**	15L

3.1	**Solvent Extraction**	12L
3.1.1	Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH. Single-step and multi- step extraction, Percentage extraction for single step and multistep extraction. Separation factor.	
3.1.2	Factors affecting extraction: Chelation, Ion pair formation and Solvation	
3.1.3	Graph of percent extraction versus pH. Concept of $[pH]_{1/2}$ and its significance (derivation not expected)	
3.1.4	Batch and continuous extraction, Craig's counter current extraction: Principle, apparatus and applications	
3.2	**Solid phase extraction:** Principle, process and applications with special reference to water and industrial effluent analysis.	03L
	Comparison of solid phase extraction and solvent extraction.	
4.	**Optical Methods**	15L
4.1	**Basic Components of Spectroscopic Instruments:** Sources of Energy, Wavelength Selectors, Detectors, Signal Processors	02L
4.2	**Molecular Spectroscopy: UltraViolet-Visible Spectroscopy**	04L
4.2.1	Instrumentation: Single beam and double beam spectrophotometer;	
4.2.2	Quantitative Applications (Calibration curve method); Qualitative Applications in Photometric titration, Job's method for study of complexes.	
4.3	**Atomic Spectroscopy: Flame Emission spectroscopy (FES) and Atomic Absorption Spectroscopy (AAS)**	06L
4.3.1	Introduction, Energy level diagrams, Atomic spectra, Absorption and Emission Spectra	
4.3.2	Flame Photometry – Principle, Instrumentation (Flame atomizers, types of Burners, Wavelength selectors, Detectors)	
4.3.3	Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electrothermal Atomiser)	
4.3.4	Quantification methods of FES and AAS – Calibration curve method, Standard addition method and Internal standard method.	
4.3.5	Comparison between FES and AAS	

4.3.6	Applications, Advantages and Limitations	
4.4	**Turbidimetry and Nephelometry**	03L
4.4.1	Introduction and Principle	
4.4.2	Factors affecting scattering of Radiation: Concentration, particle size, wavelength, refractive index	
4.4.3	Instrumentation and Applications	

References

1. 3000 solved problems in Chemistry, David E. Goldberg, Schaums Outline
2. A guide to Quality in Analytical Chemistry: An aid toaccreditation, CITAC and EURACHEM, (2002),
3. A premier sampling solids, liquids and gases, Smith Patricia I, American statistical association and the society for industrial and applied mathematics, (2001)
4. Analytical Chemistry, Gary.D Christan, 5th edition
5. Analytical Chemistry Skoog, West, Holler,7th Edition
6. Basic Concepts of Analytical Chemistry, by S. M. Khopkar new Age International (p) Limited
7. Chemical methods of separation, J A Dean, VanNostrand Reinhold, 1969
8. Fundamentals of Analytical Chemistry by Skoog andWest, 8th Edition
9. Handbook of quality assurance for the analytical chemistry laboratory, 2ndEdn., James P. Dux Van Nostrand Reinhold, 1990
10. Instrumental methods of Analysis, by Dr Supriya S Mahajan, Popular Prakashan Ltd
11. Instrumental methods Of Analysis, by Willard Merritt Dean, 7thEdition, CBS Publisher and distribution Pvt Ltd
12. Instrumental Methods of Chemical Analysis by B.K.Sharma Goel Publishing House
13. Principles of Instrumental Analysis, 5th Edition, BySkoog, Holler, Nieman
14. Quality control and Quality assurance in Analytical Chemical Laboratory, Piotr Konieczka and Jacek Namiesnik, CRC press (2018)
15. Quality in the Analytical Chemistry Laboratory, Elizabeth Prichard, Neil T. Crosby,

Florence, John Wiley and Sons, 1995

16. Solvent extraction and ion exchange, J Marcus and A. S.Kertes Wiley INC 1969

17. Solvent Extraction of Metals, Anil Kumar De, Shripad Moreshwar Khopkar, Robert Alexander Chalmers Van Nostrand Reinhold Company, 1970

18. Solid-Phase Extraction: Principles, Techniques, and Applications By Nigel J.K. Simpson 1st Edition, CRC Press 2000.

19 Instrumental methods of chemical analysis, by H. Kaur Pragati Prakashan, Meerut.

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Course Description	
Semester	**V**
Course Name	**Practical (Analytical Chemistry)**
Course Code	**USC5CP2**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**1.5**
Hours	**24L**

Spectroscopy by B. K., Sharma, Goel Publishing House, Meerut. 2006.

Course Objectives

- To develop laboratory skills
- To acquaint the students with various analysis, and separation methods

Course Outcomes

After completion of this course students will be able to

CO1: Demonstrate the skills in quantitative analysis of the real samples such as cosmetics, environmental samples, fertilizers etc., apply appropriate methods to obtain experimental data and interpret it.

CO2: Use instrumental techniques for the estimation of various samples, and practice calibration of instruments and preparation of standards and references

Title of Experiments

1. Colorimetric determination of fluoride in given water sample.

2 Estimation of magnesium content in Talcum powder by complexometry, using standardizedsolution of EDTA

3 To determine potassium content of a Fertilizer by Flame Photometry (Calibration curvemethod).

4 Estimation of Fe^{2+} in Mohr's salt by redox titration.

5 To determine the amount of sulphate in given water sample turbidimetrically.

6 Extraction of I_2 from aqueous solution of I_2/KI in single step and multiple extraction using hexane as an organic solvent.

References

1. Vogel's Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).
2. Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, Mendham et.al

Drugs and Dyes

Course Description	
Semester	**V**
Course Name	**Drugs and Dyes**
Course Code	**USC5CH5**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

COs. No.	**After completing the course, students will be able to:**	**Bloom Taxonomy Level (BTL)**
CO1	Define the routes of administration, methods of ingestion, tolerance, withdrawal and interactions of these drugs with other psychoactive and non-psychoactive drugs.	Remember
CO2	Explain details about the pharmacodynamics agents used for the treatment of different diseases side effects and synthesis.	Understand
CO3	Classify the dyes based on applications and dyeing methods	Understand
CO4	Make use of Unit processes required for the synthesis of dyes intermediates	Apply

Unit	**Course Description**	Hrs
1.	**1.1 General Introduction to Drugs**	

	Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action), Nomenclature of drugs: Generic name, Brand name, Systematic name Definition of the following medicinal terms: Pharmacon, Pharmacology, Pharmacophore, Prodrug, Half – life efficiency, LD_{50}, ED_{50},GI_{50} Therapeutic Index. Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs,Adulterated Drugs, Pharmacopoeia **1.2 Routes of Drug Administration and Dosage Forms** Oral and Parenteral routes with advantages and disadvantages. Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets). **1.3 Pharmacodynamic agents:** A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects. **CNS Drugs:** Classification based on pharmacological actions: CNS Depressants &CNS Stimulants. Concept of sedation and hypnosis, anaesthesia. **Psychoactive Drugs:** Introduction, Classification, Synthesis of Diazepam, (Oxazepam, Alprazolam)	15
2.		
	2.1 Analgesics, Antipyretics and Anti-inflammatory Drugs. **Analgesics and Antipyretics** • Morphine (Phenanthrene alkaloids) • Tramadol (Cyclohexanols) (**Synthesis from salicylic acid)** • Aspirin (Salicylates) Paracetamol (p-Amino phenols) **Anti-inflammatory Drugs** Mechanism of inflammation and various inflammatory conditions. • Steroids: Prednisolone, Betamethasone • Sodium Diclofenac, Aceclofenac (N- Aryl anthranilicacids) **(Synthesis from 2,6-dichlorodiphenyl amine)**	15

2.2 Antihistaminic Drugs

- Diphenhydramine (Ethanol amines)
- Cetrizene (Piperazine) (**Synthesis from 4-Chlorobenzhydryl chloride)**
- Chlorpheniramine maleate (Ethyl amines)

Pantoprazole (Benzimidazoles)

2.3 Cardiovascular drugs

Classification based on pharmacological action

- Isosorbide dinitrate (Nitrates)
- Valsartan (Amino acids) (structure not expected)
- Atenolol (Aryloxy propanol amines) (**Synthesis from 3-Hydroxy phenyl acetamide)**
- Amlodipine (Pyridines)
- Frusemide /Furosemide (Sulfamoyl benzoic acid)
- Rosuvastatin (Pyrimidine)

2.4 Antidiabetic Agents

General idea and types of diabetes; Insulin therapy

- Glibenclamide (Sulphonyl ureas)
- Metformin (Biguanides)
- Dapagliflozin (Pyranose)

Pioglitazone (Thiazolidinediones) (**Synthesis from 2-(5-ethylpyridin-2-yl) ethanol)**

2.5 Antiparkinsonism Drugs

Idea of Parkinson's disease.

- Procyclidine hydrochloride (Pyrrolidines)
- Ethopropazine hydrochloride (Phenothiiazines)

Levodopa (Amino acids) (**Synthesis from Vanillin**

2.6 Drugs for Respiratory System

General idea of: Expectorants; Mucolytes; Bronchodilators; Decongestants; Antitussives

	• Ambroxol (Cyclohexanol) (**Synthesis from paracetamol)** • Salbutamol (Phenyl ethyl amines) • Oxymetazoline (Imidazolines) Codeine Phosphate (Opiates)	
3.	3.1 Introduction to the dye-stuff Industry	**(5L)**
3.1.1	Dyes	
	Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. Definition of fastness and its properties and Mordants with examples Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B,GK, 6GK, Naming of dyes by colour index (two examples) used in dye industries.	
3.1.2	Natural and Synthetic Dyes	
	Natural Dyes: Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –**names** of the chief dyeing material/s in each natural dye **[structures not expected]**, Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in the development of synthetic dyes – Emphasis on Name of the Scientist, dyes and the year of the discovery is required. (structure is not expected)	
	3.2 Substrates for Dyes : Types of fibres	**(3L)**
3.2.1	Natural: cellulosic and proteinaceous fibres, examples – wool and cotton structures and names of dyes applied on each of them.	
3.2.2	Semi – synthetic: definition and examples i) Viscose rayon ii) Acetate rayon (Cellulose acetate) [structures not expected]	
3.2.3	Synthetic: Nylon, Polyesters and Polyamides structures and names ofdyes applied on each of them	
3.2.4	Blended fabrics: definition and examples [structures not expected]	
	3.3 Classification of dyes based on applications and dyeing methods	**(7L)**
3.3.1	Dyeing methods	
	Basic Operations involved in dyeing process:	

	i. Preparation of fibres ii. Preparation of dyebath iii. Application of dyes iv. Finishing	
	Dyeing Method of Cotton Fibres: (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing	
3.3.2	Classification of dyes based on applicability on substrates (examples with structures) i) Acid Dyes- Acid Red 88 , ii) Basic Dyes- Methyl violet iii) Direct cotton Dyes- Benzofast Yellow 5GL iv) Azoic Dyes – Diazo components; Fast yellow G Coupling components-Naphthol AS v) Mordant Dyes- Alizarin. vi) Vat Dyes- Indanthrene Red 5GK, vii) Disperse Dyes-Celliton Fast brown 3R, Reactive Dyes- Procion Brilliant Blue HB	
3.3.3	**Optical Brighteners**: General idea, important characteristics of optical brighteners and their classes [Heterocyclic vinylene derivatives, Naphthalimide derivatives] general structure of each class.	
4	**4.1 Colour and Chemical Constitution of Dyes**	**(4L)**
4.1.1	Absorption of visible light, Colour of wavelength absorbed, Complementary colour.	
4.1.2	Relation between colour and chemical constitution.	
	a) Chromogen, chromophore, auxochrome, quinonoid structures b) Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. Comparative study and relation of colour in the following classes of compounds: Nitrobenzene, Nitroanilines, Nitrophenols, Anthraquinones, Diphenyl polyenes c) Four types of electronic transitions	
	4.2 Unit process and Dye Intermediates	
4.2.1	**A brief idea of Unit Processes**	**(3L)**
	Introduction to primaries and intermediates	
	Unit processes: definition and brief ideas of below unit processes:	

	(a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods & its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentionedabove with reaction conditions (mechanism is not expected)	
4.2.2	**Preparation of the Dye Intermediates**	**(8L)**
	4.3.1) Benzene derivatives: i) Benzene sulphonic acid ii) Benzene-1,3- disulphonic acid iii) Sulphanilic acid iv) o/m/p-chloronitrobenzenes v) o/m/p-nitroanilines vi) o/m/p-phenylene diamines vii) Naphthol ASG **4.3.2) Naphthalene derivative:** ii) Schaeffer's acid ii)Tobias acid iii) Naphthionic acid iv) 1 8-Naphthalimide v) H-acid vi) Naphthol AS **4.3.3) Anthracene derivative:** i) 1-Nitroanthraquinone ii) 1-Aminoanthraquinone iii) Anthraquinone-2-sulphonic acid iv) Benzanthrone	

References (For Units III & IV):

1. Color Chemistry: Synthesis, Properties and Applications of Organic Dyes and Pigments. Heinrich Zollinger, H. (2003), 3rd Edition, Wiley-VCH, Cambridge
2. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
3. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
4. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973

Semester-V
Practical

COs. No.	After completing the course, students will be able to:	Bloom Taxonomy Level (BTL)
CO1	Synthesis of simple drugs i.e aspirin	Evaluate
CO2	Estimation of Ibuprofen.	Create
CO3	Determination of iron from given drug sample.	Apply
CO4	Project on cotton dyeing.	Apply

Unit	Course Description	Hrs
1.	**Practical's Semester-V**	
	1. Estimation of Ibuprofen (back titration method) 2. Determination of iron from given drug sample 3. Preparation of Aspirin from salicylic acid. 4. Separation of components of natural pigments by paper chromatography (eg: chlorophyll) **II] Project:** **Preparation of Orange II dye (semi-microscale1.0gms) and its use for dyeing differentfabrics**	30

References:

1. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.

2. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.

3. Burger's Medicinal Chemistry, Drug Discovery and Development. Abraham and Rotella. Wiley

4. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.

5. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.

6. Principle of medicinal chemistry. Vol 1 &2 S. S. Kadam, K. R. Mahadik, K. G. Bothara

7. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.

8. The organic chemistry of drug design & drug action. 2 nd ed. By Richard B Silvermann, Academic Press

SEMESTER VI

Physical Chemistry

Course Description	
Semester	**VI**
Course Name	**Physical Chemistry**
Course Code	**USC6CH1**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Course Objectives

- To define electromotive force (EMF) and understand its fundamental concept.
- To comprehend the relationship between voltage, current, and resistance in electrical circuits.
- To describe the internal workings of electrochemical cells and their role in EMF generation.
- To identify and classify polymers based on their origin and properties.
- To analyse the physical and chemical properties of polymers and their industrial significance.
- To define polymers and distinguish between natural and synthetic polymers.
- To understand the fundamental principles of quantum mechanics and its relevance to chemistry.
- To explain the wave-particle duality of electrons and the quantization of energy levels
- To define nanomaterials and understand their unique properties at the nanoscale.
- To describe the various methods for synthesizing and fabricating nanomaterials.
- To understand the principles and physical basis of nuclear magnetic resonance (NMR) spectroscopy.
- To define and explain the phase rule and its components, including phases, components, and degrees of freedom.
- To apply the phase rule to analyze and predict phase equilibria in multi-component systems.

Course Outcomes

COs	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Recall the concept Ionic Strength, activity and activity Coefficient, examples of different polymers, and concept of nanomaterial and nanotechnology	I
CO2	Differentiate between Concentration cell and chemical cell natural and artificial polymers.	III
CO3	Understand cell representation rules to representation of cells phase rule to determine degree of freedom	II
CO4	Apply co-precipitation method for synthesis of new nanomaterials in laboratory	IV

Module / Unit	**Topics** **ELECTROMOTIVE FORCE**	**(15L)**
1.		
1.1	Introduction	
1.2	Thermodynamics of electrode potentials, Nernst equation for electrode and cell potentials in terms of activities	
1.3	Types of electrodes: Description in terms of construction, representation, half-cell reaction and emf equation for i) Metal – metal ion electrode. ii) Amalgam electrode. iii) Metal – insoluble salt electrode. iv) Gas – electrode. v) Oxidation – Reduction electrode.	
1.4	Reversible and Irreversible cells. i) Chemical cells without transference. ii) Concentration cells with and without transference. iii) Liquid – Liquid junction potential: Origin, elimination and determination	
1.4	Equilibrium constant from cell emf, Determination of the thermodynamic parameters such as ΔG, ΔH and ΔS.	
1.5	Applications of emf measurements: i) Determination of pH of solution using Hydrogen electrode. ii) Solubility and solubility product of sparingly soluble salts (based on concentration cell).	

1.6	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).	
1.7	Numerical problems	
II	**POLYMERS**	**(15L)**
2.1	**Basic terms:** Macromolecule, monomer, repeat unit, degree of polymerization.	
2.2	**Classification of polymers:** Classification based on source, structure, thermal response and physical properties.	
2.3	**Molar masses of polymers:** Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity	
2.4	**Method of determining molar masses of polymers:** Viscosity method using Ostwald Viscometer. (Derivation expected)	
2.5	**Light Emitting Polymers:** Introduction, Characteristics, Method of preparation and applications.	
2.6	**Antioxidants and Stabilizers:** Antioxidants, Ultraviolet stabilizers, Colourants, Antistatic agents and Curing agents.	
III 3.1	**BASICS OF QUANTUM CHEMISTRY**	**(9L)**
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	**Interpretation and properties of the wave function on the basis of postulates of 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.	
3.2	**NANOMATERIALS**	**(6L)**
3.2.1	Terminology and history: Optical properties of nanomaterials. i. Semiconducting nanoparticle ii. Metallic nanoparticles	
3.2.2	Characterization i. Characterization methods a) Scanning electron microscopy (SEM) b) Transmission electron microscopy (TEM) fabrication methods, Top-down, bottom-up fabrication a) Co-precipitation method b) Sol-gel method c) Chemical reduction method d) Electrochemical method.	
3.2.3	Applications of Nanomaterials	
IV 4.1	**NMR- NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY**	**(7L)**
4.1.1	**Principle**: Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes inNMR (spin -spin relaxation and spin - lattice relaxation).	
4.1.2	**Instrumentation**: NMR Spectrometer.	
4.2	**PHASE RULE**	**(8L)**
4.2.1	Gibb's phase rule and terms involved in the equation.	
4.2.2	Application of phase rule to TWO component systems, condensed systems, condensed phase rule, eutectic systems (Lead-Silver system), desilverisation of lead.	
4.2.3	Introduction to THREE component systems, explanation of the phase diagram for three liquids forming one immiscible pair.	

Note: Numericals and word problems are expected from all units of semester VI.

References

- **Physical Chemistry**, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.
- **Physical Chemistry**, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkata.
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- **Physical Chemistry**, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.
- **Modern Electrochemistry**, J.O.M Bockris & A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer
- **Fundamental of Molecular Spectroscopy**, 4th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
- **Physical Chemistry**, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- **The Elements of Physical Chemistry**, P.W. Atkins, 2nd Edition, Oxford University Press Oxford.
- **Physical Chemistry**, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt. Ltd. New Delhi.
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- **Polymer Science**, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.
- **Essentials of Nuclear Chemistry**, Arnikar, Hari Jeevan, New Age International (P) Ltd., Publishers, 2011.
- **Chemical Kinetics**, K. Laidler, Pearson Education India, 1987.
- **Fundamentals of nanoparticles** Ahmed Barhoum, Abdel Salam, Hamdy Makhlouf, Micro and nanotechnologies series, 2018.
- **Nanotechnology** - Fundamentals and Applications Manasi Karkare, 2020.
- **Nanotechnology**: Principles and Practices – Sulbha Kulkarni

P-I Physical (SEM-VI)-Practical's

COs	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)

CO1	Determine molecular weight by Rast method and order of reaction by fractional change method and Explain the adsorption phenomenon and the validity of adsorption isotherm.	II
CO2	Demonstrate practical skills based on instruments such as conductometry, pH meter, potentiometry.	III

Sr. No.	TYPE	PRINCIPLE	TITLE
1	**Non-Instruments**	**Viscosity**	To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement.
2		**Chemical Kinetics**	To interpret the order of reaction graphically (Graph should be plot traditional way or using origin software) from the given experimental data and calculate the specific rate constant. (No fractional order)
3	**Instruments**	**Potentiometry**	I. To determine the amount of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate. II. To determine the number of electrons in the redox reaction between ferrous ammonium sulphate and ceric sulphate potentiometrically.
4		**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.
5		**Colorimetry**	To estimate the amount of Fe (III) in the complex formation with salicylic acid by Static Method.

Reference books

- **Practical Physical Chemistry** 3rd edition A.M. James and F.E. Prichard, Longman publication
- **Experiments in Physical Chemistry** R.C. Das and B. Behra, Tata Mc Graw Hill
- **Advanced Practical Physical Chemistry** J.B. Yadav, Goel Publishing House

- **Advanced Experimental Chemistry** Vol-I J.N. Gurtu and R Kapoor, S. Chand and Co.
- **Experimental Physical Chemistry** by V.D. Athawale.
- **Senior Practical Physical Chemistry** by B.D. Khosla, V.C. Garg and A. Gulati, R Chand and Co.

Inorganic Chemistry

Course Description	
Semester	**VI**
Course Name	**Inorganic Chemistry**
Course Code	**USC6CH2**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Course Objectives:

1. To understand the bond formation in coordination compounds with special reference to CFT and MOT.
2. To study Stability and reactivity of complexes and Electronic Spectra of complexes.
3. To impart knowledge on organometallic compounds of main group elements
4. To provide a basic understanding of organometallic reactions including oxidative addition, reductive elimination, insertion, elimination, reactions.
5. To provide a foundation for understanding important catalytic processes commonly utilized in both academic and industrial laboratories.
6. To learn and emphasize the physicochemical principles involved in extraction of cast iron.
7. The learner is made familiar with industrially relevant topics such as Nanomaterials – their types, properties and applications.
8. Role of metal ions in biological systems.

Course Outcomes:

COs.	After completing the course, students will be able to:	Bloom Taxonomy Level (BTL)
CO 1	Demonstrate the knowledge of organometallic chemistry, and	Understand

	metallurgy.	
CO 2	Explain importance of nanomaterials,Chemical methods of synthesis of nanomaterials and forms of nanomaterials	Understand
CO 3	Construct molecular orbital diagram of different coordination compounds, Analyse the electronic spectra of complexes.	Apply
CO 4	Measure Crystal field stabilization energy (CFSE) for octahedralcomplexes using basic concepts of Crystal Field Theory.	Evaluate

Unit		**Topics**	
I	**1.0**	**THEORIES OF THE METAL-LIGAND BOND (I)**	**(15L)**
	1.1	Limitations of Valence Bond Theory.	
	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)	
	1.3	Splitting of d orbitals in octahedral, square planar and tetrahedral crystal fields.	
	1.4	Distortions from the octahedral geometry: (i) effect of ligand field and (ii) Jahn-Teller distortions.	
	1.5	Crystal field splitting parameter Δ; its calculation and factors affecting it in octahedral complexes, Spectrochemical series.	
	1.6	Crystal field stabilization energy (CFSE), calculation of CFSE for octahedral complexes with d0 to d10 metal ion configurations.	
	1.7	Consequences of crystal field splitting on various properties such as ionic radii, hydration energy and enthalpies of formation of metal complexes of the first transition series.	
	1.8	Limitations of CFT: Evidences for covalence in metal complexes (i) intensities of d-d transitions, (ii) ESR spectrum of [IrCl6]2- (iii) Nephelauxetic effect.	

	2.0	**THEORIES OF THE METAL-LIGAND BOND (II)**	
II	**2.1**	MOLECULAR ORBITAL THEORY FOR COORDINATION COMPOUNDS.	(4L)
	2.1.1	Introduction, Application of MOT to octahedral complexes involving σ-bonding.	
	2.1.2	2.1.2 Examples like $[FeF6]^{4-}$, $[Fe(CN)6]^{4-}$, $[FeF6]^{3-}$, $[Fe(CN)6]^{3-}$, $[CoF6]^{3-}$, $[Co(NH3)6]^{3+}$	
	2.1.3	Effect of π-bonding on complexes.	
		STABILITY OF METAL-COMPLEXES	(4L)
	2.2.1	Thermodynamic and kinetic perspectives of metal complexes with examples.	
	2.2.2	Stability constants: stepwise and overall stability constants and their Interrelationship.	
	2.2.1	Factors affecting thermodynamic stability.	
		REACTIVITY OF METAL COMPLEXES.	(4L)
	2.3.1	Introduction, Types of reactions in metal complexes.	
	2.3.2	Ligand substitution reactions: Associative and Dissociative mechanisms.	
	2.3.3	Inert and labile complexes: correlation between electronic	
		configurations and lability of complexes.	
	2.3.4	Acid hydrolysis, base hydrolysis and anation reactions.	
	2.4	**ELECTRONIC SPECTRA.**	**(3L)**
	2.4.1	Origin of electronic spectra	
	2.4.2	Types of electronic transitions in coordination compounds: intra- ligand, Charge transfer and intra-metal transitions.	
	2.4.3	Selection rules for electronic transitions.	
	2.4.4	Electronic configuration and electronic micro states, Terms and Term symbols for transition metal ions, rules for determination of ground state term.	
	2.4.5	Determination of Terms for d1 electronic configuration.	
III	**3.0**	**ORGANOMETALLIC CHEMISTRY**	

	3.1	**ORGANOMETALLIC COMPOUNDS OF MAIN GROUP METAL**	**(6L)**
	3.1.1	General characteristics of various types of organometallic compounds, viz. ionic, □-bonded and electron deficient compounds.	
	3.1.2	General synthetic methods of organometallic compounds: (i) Oxidative-addition (ii)Metal-metal exchange (transmetallation) banion-halide exchange (iv) Metal-hydrogen exchange (metallation) 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, (iv) Redistribution reactionsand (v) Complex formation reactions.	
		METALLOCENE'S	**(3L)**
	3.2.1	Introduction, Ferrocene: Synthesis, properties, structure and bonding on the basis of VBT.	
		METAL CLUSTERS	**(2L)**
	3.3.1	δ bonding, bonding in Rhenium and Molybdenum halide complexes.	
		CATALYSIS	**(4L)**
	3.4.1	Comparison between homogeneous and heterogeneous catalysis	
	3.4.2	Basic steps involved in homogeneous catalysis	
	3.4.3	Mechanism of Wilkinson's catalyst in hydrogenation of alkenes.	
IV	**4.0**	**SOME SELECTED TOPICS**	
	4.1	**METALLURGY**	**(4L)**
	4.1.1	Introduction, Metallurgy of Iron: Occurrence, Physicochemical Principles, Extraction of cast iron.	
	4.2	**Nanomaterials**	**(8L)**
	4.2.1	Introduction and importance of nanomaterials.	
	4.2.2	Properties (Comparison between bulk and nanomaterials) i) optical properties, ii) Electrical conductivity iii) Melting points, iv) Mechanical properties.	

	4.2.3	Forms of nanomaterials: Nanofilms, Nonolayers, Nanotubes, Nanowires and Nanoparticles.	
	4.2.4	Chemical methods of preparation : i) Colloidal routes and ii) sol gel synthesis.	
	4.3	**Introduction to Bioinorganic Chemistry.**	**(3L)**
	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)	

REFERENCES

Unit-I:

1. Geoffrey A. Lawrance Introduction to Coordination Chemistry John Wiley & Sons.
2. R. K. Sharma Text Book of Coordination Chemistry Discovery Publishing House
3. R. Gopalan , V. Ramalingam Concise Coordination Chemistry, Vikas Publishing House;
4. Shukla P R, Advance Coordination Chemistry, Himalaya Publishing House
5. Glen E. Rodgers, Descriptive Inorganic, Coordination, and Solid-State Chemistry Publisher:
ThomsonBrooks/Cole

Unit-II:

1. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers,
2. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY,
3. Twigg, Mechanisms of Inorganic and Organometallic Reactions
4. Publisher: Springer
5. R.K. Sharma Inorganic Reaction Mechanisms Discovery Publishing House
6. M. L. Tobe Inorganic Reaction Mechanisms PublisherNelson,1972

Unit-III:

1 Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.

2 H.W. Porterfield, Inorganic Chemistry, Second Edition, Academic Press, 2005

3 Purecell, K.F. and Kotz, J.C., Inorganic Chemistry W.B. Saunders Co. 1977.

4 Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, Publication by JohnWiley & Sons

5 B D Gupta & Anil J Elias Basic Organometallic Chemistry: Concepts, Syntheses and Applications,University press

6 Ram Charan Mehrotra, Organometallic Chemistry: A Unified Approach, New Age International.

Unit-IV

1 R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.

2 D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press

3 Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.

4 Jack Barrett and Mounir A Malati, Fundamentals of Inorganic Chemistry, Affiliated East westPress Pvt. Ltd., New Delhi.

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11 Sulabha K. Kulkarni, Nanotechnology-Principles and Practices, Capital Publishing Co.,2007.

12 Claudia-Altavilla, Enrico-Ciliberto, Inorganic Nanoparticles: Synthesis, Application and Perspectives,2010.

13 Geoffrey-A.-Ozin, Andre-C.-Arsenault**,** Nanochemistry A Chemical Approach to Nanomaterials, 2005.

Course Description	
Semester	**VI**
Course Name	**Inorganic Chemistry Practicals**
Course Code	**USC6CP2**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**1. 50 for (Inorganic Chemistry)**
Hours	Lectures: 30

Course Outcomes:

COs. No.	After completing the course, students will be able to:	Bloom Taxonomy Level (BTL)
CO 1	Develop the practical skills for preparation of different inorganic metalcomplexes	Understand
CO 2	Examine the percentage purity of the inorganic compounds qualitativelyand quantitively and impurity identification.	Analyse

COURSE CODE: USC6CP1 CREDITS: 1.50 for USC6CH2 (Inorganic Chemistry)

I- Inorganic Preparations:

1. Preparation of Manganese (III) acetylacetonate, $[Mn(acac)_3]$
2. Green synthesis of bis(dimethylglyoximato) nickel (II) complexusing nickel carbonate and sodium salt of dmg.
3. Preparation of potassium trioxalato aluminate (III)

II- 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 main group metal ions)

References

1. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
2. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N. Dhur & Sons Pvt Ltd.
3. Vogel's. Textbook of. Macro and Semi micro *qualitative* inorganic *analysis*. Fifth edition.

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Organic Chemistry

Course Description	
Semester	**VI**
Course Name	**Organic Chemistry**
Course Code	**USC6CH3**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Course Objectives

- To bring organic chemistry to students in the most thought-provoking and comprehensible way possible.
- Develop analytical thinking and apply the same for understanding principles, proposing mechanism and logical conclusions.
- Understanding of the interdisciplinary nature of organic chemistry and emerging trends in organic chemistry.
- To provide an overview and familiarize the students with the basic principles of organic reactions and its stereochemistry.
- Comprehensive and accessible overview of spectroscopy to build the necessary competency among the students for interpretation of spectral data in structure determination of organic compounds.
- To know the structure, elucidation and reactivity of the number of natural products and synthetic polymers.
- Competency in design and planning of synthesis and carry out with Good Laboratory Practices.
- Competency in handling instruments and techniques of separation of mixtures of organic compounds.

Course Outcomes

COs	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Explain stereoselectivity, stereospecificity, mechanism and stereochemistry of substitution, elimination and addition and rearrangement reactions.	II
CO2	Predict the synthons and functional group transformation and classify the selectivity of reagents and catalyst in organic synthesis.	VI
CO3	Explain the structures of proteins, nucleic acids and its components.	II
CO4	Interpret the analytical and chemical evidences for structure elucidation of natural products.	V

Module / Unit	**Topics**	**(15L)**
I		
1.1	**MOLECULAR REARRANGEMENTS**	**(5L)**
	Mechanism of the following rearrangements with examples and stereochemistry wherever applicable.	
1.1.1.	Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement, Benzilic acid rearrangement	
1.1.2	Migration to the electron deficient nitrogen: Beckmann rearrangement.	
1.1.3	Migration involving a carbanion: Favorski rearrangement.	
1.1.4	Migration to electron deficient oxygen: Baeyer-Villiger rearrangement	
1.2	**CHEMISTRY OF ENOLATES**	**(7L)**
1.2.1	Introduction: generation of enolates, kinetically controlled and thermodynamically controlled enolates	
1.2.2	Mechanism and applications of the following reactions: a. Aldol reaction b. Claisen-Schmidt reaction c. Dieckmann Reaction	

	d. Michael reaction e. Wittig reaction	
1.3	**RETROSYNTHESIS**	**(3L)**
1.3.1	Introduction to Retrosynthetic analysis and synthetic planning, Target molecule (TM), synthons, synthetic equivalents, disconnection approach, functional group interconversions (FGI)	
1.3.2	Concept of umpolung (Reversal of polarity)	
II		**(15L)**
2.1	**STEREOCHEMISTRY-II**	**(10L)**
2.1.1	Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and diastereoselectivity (de)	
2.1.2	Stereochemistry of- i) Substitution reactions: SNi (reaction of alcohol with thionyl chloride) ii) Elimination reactions: E2-Base induced dehydrohalogenation of 1-bromo-1, 2- diphenylpropane. Iii) Addition reactions to olefins: a) bromination (electrophilic anti addition) b) syn-hydroxylation with OsO_4 and $KmnO_4$ c) epoxidation followed by hydrolysis.	
2.2	**AMINO ACIDS & PROTEINS**	**(5L)**
2.2.1	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 phthalamide synthesis.	
2.2.2	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	

III		**(15L)**
3.1	**SYNTHESIS OF ORGANIC COMPOUNDS**	**(8L)**
3.1.1	Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemoselectivity and regioselectivity with examples, calculation of yields.	
3.1.2	Multicomponent Synthesis: Mannich reaction and Biginelli reaction. Synthesis with examples (no mechanism)	
3.1.3	Green chemistry: 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	**CATALYST AND REAGENTS**	**(7L)**
	Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism)	
3.2.1	**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: alkyne	
3.2.2	**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. m-CPBA (epoxidation of C=C) e. NBS (allylic and benzylic bromination)	
IV		**(15L)**
4.1	**NATURAL PRODUCTS**	**(10L)**
4.1.1	Terpenoids: Occurrence, Classification, Isoprene rule, special isoprene rule	

4.1.2	Citral: a. Structural determination of citral. b. Synthesis of citral from methyl heptenone c. Isomerism in citral. (cis and trans form).	
4.1.3	Alkaloids: Introduction and occurrence. Hofmann's exhaustive methylation and degradation in: simple open chain and N–substituted monocyclic amines.	
4.1.4	Nicotine: a. Structural determination of nicotine. (Pinner's work included) b. Synthesis of nicotine from nicotinic acid c. Medicinal Importance and harmful effects of nicotine	
4.1.5	Hormones: Introduction, structure of adrenaline (epinephrine), physiological action of adrenaline. Synthesis of adrenaline from a. Catechol b. p-hydroxybenzaldehyde (Ott's synthesis)	
4.2	**NUCLEIC ACIDS**	**(5L)**
	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.	

REFERENCES:

1. Advanced Organic Chemistry by J. March, 6th Edition.
2. Organic Reaction Mechanism, 4th edition, V. K. Ahluvalia, R. K. Parashar, Narosa Publication.
3. Organic Chemistry, Part A and B, Fifth edition, 2007, Francis A. Carey and Richard J. Sundberg, Springer.
4. Organic Chemistry, J. Clayden, S. Warren, N. Greeves, P. Wothers, 1st Edition, Oxford University Press (2001)
5. Organic Chemistry, Seventh Edition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.
6. Organic reactions & their mechanisms, third revised edition, P.S. Kalsi, New Age International Publishers.
7. Organic Chemistry, W. G. Solomons, C. B. Fryhle, 8th Edition, Wiley India Pvt. Ltd.
8. Modern methods of Organic Synthesis, 4th Edition W. Carruthers and Iain Coldham, Cambridge University Press 2004.

9. Stereochemistry of Carbon Compounds: Principles and Applications, D, Nasipuri, 3rd edition, New Age International Ltd.
10. Stereochemistry of Organic Compounds, Ernest L. Eliel and Samuel H. Wilen, Wiley-India edition
11. Stereochemistry, P. S. Kalsi, 4th edition, New Age International Ltd.
12. Biochemistry, 8th Ed., Jeremy Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto Pub. W. H. Freeman Publishers.
13. Lehninger Principles of Biochemistry 7th Ed., David Nelson and Michael Cox, Publisher W. H. Freeman.
14. Name Reactions – Jie Jack Li, 4th Edition, Springer Pub.
15. Organic Chemistry volume-I & II – I L Finar.
16. Introduction to Organic chemistry, John McMurry
17. S.H. Pine, Organic Chemistry 4th edition. McGraw Hill
18. Organic chemistry by Francis Carey – McGrawHill
19. Green chemistry: V. K. Ahluwalia (Narosa publishing house Pvt. Ltd.)
20. New trends in green chemistry V. K. Ahluwalia, M. Kidwai, Klumer Academic publisher.
21. Green chemistry by V. Kumar.
22. Natural Products Volume I and Volume II by O.P. Agarwal
23. Chemistry of Natural Products, Sujata V. Bhat, B.A. Nagasampagi, Meenakshi Sivakumar.

P-III Organic (SEM-VI)-Practical's

Course code: USC6CP2

COs	After completing the course, Student will able to:	Bloom Taxonomy Level (BTL)
CO1	Demonstrate the separation of the liquid-liquid and solid-liquid mixtures by fractional distillation.	II
CO2	Plan organic synthesis with calculations, stoichiometry, aspects of synthesis and predictions of spectral data in IR and NMR of the reactant and product.	III

Separation of Binary liquid-liquid and liquid- solid mixture of organic compounds using micro-scale technique.

1. Minimum six mixtures to be completed by the students.

2. Components of the liquid-liquid mixture should include volatile liquids like acetone, methyl acetate, ethyl acetate, isopropyl alcohol, ethyl alcohol, EMK and non-volatile liquids like chlorobenzene, bromobenzene, aniline, N,N dimethyl aniline, acetophenone, nitrobenzene, ethyl benzoate.
3. Components of the liquid-solid mixture should include volatile liquids like acetone, methyl acetate, ethyl acetate, ethyl alcohol, IPA, EMK and solids such as water insoluble acids, phenols, bases, neutral.
4. A sample of one ml mixture to be given to the student for detection of the physical type of the mixture.
5. After correct determination of physical type, separation of the binary mixture to be carried out by distillation method using micro-scale technique.
6. After separation into component A and component B, yield and physical constant are to be determined.

Planning of Organic Synthesis: To be recorded in to the journal (minimum four preparations)

Students are expected to know (i) the planning of synthesis, Literature, effect of reaction parameters including stoichiometry **and** green chemistry aspects ii) the possible mechanism, expected spectral data (IR and NMR) of the starting material and final product.

1. Cyclohexanone to oxime
2. Nitrobenezene to m-diniteobenzene
3. m-dinitrobenzene to m-nitroaniline
4. Acetanilide to p-bromoacetanilide
5. p-nitroacetanilide to p-nitroaniline
6. Acetanilide to p-nitroacetanilide

References for Practicals:

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H. Middleton
3. Practical organic chemistry – O.P. Agarwal
4. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.

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Important Note:

1. The candidate is expected to submit a journal certified by the Head of the Department /institution at the time of the practical examination.

2. A candidate will not be allowed to appear for the practical examination unless he/she produces a certified journal or a certificate from the Head of the institution/department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such certificate.
3. Use of non-programmable calculator is allowed both at the theory and the practical examination.

Analytical Chemistry

Course Description	
Semester	**VI**
Course Name	**Analytical Chemistry**
Course Code	**USC6CH4**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Course Objectives

- To provide broad understanding of various advanced instrumental techniques
- To understand the role of instrumental methods in specific applications
- To familiarise the students with processes in food and cosmetics industry

Course Outcomes

After completion of this course students will be able to

CO1: Explain the fundamentals and working of electroanalytical techniques such as polarography and amperometry.

CO2: Discuss the basics of chromatography, contrast and describe underlying principle, instrumentation and working of advanced separation methods such as GC, HPLC and HPTLC

CO3: Explain principles of thermal and radioanalytical methods and study of thermal decomposition of materials.

CO4: Apply analytical techniques for the analysis of cosmetics and food and describe food preservation and processing techniques.

Module/ Unit	Course Description	Lectures
1.	**Electroanalytical Techniques**	15L
1.1	**Polarography (Numerical and word problems are expected)**	11L
1.1.1	Difference between potentiometry and voltammetry, Polarizable and non-polarizable electrodes	
1.1.2	Basic principle of polarography Polarographic cells, 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 Standard addition method	
1.1.5	Applications advantages and limitations	
1.2	**Amperometric Titration**	04L
1.2.1	Principle, Rotating Platinum Electrode (Construction, advantages and limitations)	
1.2.2	Titration curves with example	
1.2.3	Advantages and limitations	
2.	**Methods of Separation – II**	**15L**
2.1	**Gas Chromatography (Numerical and word problems are expected)**	07L
2.1.1	Introduction, Principle, Theory and terms involved	
2.1.2	Instrumentation: Block diagram and components, types of columns, stationary phases in GSC and GLC, Detectors: TCD, FID, ECD	
2.1.3	Qualitative, Quantitative analysis and applications	

2.1.4	Comparison between GSC and GLC	
2.2	**High Performance Liquid chromatography (HPLC)**	04L
2.2.1	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)	
2.2.2	Qualitative and Quantitative Applications of HPLC	
2.3	**High Performance Thin Layer chromatography (HPTLC)**	03L
2.3.1	Introduction and Principle Stationary phase, Sample application and mobile phase	
2.3.2	Detectors- a) Scanning densitometer- Components. Types of densitometers- Single beam and Double beam, b) Fluorometric Detector	
2.3.3	Advantages, disadvantages and applications	
2.3.4	Comparison of TLC and HPTLC	
3.	**Ion Exchange Chromatography & Miscellaneous Methods of Analysis**	15L
3.1	**Ion Exchange Chromatography**	05L
3.1.1	Introduction, Principle.	
3.1.2	Types of Ion Exchangers, Ideal properties of resin	
3.1.3	Ion Exchange equilibria and mechanism, selectivity coefficient and separation factor	
3.1.4	Factors affecting separation of ions	
3.1.5	Ion exchange capacity and its determination for cation and anion	
3.2	**Thermal Methods**	07L
3.2.1	Introduction to various thermal methods	
3.2.2	Thermogravimetric Analysis (TGA):	
	Principle, Instrumentation, TG curve CaC2O4 .H2O and CuSO4.5H2O, Applications	
3.2.3	Differential Thermal Analysis (DTA):	
	Principle, Instrumentation, and Reference material used, Differential thermogram (DTA curve) CaC2O4 .H2O and CuSO4.5H2O, Applications	

	Comparison between TGA and DTA.	
3.3	**Radio-analytical Methods**	03L
3.3.1	Introduction to Radio analytical Methods, Classification	
3.3.2	Introduction to Neutron Activation Analysis, Theory, Advantages, Disadvantages, Applications	
4.	**Food and Cosmetics Analysis**	15L
4.1	**Introduction to Food Analysis**	10L
4.1.1	Food legislation: Sampling of food; General methods of analysis – moisture, ash, titrable acidity, pH and Sodium chloride	
4.1.2	Analysis of food and food products 1) Milk: Composition Analysis of milk for lactose by Lane Eynon's Method 2) Honey: Composition, Analysis of reducing sugars in honey by Coles Ferricyanide method Tea: Composition, Analysis of Tannin by Lowenthal's method 3) Coffee: Constituents and composition, Role of Chicory Analysis of caffeine by Bailey Andrew method	
4.1.3	Food Preservatives: need of food preservatives; different types of food preservatives and their role as preservatives. Determination of boric acid and sodium benzoate from food products	
4.1.4	Food Adulteration: Detection of common adulterants in milk, honey, tea and coffee	
4.2	**Introduction to Cosmetics Analysis**	05L
4.2.1	Introduction and sensory properties	
4.2.2	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	

References

1.	An Advance Dairy chemistry, V 3, P. F. Fox, P. L. H.McSweeney Springer
2.	Analysis of food and Beverages, George Charalanbous,Academic press 1978
3.	Analytical Chemistry of Open Learning(ACOL),James W. Dodd & Kenneth H. Tonge
4.	Analytical chemistry David Harvey The, McGraw Hill Companies, Inc.
5.	Analytical Chemistry, Gary D. Christan, 5th edition
6.	Analytical chemistry, R. K. Dave.
7.	Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
8.	Modern Analytical Chemistry, David Harvey, McGraw-Hill, 2000
9.	Food Analysis, Edited by S. Suzanne Nielsen, Springer
10.	Food Analysis: Theory and practice, YeshajahuPomeranz,Clifton E. Meloan, Springer
11.	Formulation and Function of cosmetics, Sa Jellineck
12.	Fundamentals of Analytical Chemistry, D. A. Skoog and D. M.West and F. J. Holler Holt., Saunders 6th Edition (1992)
13.	Government of India publications of food drug cosmetic act andrules.
14.	Harry's Cosmetology, Longman scientific co.
15.	High Performance Thin Layer Chromatography in Foodanalysis, by Prem kumar, CBS Publisher and distributer
16.	Instrumental methods Of Analysis, by Willard Merritt Dean,7thEdition, CBS Publisher and distribution Pvt Ltd
17.	Introduction to Polarography and Allied Techniques, By Kamala Zutshi, New Age International, 2006.
18.	Modern cosmetics, E. Thomessen Wiley Inter science
19.	Principles of Instrumental Analysis , 5th Edition, By Skoog,Holler, Nieman
20.	Principles of Polarography by Jaroslav Heyrovský , Jaroslav Kůta, 1st Edition, Academic Press, eBook ISBN: 978148326478
21.	Solvent extraction and ion exchange, J Marcus and A. S. KertesWiley INC 1969
22.	High Performance Thin Layer Chromatography by Dr P.D. Sethi, CBS Publisher and Distribution

23.	High Performance Thin Layer Chromatography in Foodanalysis, by Prem kumar, CBS Publisher and distributer
24	Analytical Chromatography, Gurdeep R Chatwal,Himalaya publication
25	A textbook of Gas chromatography by Rajbir Singh, Mittal Publication
26	Basic Gas Chromatography, Harold M. Mcnair James M. Miller, Wiley (e-book)

Course Description	
Semester	**VI**
Course Name	**Practical (Analytical Chemistry)**
Course Code	**USC6CP2**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**1.5**
Hours	**24L**

Course Objectives

- To understand the chemist's broad role in the problem-solving of analytical tasks
- To handle the instruments correctly and learn calibration, interpretation and representation of measurements.

Course Outcomes:

After completion of this course students will be able to

CO1: Demonstrate the analytical skills required for detection, identification, separation and analysis of food samples, environmental samples, pharmaceuticals etc.

CO2: Conduct, analyze and interpret results of a chemical analysis and communicate effectively in written reports and other formats

Title of Experiments

1 Estimation of Chromium in water sample spectrophotometrically by using Diphenyl carbazide.

2 Estimation of reducing sugar in honey by Willstatter method.

3 Separation of Mg (II) and Zn(II) by using anion exchange resin and their estimation by complexometric titration.

4 Determination of % purity of Hydrogen peroxide potentiometrically

5 Determination of phosphoric acid in cola sample pH metrically.

6 Detection of adulterants in milk, (Sugar, Starch, Soap, Formalin, Ammonium sulphate).

Note: Calculation of percent error is expected for all the experiments.

References

1. Vogel's Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).
2. Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J.Mendham et.al
3. The chemical analysis of food and food products III edition Morris Jacob
4. The chemical analysis of food by David Pearson and Henry Edward

Drugs and Dyes

Course Description	
Semester	**VI**
Course Name	**Drugs and Dyes**
Course Code	**USC6CH2**
Eligibility for the Course	**S.Y.B.Sc.**
Credit	**2.5**
Hours	**48 h (60L)**

Unit	Course Description	Hrs
1.		
	1.1 Drug Discovery, Design and Development Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5 Medicinal properties of compounds from Natural Sources: Anti-infective and anticancer properties of Turmeric (Curcumin) Development of drug: The Pharmacophore identification, modificationof structure or functional group, Structure activity relationship (Sulphonamides and Benzodiazepines). Structure modification to increase potency: Homologation, Chain branching and Extension of the structure, Ring chain transformation, Bioisoterism. Computer assisted drug design. **1.2 Drug Metabolism:** Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples. **1.3 Chemotherapeutic Agents:** Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class,therapeutic uses, side effects and introduction to MDR wherever applicable. **Antibiotics and antivirals:** Definition, • Amoxicillin (□- lactum antibiotics) • Cefpodoxime (Cephalosporins) • Doxycycline (Tetracyclines)	15

	• Levofloxacin (Quinolones) (**Synthesis from 2,3,4 – Trifluro - 1-nitrobenzene)** Aciclovir/Acyclovir (Purines) **Antimalarials:** Types of malaria; Symptoms; Pathological detection during window period (Life cycle of the parasites not to be discussed) • Chloroquine (3-Amino quinolones) • Artemether (Benzodioxepins) • Synthesis of Chloroquine **Following combination to be discussed:** Atremether-Lumefantrine (no structure) **Anthelmintics and Antifungal agents** Drugs effective in the treatment of Nematodes and Cestodesinfestations. • Diethyl carbamazine (Piperazines) • Albendazole (Benzimidazoles) (**Synthesis from 2-Nitroaniline)** • Clotrimazole (Imidazole) Fluconazole (Triazole) (**Synthesis from 1- Bromo – 2,3,4-trifluoro benzene)**	
2.		
	Chemotherapeutic Agents continued. **2.1 Antiamoebic Drugs** Types of Amoebiasis • Metronidazole, Ornidazole, Tinidazole (Imidazole) Synthesis of Metronidazole from glyoxal by Debus-Radziszewski imidazole synthesis route **Following combination therapy to be discussed:** Ciprofloxacin-Tinidazole **2.2 Antitubercular and Antileprotic Drugs**	15

Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis.Types of Leprosy.

General idea of Antibiotics used in their treatment.

- PAS (Amino salicylates)
- Isoniazide (Hydrazides)
- Pyrazinamide (Pyrazines)
- (+) Ethambutol (Aliphatic diamines) (**Synthesis from 1-Nitropropane)**
- Dapsone(Sulphonamides) (**Synthesis from 4- Chloronitrobenzene)**
- Clofazimine (Phenazines)
- Bedaquiline (Quinoline)

Following combination therapy to be discussed:

(i) Rifampin + Ethambutol + Pyrazinamide

(ii) Rifampin + Isoniazide + Pyrazinamide

2.3 Anti-Neoplastic Drugs

Idea of malignancy; Causes of cancer

Brief idea of Immuno Stimulants &Immuno depressants

- Lomoustine (Nitrosoureas)
- Anastrozole(Triazoles) (**Synthesis from 3,5-bis (bromomethyl) toluene)**
- Cisplatin (Chloro Platinum)

Vincristine, Vinblastine, Vindesine) (Vinca alkaloids) (structure not expected

2.4 Anti-HIV Drugs

Idea of HIV pathogenicity, Symptoms of AIDS

AZT/Zidovudine, Lamivudine,DDI (Purines)

2.5 Drug Intermediates: Synthesis and uses

1. p-Acetyl amino benzenesulphonyl chloride from Aniline

	2. Epichlorohydrine from propene **Local Anti-infective Drugs:** (Introduction, Classification, Synthesis of Sulphonamides, Dapsone, Aminosalicyclic acid) **2.6 Nano particles in Medicinal Chemistry** Introduction; Carbon nano particles (structures) and Carbon nano tubes: • Functionalization for Pharmaceutical applications • Targeted drug delivery • In vaccine (Foot and mouth disease) • Use in Bio-physical treatment. Gold nano particles in treatment of: Cancer; Parkinsonism; Alzheimer. Silver nano particles: Antimicrobial activity. **2.7 Drugs and Environmental Aspects** • Impact of Pharma-industry on environment, International regulation for human experimentation with reference to: "The Nuremberg Code" and "The HelsinkiDeclaration".	
3	**3.1 Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes** (Synthesis of the dyes marked with * is expected)	**(12L)**
	i) Nitro Dye: Naphthol Yellow S	
	ii) Nitroso Dye: Gambine Y	
	iii)Azo dyes: a) Monoazo dyes: Orange IV *(from sulphanilic acid) & Eriochrome Black T* (from β- naphthol) b) Bisazo dyes: Congo Red* (from nitrobenzene) Trisazo Dye: Direct Deep Black EW* (from benzidine)	
	iv)Diphenylmethane dye: Auramine O* (from N,N-dimethyl aniline)	
	v)Triphenylmethane dye:	

	a) Diamine series: Malachite Green* (from benzaldehyde) b) Triamine series: Acid Magenta Phenol series: Rosolic acid	
	vi)Heterocyclic Dyes: a) Thiazine dyes: Methylene Blue b) Azine dyes: Safranin T* (from o-toluidine) c) Xanthene Dyes: Eosin* (from phthalic anhydride) d) Oxazine Dyes: Capri Blue Acridine Dyes: Acriflavine	
	vii)Quinone Dyes: a) Naphthaquinone: Naphthazarin Anthraquinone Dyes: Indanthrene Blue* (from anthraquinone)	
	viii) Indigoid Dyes: Indigo* (from aniline + monochloroacetic acid)	
	ix) Phthalocyanine Dyes: Monastral Fast Blue B	
3.2	**Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes**	**(3L)**
3.2.	**Impact of the textile and leather dye Industry on the environment**	
1	with special emphasis on water pollution	
3.2. 2	**Health Hazards:** Toxicity of dyes w.r.t food colours.	
3.2. 3	**Effluent Treatment Strategies**: Brief introduction to effluent treatment plants (ETP) Primary Remediation processes:(Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ashetc.)	
	Secondary Remediation processes: Biological Remediation –Biosorption, bioremediation and biodegradation	
	Chemical Remediation: Oxidation Processes (chlorination),Coagulation-flocculation-Precipitation	
4	**4.1 Non-textile uses of dyes:**	**(8L)**
4.1. 1	**Biomedical uses of dyes** i) Dyes used in formulations (Tablets, capsules, syrups etc) Sunset yellow, Tartrazine, Erythrosin	

	ii) Biological staining agents Methylene blue, Crystal violet and Safranine T iii) DNA markers Bromophenol blue, Orange G, Cresol red iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Neoprontosil	
4.1.2	**Dyes used in food and cosmetics:** i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI Commonly used food colours and their limits	
4.1.3	**Paper and leather dyes** i) Structural features of paper and leather Dyes applicable to paper and leather	
4.1.4	**Miscellaneous dyes** i) Hair dyes ii) Laser dyes iii) Indicators iv) Security inks iv) Coloured smokes and camouflage colours	
4.2	**Pigments**	**(3L)**
	Definition of pigments, examples, properties of pigments, difference between dyes and pigments. Definition of Lakes and Toners	
4.3	**Dyestuff Industry - Indian Perspective**	**(4L)**
4.3.1	Growth and development of the Indian Dyestuff Industry	
3.3.2	Strengths, Weaknesses, Opportunities and Challenges of theDyestuff industry in India	
4.3.3	Make in India - Future Prospects of the Dye Industry	

References (For Units III & IV)

1. Chemistry of Synthetic Dyes, Vol I – IV, Venkatraman K., Academic Press 1972
2. Color Chemistry: Synthesis, Properties and Applications of Organic Dyes and Pigments. Heinrich Zollinger, H. (2003), 3rd Edition, Wiley-VCH, Cambridge
3. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger PublishingCompany, NY ,1995
4. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
5. Environmental Studies, Joseph Benny, Tata McGraw Hill Education, 2005
6. Fundamental Concepts of Environmental Chemistry,Sodhi. G. S.,Alpha Science International, 2009
7. Planning Commission, Niti Aayog, FSSAI and FDA websites
8. Green Chemistry for Dyes Removal from Waste Water- Research Trends and Applications,Ed. Sharma S.K., Wiley, 2015
9. Environmental Pollution- Monitoring and Control, Khopkar S.M., New Age International (P)Ltd, New Delhi, 1982

Semester-VI
Practical

COs. No.	**After completing the course, students will be able to:**	**Bloom Taxonomy Level (BTL)**
CO1	Synthesize, Crystallization Physical constant, able to understand process of purification.	Apply
CO2	Determination of Calcium from given Calcium tablet	Create
CO3	Examine monograph	Evaluate
CO4	Apply the TLC technique for the separation of the mixture of dyes	Apply

Unit	Course Description	Hrs
1.	**Practical's Semester-VI**	
	1.O-Methylation of β-naphthol. 2. Determination of Calcium from given Calcium tablet. 3. Preparation of Fluorescein 4. TLC of a mixture of dyes (safranine-T, Indigo carmine, methylene blue) II] Preparation of monograph of any one drug from syllabus by I.P. method.	30

References:

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.

2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.

3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.

4. Burger's Medicinal Chemistry, Drug Discovery & Development. Abraham & Rotella. Wiley

5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.

6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.

7. Principle of medicinal chemistry. Vol 1 & 2 S. S. Kadam, K. R. Mahadik, K. G. Bothara

8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.

9. The organic chemistry of drug design & drug action. 2 nd ed. By Richard B Silvermann, Academic Press.

10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey. 11. Text book of drug design and discovery. Povl-Krog-Sgaard-Larsen, Tommy Liljefors and ULF Madsen, 3rd Edition Taylor & Francis.

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