Department of Chemistry
S.Y.B.Sc Chemistry Semester III
Syllabus 2022 Pattern with effect from June 2023

USCH231: Physical and Analytical Chemistry-I (48 L, 3 Credits)

Course Objectives:

1. Students will be able to remember the stereochemistry of mono substituted cyclohexane.
2. Students will be able to understand terms used in the stereochemistry.
3. Students will be able to remember the oxidizing and reducing agents.
4. Students will be able to understand the applications of oxidizing and reducing agents.
5. Students will be able to remember the concepts of amines.
6. Students will be able to understand the theories of acids and bases.
7. Students will be able to remember concepts of d-block elements and molecular orbital theory.

Course Outcomes:

1. Students should be able to know the stereochemistry of mono substituted cyclohexane. Apply it for to make the models to study their stability.
2. Students should be able to know the configuration and assignment of configuration of optically active molecule.
3. Students should be able to compare uses of oxidizing and reducing agents in organic synthesis.
4. Students should be able to know reactions of aliphatic amines.
5. Students should be able to compare the theories of acids and bases.
6. Students should be able to know colors of inorganic compounds.
7. Students should be able get the knowledge of MOT and able to know the bond order in diatomic molecules.

Section I: Physical Chemistry

1. Chemical Kinetics (10 L)

Introduction, The concept of reaction rate. Effects of various factors like temperature, pressure, presence of catalyst on the reaction rate. Order and Molecularity of a chemical reaction. Derivation of integrated reaction rate equation for zero, first, second order (both for equal and unequal initial concentrations of reactants) reactions and third order reaction (no derivation). Half-life period of reaction. General methods for determination of order of reaction. Concept of activation energy and its determination from Arrhenius equation. Numerical problems.

2. Chemical Thermodynamics (6 L)

Second Law of Thermodynamics: Concept of entropy; statement of the second law of thermodynamics; Calculation of entropy change (Δ S) forreversible and irreversible processes under different conditions. Numerical problems.

Third Law of Thermodynamics: Concept of absolute entropy. Statement of third law.

3. Free energy and Chemical Equilibrium (8L)

Introduction, Helmholtz free energy, variation of it with volume and temperature, Gibbs free energy, variation of it with pressure and temperature,

Gibbs free energy change for chemical reaction, Free energy change for an ideal gas. Free Energy and equilibrium - Concept, Definition and significance

The reaction Gibbs energy. The perfect gas equilibrium, the general case of equilibrium, the relation between equilibrium constants, molecular interpretation of equilibrium constant.

van't Haff equation, Value of K at different temperature, Problems

Reference books:

1. Principles of Physical Chemistry, S. H. Marron and C. F. Pruton, 6th edn.
2. Essentials of Physical Chemistry, Bahl, Tuli, Revised multicolour edn. 2009
3. Physical Chemistry, G. M. Barrow, Tata McGraw-Hill (2007)
4. University Chemistry, B. H. Mahan, 3rd edn. Narosa (1998)
5. Chemical Thermodynamics, R. P. Rastogi and R.P. Misera

Section II: Analytical Chemistry

1. Analytical Chemistry and Essentials (10 L)

A brief introduction of analytical chemistry, the analytical perspectives, Common analytical problems.Solution and their concentrations- Molar concentrations, Molar analytical Concentrations, Molar equilibrium concentration, percent Concentration, Preparation of ppm level solutions from source materials (salts), conversion factors, density and specific gravity of solutions, Numerical problems. Chemical Stoichiometry – empirical and molecular formulas, Stoichiometric calculations,Numerical problems.

2. Volumetric Analysis (14 L)

Introduction to volumetric analysis Calibration of apparatus, Standard solutions, Equivalent weights in different type of reactions, Classification of volumetric analysis,

I. Neutralization titration: Acid base indicators, Ostwald's theory of indicators, neutralization curves for strong acid- strong base, weak acid- strong base, weak base- strong acid, Determination of equivalence point and calculations. Problems.

II. Complexometric titration: Principle, Mg- EDTA titration, metal ion indicators, choice of indicators. Applications,

III. Redox titration: Principle, detection of equivalence point using suitable indicators. Titration between oxalic acid and $KMnO_4$. Applications.

IV. Precipitation titration: Principle, titration between $AgNO_3$ and halide ions byVolhard's method and Fajan's method. Detection of end point of the titration. Applications.

V. Iodometric titration: Principle, detection of end point, difference between iodometry and iodimetry, standardization of $Na_2S_2O_3$ solution using $K_2Cr_2O_7$and estimation ofiodine. Applications.

Reference books:

1. Basic concept of Analytical Chemistry, S. M. Khopkar
2. Instrumental methods of chemical analysis, Willard, Merritt, Dean
3. Analytical Chemistry, G. D. Christian
4. Introduction to Instrumental analysis, R. D. Brown
5. Fundamentals of Analytical Chemistry, Skoog
6. Instrumental methods of chemical analysis, Chatwal and Anand

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (SEM III) **Subject:** Chemistry
Course: Physical and Analytical Chemistry -I **Course Code:** USCH-231
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	0	0	0	0	0	0	0	0
CO2	3	0	0	0	0	3	0	0	0
CO3	3	0	0	0	0	0	0	0	0
CO4	0	0	3	0	0	3	0	0	0
CO5	0	0	0	3	3	0	0	0	0
CO6	0	0	0	0	0	3	0	0	0
CO7	0	0	0	0	0	3	3	0	0

Justification of Mapping:

PO1: Disciplinary Knowledge:
CO1: Students should able to know concept of reaction rate, order of reaction, activation energy and rate theories.
CO2: Students should able to understand second law of thermodynamics, entropy calculation.
CO3: Students should able to know concept of free energy, chemical equilibrium and response to different factors.

PO2: Critical Thinking and Problem Solving:
CO2: Students should able to understand second law of thermodynamics, entropy calculation.
CO6: Students should able to solve related numerical and problems.
CO7: Students should able to know different techniques and applied in analysis

PO 3: Social Competence
CO 3: Student will able to prepare the standard solutions required in chemical synthesis/analysis with qualitative/ quantitative approach.

PO 4: Research-Related Skills and Scientific Temper
CO 4: Student will able to perform good laboratory practises through pre-setting of experiments by utilizing their scientific temper with interdisciplinary manner.

PO 5: Trance-disciplinary Knowledge
CO 5: Student will able to carry out the analysis of soil, water, food, pharmaceutical, chemical and industrial samples by volumetric and instrumental techniques considering social, economic and legal ethics/ accepts.

PO 6: Personal and Professional Competence
CO6: Solving numerical problems, understanding techniques applied in analysis, and calculations in stoichiometry contribute to enhancing problem-solving skills

PO7:Effective Citizenship and Ethics
CO7: Exposure to different analysis techniques directly links to the enhancement of analytical skills.

USCH 232: ORGANIC AND INORGANIC CHEMISTRY- I (48 L, 3 Credits)

Course Objective:

1. To understand basic concept of isomerism, types of isomers and their stereochemistry.
2. To introduce the Baeyer's strain theory and its applications.
3. Students should learn to optical isomerism and know about stability, energy calculation with Potential diagram and optical activity of these conformers.
4. Students should know-definition and types of aliphatic amines and analysis of primary, secondary and tertiary amines.
5. Students should provide the types of reagents, types of organic reaction and types of rearrangement.
6. Students should understand the concept MOT of Oh complex with sigma bonding.
7. To know the limitation of VBT and the assumption of CFT
8. Students should able to explain d-d transitions and colour of the complex.
9. Students should understand and the concept of acid, base theory.

Course Outcome:

1. Learning stereochemistry of the mono-substituted cyclohexane with their stereoisomerismand their stability.
2. Students will be able to learn concepts of the aliphatic substitution reaction and differencebetween them.
3. Students will be able to apply the knowledge to represent the mechanism of organicreaction.
4. Students will be learn the VB representation of tetrahedral, square planer, trigonalbipyramidal and octahedral complex.
5. Students will be able to learn the concepts of the VBT and CFT.
6. Learning of acid, base and solvent of Arrhenius theory, Lowry-Brönsted theory, Lux-Flood concept, Lewis concept.

Section I: Organic Chemistry

1. Stereoisomerism (10 L)

i) Introduction to optical isomerism - Optical Activity and polarimetry- Ordinary light, mono chromatic light, plane polarized light, optical activity, dextro rotatory, leavo rotatory, specific rotation, causes of optical activity, chirality, asymmetric carbon atom, Enantiomerism, Diastereomerism.

ii) Stereoisomerism - Baeye'rs strain theory, heat of combustion, cycloalkanes, factors affecting the stability of conformation, Conformation of cyclohexane

- equatorial and axial bonds, Mono-substituted cyclohexane stability with $-CH_3$ and-$C(CH_3)_3$ substitutes. Structures of geometrical isomers of dimethyl cyclohexane.

2. Aliphatic amines (6 L)

a) Structure b) Classification c) nomenclature d) physical Properties.

e) preparation of amine from – reduction of nitro compounds, reductive amination, reduction

of nitriles, Hoffmann degradation of amides f) Reactions of amines - alkylation, conversion into amides, Analysis of amine.

3. Organic reaction Mechanism (8 L)

Introduction, types of reagents–electrophile, nucleophile and free radical. Types of organic reactions: Addition, Elimination (β-elimination and Hofmann elimination), substitution (aliphatic electrophilic and nucleophilic, aromatic electrophilic) and rearrangement. Mechanism: (i) Markovnikov and anti-Markovnikov addition reaction (ii) Saytzeff and Hoffmann elimination (iii) SN^1 and SN^2 reactions (v) Pinacol-Pinacolone rearrangement (vi) Wagner-Meerwin reaction.

Reference Books:

1. Organic Chemistry. Morrison and Boyd, 6th Ed Prentice Hall, New Delhi-2001.
2. Stereochemistry of carbon compounds, E. L. Eliel
3. Reactions, rearrangements and reagents, S N Sanyal
4. A guide book to Mechanism in Organic Chemistry, Peter Sykes, 6th Ed

Section II: Inorganic Chemistry

1. Molecular Orbital Theory of diatomic molecules (12 L)

Limitations of Valence Bond theory(VBT), Need of Molecular orbital theory (MOT), Features of MOT, Sigma and pi bond, Molecular orbital Method, LCAO principle and method, s-s combinations of orbitals, s-p combinations of orbitals, p-p combinations of orbitals, p-d combinations of orbitals, d-d combinations, Non-bonding combinations of orbitals, Rules for linear combination of atomic orbitals.

Examples of molecular orbital treatment for homo-nuclear diatomic molecules: (Explain each molecule with respect to MO energy level diagram, bond orderand magnetic behavior) H_2^+ molecule ion, H_2 molecule, He_2^+ molecule ion, He_2 molecule, Li_2 molecule, Be_2 molecule, B_2 molecule, C_2 molecule, N_2 molecule, O_2 molecule, O_2^+, O_2^- and O_2^{2-} molecule ion, F_2 molecule, Ne_2 molecule.
Heteronuclear diatomic molecules: Examples of molecular orbital treatment for hetero-nuclear diatomic molecules, NO molecule, CO molecule, HF molecule.

2. Chemistry of d-block (6 L)

Introduction, electronic configuration, size of atoms and ions, density,melting points and boiling points, reactivity, oxidation state, catalytic properties, colour and magnetic properties of complexes. Comparison of 1 st transition series with 2 nd & 3 rd transition series w.r.t.- a) electronic configuration b) reactivity c) Stability of oxidation state d) magnetic behavior and e) Stability of complexes (in brief)

3. Acid, base and solvents (6 L)

Properties of solvents, Arrhenius theory, Lowry-Brownsted theory, Solvent system, Lux-Flood concept, Lewis concept, Hydracids and Oxyacids.

Reference Books:

1. Concise Inorganic Chemistry, Lee, J.D. ELBS, 1991.
2. Basic Inorganic Chemistry, Cotton, F.A., Wilkinson, G. & Gaus, P.L. 3rd ed.,Wiley.
3. Concepts and Models in Inorganic Chemistry, Douglas, B.E., McDaniel, D.H. & Alexander, J.J. John Wiley & Sons.
4. Inorganic Chemistry: Principles of Structure and Reactivity, Huheey, J. E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. Pearson (2006)

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (SEM III) **Subject:** Chemistry
Course: Chemistry Practical III **Course Code:** USCH-232
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	0	0	0	0	0	0	0	0
CO2	3	3	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0
CO4	0	0	0	3	0	0	0	0	0
CO5	0	0	0	0	3	0	0	0	0
CO6	0	0	0	0	0	3	0	0	0
CO7	0	0	0	0	0	0	3	0	0

Justification of Mapping

PO1: Disciplinary Knowledge:
CO1: Understanding the stereochemistry of cyclohexane and applying it to study stability directly aligns with disciplinary knowledge.
PO2: Critical Thinking and Problem Solving:
CO2: Configuring optically active molecules and their assignments involve critical thinking and practical applications
PO3:Social Competence
CO3: Comparing uses of oxidizing and reducing agents in organic synthesis requires a deep understanding and application of these concepts
PO4:Research-Related Skills and Scientific Temper
CO4: Knowledge of reactions of aliphatic amines contributes to understanding the reactivity of organic compounds
PO5:Trance-disciplinary Knowledge
CO5: Comparing theories of acids and bases contributes to understanding fundamental principles in chemistry
PO6:Personal and Professional Competence
CO6: Knowing colors of inorganic compounds demonstrates knowledge in inorganic chemistry
PO7: Effective Citizenship and Ethics
CO7: Understanding Molecular Orbital Theory and bond order aligns with theoretical and conceptual understanding

USCH233: Chemistry Practical- III (10 P, 2 credit)

Course Objectives:

1. To introduce chemical and laboratory safety.
2. To adequate students with graph of various functions.
3. To learn basic of chemistry practical from all the discipline of chemistry.
4. .To learn the estimation of compounds.
5. To know the synthesis of derivatives.
6. To learn the volumetric analysis

Course Outcomes:

1. Student will able to understand the theoretical aspects and scientific principles of selected experiments through demonstrations which helps in developing the subject interest.

2. Student will able to develop experimental and operational skills through hands on training showcasing accident-free working, critical thinking and numerical solving ability in laboratory.

3. Student will able to prepare the standard solutions required in chemical synthesis/analysis with qualitative/ quantitative approach.

4. Student will able to perform good laboratory practices through pre-setting of experiments by utilizing their scientific temper with interdisciplinary manner.

5. Student will able to carry out the analysis of soil, water, food, pharmaceutical, chemical and industrial samples by volumetric and instrumental techniques considering social, economic and legal ethics/ accepts.

6. Student will be aware with the MSDS data of various chemicals which inform the toxicity level. It helps in developing the safe working methods and ethical use of them.

7. Student will able to apply their experimental skill during use of sophisticated instruments. It helps in demonstrating standard operational procedures(SOP'S) which can be useful in future research focus/approach with enrichment in personal and professional ability.

8. Student will able to apply the knowledge about various chemical methods of analysis to solve various social/ scientific problems. It can be useful in the research with many interdisciplinary subjects such as microbiology, nanoscience and engineering.

Section I: Physical Chemistry Practical (Any five experiments)

1. Study of variation of mutual solubility temperature with concentration for thephenol water system and determination of the critical solubility temperature.
2. Determination of solubility of Benzoic acid at different temperature and calculate ΔH of solution.
3. To determine the first order rate constant of acid catalyzed ester hydrolysis.
4. To determine the rate constant of base catalyzed ester hydrolysis.
5. To study the standardization and working of potentiometer and determine the potential and pH of two buffer solutions.
6. To study the standardization and working of pH meter and determine the equivalence

point for pH metric titration between strong acid and strong base.

Reference Book:

1 A Senior Practical Physical Chemistry, Khosla, Garg & Gulati, R, Chand & Co
2. Practical Physical Chemistry, A M. Jemes, F. E. Prichard, 3rd edn, Longman.
3. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing house

Section II: Organic Chemistry Practical

1) Organic Qualitative Analysis (Four Single compounds).

Identification of organic compounds through –

a) Type determination b) preliminary tests c) detection of elements (Sodium fusion tests) d) detection of functional groups e) melting point / Boiling point

i) Acid (any two): benzoic, salicylic, phthalic, cinnamic, oxalic, salicylic acid

ii) Phenol (any two): α-naphthol, β-naphthol, resorcinol, o-nitrophenol, p- nitrophenol

iii) Base (any two): Aniline, p-toludine, diphenylamine, N, N-dimethylaniline, o-nitroaniline m-nitroaniline, p-nitroaniline

iv) Neutral (any two): Benzaldehyde, glucose, fructose, acetone, ethylmethyl ketone, acetophenone, methyl acetate, ethyl acetate, naphthalene, Anthracene, Nitrobenzene, mdinitrobenzene, Acetamide, Urea, Acetanilide, Chloroform, Carbon tetrachloride, Thiourea.

2) Organic Preparation (any two) (With crystallization, M. P. and TLC)

i) Aspirin from salicylic acid
ii) P-Nitro Benzoic acid from P- Nitro Toluene
iii) phthalic anhydride from phthalic acid
iv) Osazone form glucose
v) Quinone form Hydro Quinone

Reference Book:

1 Organic Qualitative Analysis – A. I. Vogel

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CO2	3	0	0	0	0	3	0	0	0
CO3	3	0	0	0	0	0	0	0	0
CO4	0	0	3	0	0	3	0	0	0
CO5	0	0	0	3	3	0	0	0	0
CO6	0	0	0	0	0	3	0	0	0
CO7	0	0	0	0	0	3	3	0	0

Justification of Mapping

PO1: Disciplinary Knowledge:

CO 1: Student will able to understand the theoretical aspects and scientific principles of selected experiments through demonstrations which helps in developing the subject interest.

CO 2: Student will able to develop experimental and operational skills through hands on training showcasing accident-free working, critical thinking and numerical solving ability in laboratory.

CO 3:Student will able to prepare the standard solutions required in chemical synthesis/analysis with qualitative/ quantitative approach.

PO2: Critical Thinking and Problem Solving:

CO 2: Student will able to develop experimental and operational skills through hands on training showcasing accident-free working, critical thinking and numerical solving ability in laboratory.

CO 6: Student will be aware with the MSDS data of various chemicals which inform the toxicity level. It helps in developing the safe working methods and ethical use of them.

CO 7: Student will able to apply their experimental skill during use of sophisticated instruments. It helps in demonstrating standard operational procedures(SOP'S) which can be useful in future research focus/approach with enrichment in personal and professional ability

PO 3: Social Competence

CO 3: Student will able to prepare the standard solutions required in chemical synthesis/analysis with qualitative/ quantitative approach.

PO 4: Research-Related Skills and Scientific

CO 4: Student will able to perform good laboratory practises through pre-setting of experiments by utilizing their scientific temper with interdisciplinary manner.

PO 5: Trance-disciplinary Knowledge

CO 5: Student will able to carry out the analysis of soil, water, food, pharmaceutical, chemical and industrial samples by volumetric and instrumental techniques considering social, economic and legal ethics/ accepts.