S. Y. B.Sc. Chemistry (2022 Pattern) SEM IV

USCH 241: Physical and Analytical Chemistry (30 L, 2 Credits)

A. Learning Objective:

1. To introduce the basic concepts of solution, types and ideal behavior
2. To provide the details of Raoult's law and deviations from it.
3. To learn the basic principles P-X and T-X diagrams.
4. To adequate the student about the partially miscible liquids and their types.
5. To obtain the details about ionic equilibrium, types of electrolytes and ionization.
6. To learn the basic principle of salt hydrolysis and hydrolysis constant with related numerical.
7. To adequate the student about concept of phase and statement of Gibb's phase rule.
8. To obtain the details about phase diagrams of one component system (water and Sulphour)

B. Learning Outcome:

1. Students will be able to apply the knowledge of concept of solution, their types.
2. Students will be able to learn concepts like ideal and non-ideal solution with Raoult's law
3. Students will able to draw and explain P-X and T-X diagrams.
4. Students will be able to apply the knowledge of ionic equilibrium for ionization of acid, base salt and the hydrolysis of them.
5. Students will be able to understand the factors affecting the ionization of electrolytes.
6. Students will be able to understand the application of Gibb's phase rule.
7. Students will be able to apply the Gibb's phase rule for water and Sulphour system.

Section I: Physical Chemistry

1. SOLUTIONS (6 L)

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, Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids.

2. IONIC EQUILIBRIUM (5 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, Salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.

3) PHASE EQUILIBRIUM (4 L)

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Phase diagrams of one-component systems (water and sulphur) and details.

References:
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. ERRORS IN QUANTITATIVE ANALYSIS (4 L)

Introduction to Error, Accuracy, Precision, Methods of expressing accuracy and precision, Classifications of errors, Significant figures, Distribution of random errors, Mean and Standard deviations, Reliability of results, Numerical.

2. INTRODUCTION TO INSTRUMENTAL APPLICATIONS

A) pH meter (4 L)

Introduction, pH meter, Glass pH electrode, Standard Buffer pH measurement, Accuracy of pH measurement, pH meter –How does it works? pH metric titrations Applications of pH meter. Numerical based on pH metry.

B) Potentiometer (3 L)

Introduction, General Principle, Electrochemical Cell, Reference Electrodes, Determination of concentration and pH from potential measurement, Potentiometric titrations, Numerical based on potentiometry.

3. CHROMATOGRAPHY (4 L)

Introduction to chromatography. Descriptions about different types: Paper chromatography, Thin Layer Chromatography, Ion exchange Chromatography, Gas chromatography, High Performance Liquid Chromatography. Classification of chromatographic methods based on separation techniques and development procedures.

References:
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

USCH 242: Organic and Inorganic Chemistry (30 L, 2 Credits)

A. Learning Objective:

1. To learn concepts of aldehydes and ketones and their preparation..
2. To introduce name reaction related to aldehydes and ketones.
3. Students should learn basic bio-molecules.
4. Students should know definition and types of amino acids and their reactions.
5. Students should learn proteins and their structures.
6. Students should learn the concept of ligands and co-ordination compounds.
7. Students should know the complexes of metals.

B. Learning Outcome:

1. Understand the preparations and reactions of aldehydes and ketones.
2. Students should understand the name reactions.
3. Students will be able to apply the knowledge to represent the mechanisms of name reaction.
4. Students will be able to understand the biomolecules and their properties.
5. Students will be understanding coordination compounds.
6. Students will be able to learn understand the tetrahedral, square planer, trigonal bipyramidal and octahedral metal complex.
7. Understand the synthesis of metal complex by using various methods.

Section I: Organic Chemistry

1. Chemistry of Aldehydes and Ketones (4L)

a) Structure of carbonyl groups. b) Preparations of aldehydes from primary alcohol, methyl benzenes, acid chlorides, phenols c) Preparation of ketones from – secondary alcohols, Friedel Craft acylation, nitriles d) Reaction of aldehydes and ketones – (i) Oxidation (ii) reduction – catalytic reduction, metal hydrides – $LiAlH_4$, $NaBH_4$. Clemmenson's reduction, Wolf kishner, Thioketal reduction, (iii) Addition of cyanides (iv) Addition of alcohols (v) Cannizzaro reaction (vi) Aldol condensation (ix) Perkins reaction

Ref. 1

2. Chemistry of Homocyclic and Heterocyclic compounds (5L)

a) Naphthalene and Anthracene - Nomenclature, preparation and reactions of naphthalene and anthracene.b) Five membered heterocyclic compounds - furan, pyrrole, Thiophene, nomenclature, preparation dorm 1, 4-diketones, reactions sulphonation, F.C. Acylation and catalytic hydrogenations.c) Six membered heterocyclic compounds - Pyridine, structure,

preparation from – acetylene and acrolein. Reactions nitration, sulphonation, bromination, catalytic hydrogenation.d) Structure and synthesis of quinoline and Isoquinoline.

Ref. 1

3. Introduction of Bio-molecules (6L)

a) Introduction: Different Bio molecules, scope and impact of biochemistry on living system and importance of biochemistry.
Ref. 2 Relevant pages.
b) Carbohydrates : Definition, classification, reactions of carbohydrates – oxidation, reduction osazone formation, ester formation, Killiani Fischer synthesis, Ruff degradation, cyclic structure of glucose. Brief account of maltose, sucrose, lactose, cellobiose, polysaccharides – starch and cellulose.
Ref. 1
c) Amino acids and proteins: i) α-amino acids: Relative configuration, classification, properties and reactions of α-amino acids. ii) Proteins : Formation of peptide linkage, structure - primary, secondary, tertiary and quaternary structure.
Ref. 2
References:
1. Organic Chemistry – 6th Edn. Morrison and Boyd Prentice Hall (2001)
2. Outline of Biochemistry 5th Edn., Conn, Sumpf, Bruening and Roy Doi John wiley 1987.

Section II: Inorganic Chemistry

1. Introduction to Coordination chemistry (10L)

General account and meaning of the terms involved in coordination chemistry: Coordinate bond, central metal atom or ions, ligand, double salt, coordination compound, coordination number, charge on the complex ion, oxidation number of central metal ion, first and second coordination sphere,

Ligands: Definition, Classification, Chelate and chelating agents, IUPAC nomenclature of coordination compounds, Different geometries of coordination compounds with C. N.= 2, 4 and 6 with examples of each geometry. Stability of coordination complexes, Isomerism: polymerization isomerism, ionization isomerism, linkage isomerism, coordination isomerism, geometrical isomerism and optical isomerism. Werner Theory of coordination compounds, and EAN rule.

2. Chemistry of Carbonyls Complexes. (5L)

Introduction, Definition, bonding in carbonyl complexes, 18 electron rule, M-M bonds in carbonyl complexes, geometries of coordination complexes, CO π acid ligands. synthesis of carbonyl complexes: direct reaction, reductive carboxylation, photolysis, homogeneous catalysis:

hydro-formylation by Cobalt carbonyl complex, Wacker's process and Monsanto acetic acid process, Wilkinson catalyst.

References:

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)

USCH 243: Chemistry Practical III (12 practical, 2 Credits)

A. Learning Objective:

1. Students will learn the skill needed for operation and conduct the experiments from various sections of chemistry
2. Students will familiar with the experimental technique and get hands on training on sophisticated instruments.
3. Students will gain the expertise in inorganic chemistry practical through appropriate handling of apparatus and chemicals.

B. Learning Outcome:

1. Students should able to understand the theory and principles about the selected experiments.
2. Students should able to develop the experimental and operational skill through hands on training.
3. Students will able to analyze the inorganic mixtures in terms of qualitative analysis and develop the skills in synthesis of various inorganic complexes.

Section I: Analytical Chemistry Practical (any Seven experiments)

1. Determination of Ca in presence of Mg using EDTA.
2. Determination of the strength of given H_2O_2 solution with standard 0.05 N $KMnO_4$ solution.
3. To determine the amount of Aspirin from a given tablet. Also calculate the absolute error, relative error, standard deviation and relative standard deviation with reference to the mean of analysis.

4. Estimation of Nickel or Aluminum from the given salt solution by using Eriochrome Black T indicator (back titration method)
5. Determination of molecular weight of mono / dibasic acid volumetrically.
6. To perform the pH titration between weak acid and strong base and hence select the best indicator to locate the equivalence point graphically.

7. Verification of Beer's law using different concentrations of $KMnO_4$ and determine the unknown concentration of $KMnO_4$
8. Identification of metal by paper chromatography in any two mixture containing two / three metal ions like
9. To study formation of Fe(III) determine the effect of metal ion and ligand concentration on complex formation.
10. To determine the amount of copper from the given solution iodometrically.

References:

1. Analytical Chemistry, G. D. Christian 6
2. Vogel's textbook of Quantitative chemical analysis, R. C. Denney, J. D. Barnes. M. J. K. Thomas, 6

Section II: Inorganic Chemistry Practical

1. Inorganic qualitative analysis any four simple mixtures without phosphate and borate.
2. Inorganic Synthesis (any three)
    A) Synthesis and purity of Sodium cobaltinitrate
    B) Green Synthesis of [Fe(acac)3] complex
    C) Synthesis and purity of K3[Al(OX)3]
    D) Preparation of coordination complex [Cu(NH3)4]SO4.H2O and find out its purity.
    E) Preparation of coordination complex[Ni(NH3)6]Cl2 and find out its purity
    F) Preparation of coordination (Oxalato) aluminate complex and find out its purity.

References:

1. Vogel's Qualitative Inorganic Analysis, Svehla G. Pearson Education, 2012
2. Vogel's Quantitative Inorganic Analysis, Mendham J.2012

Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (SEM IV) **Subject**: Chemistry

Course: Physical and Analytical Chemistry **Course Code**: USCH-241

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

CO \ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	0	0	0	0	0	0	0	0
CO 2	3	3	0	0	0	0	0	0	0
CO 3	0	0	3	0	0	0	0	0	0
CO 4	0	0	0	3	0	0	0	0	0
CO 5	0	0	0	0	3	0	0	0	0
CO 6	0	0	0	0	0	3	0	0	0
CO 7	0	0	0	0	0	0	3	0	0
CO 8	0	0	0	0	0	0	0	3	0
CO 9	0	0	0	0	0	0	0	0	3

Program Outcome 1 (PO 1: Disciplinary Knowledge):

- CO 1: Students will be able to apply the knowledge of the concept of solutions and their types, demonstrating their grasp of chemical principles and understanding of solutions.

Program Outcome 2 (PO 2: Critical Thinking and Problem Solving):

- CO 2: Students will be able to learn concepts like ideal and non-ideal solutions with Raoult's law, showcasing their critical thinking skills in understanding solution behaviour.

Program Outcome 3 (PO 3: Social Competence):

- CO 3: Students will be able to draw and explain P-X and T-X diagrams, contributing to social competence by addressing graphical representation and communication of solution properties.

Program Outcome 4 (PO 4: Research-Related Skills and Scientific Temper):

- CO 4: Students will be able to apply the knowledge of ionic equilibrium for ionization of acids, bases, salts, and their hydrolysis, enhancing research-related skills and scientific temper in understanding chemical equilibria.

Program Outcome 5 (PO 5: Trans-Disciplinary Knowledge):

- CO 5: Students will be able to understand the factors affecting the ionization of electrolytes, demonstrating trans-disciplinary knowledge by integrating principles of ionic behaviour in various solutions.

Program Outcome 6 (PO 6: Personal and Professional Competence):

- CO 6: Students will be able to understand the application of Gibb's phase rule, enhancing their personal and professional competence in understanding phase equilibria.

Program Outcome 7 (PO 7: Effective Citizenship and Ethics):

- CO 7: Students will be able to apply Gibb's phase rule for water and sulfur systems, contributing to effective citizenship by addressing phase equilibria and the ethical conduct of research.

Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (SEM IV) **Subject**: Chemistry

Course: Organic and Inorganic Chemistry **Course Code**: USCH-242

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

CO \ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	3	0	0	0	0	0	0
CO 2	2	3	3	0	0	0	0	0	0
CO 3	0	0	3	0	0	0	0	0	0
CO 4	0	0	0	3	0	0	0	0	0
CO 5	0	0	0	0	3	0	0	0	0
CO 6	0	0	0	0	0	3	0	0	0
CO 7	0	0	0	0	0	0	3	0	0
CO 8	0	0	0	0	0	0	0	3	0
CO 9	0	0	0	0	0	0	0	0	3

Program Outcome 1 (PO 1: Disciplinary Knowledge):

- **CO 1:** Students will understand the preparations and reactions of aldehydes and ketones, demonstrating their grasp of organic chemistry concepts and reactions.

Program Outcome 2 (PO 2: Critical Thinking and Problem Solving):

- **CO 2:** Students should understand the name reactions, showcasing their critical thinking skills in recognizing and applying fundamental organic reactions.

Program Outcome 3 (PO 3: Social Competence):

- **CO 3:** Students will be able to apply the knowledge to represent the mechanisms of name reactions, contributing to social competence by explaining reaction mechanisms and principles.

Program Outcome 4 (PO 4: Research-Related Skills and Scientific Temper):

- **CO 4:** Students will be able to understand the biomolecules and their properties, enhancing research-related skills and scientific temper in biochemistry.

Program Outcome 5 (PO 5: Trans-Disciplinary Knowledge):

- **CO 5:** Students will be understanding coordination compounds, demonstrating trans-disciplinary knowledge by integrating principles of inorganic and coordination chemistry.

Program Outcome 6 (PO 6: Personal and Professional Competence):

- **CO 6:** Students will be able to learn and understand the tetrahedral, square planar, trigonal bipyramidal, and octahedral metal complexes, enhancing their personal and professional competence in inorganic chemistry.

Program Outcome 7 (PO 7: Effective Citizenship and Ethics):

- **CO 7:** Students will understand the synthesis of metal complexes using various methods, contributing to effective citizenship by addressing chemical research ethics and safe laboratory practices.

Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (SEM IV) **Subject**: Chemistry

Course: Chemistry Practical III **Course Code**: USCH-243

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

CO \ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	2	3	0	0	0	0	0	0
CO 2	2	3	3	0	0	0	0	0	0
CO 3	0	0	3	0	0	0	0	0	0
CO 4	0	0	0	3	0	0	0	0	0
CO 5	0	0	0	0	3	0	0	0	0
CO 6	0	0	0	0	0	3	0	0	0
CO 7	0	0	0	0	0	0	3	0	0
CO 8	0	0	0	0	0	0	0	3	0
CO 9	0	0	0	0	0	0	0	0	3

Program Outcome 1 (PO 1: Disciplinary Knowledge):

- **CO 1:** Students will understand the preparations and reactions of aldehydes and ketones, demonstrating their grasp of organic chemistry concepts and reactions.

Program Outcome 2 (PO 2: Critical Thinking and Problem Solving):

- **CO 2:** Students should understand the name reactions, showcasing their critical thinking skills in recognizing and applying fundamental organic reactions.

Program Outcome 3 (PO 3: Social Competence):

- **CO 3:** Students will be able to apply the knowledge to represent the mechanisms of name reactions, contributing to social competence by explaining reaction mechanisms and principles.

Program Outcome 4 (PO 4: Research-Related Skills and Scientific Temper):

- **CO 4:** Students will be able to understand the biomolecules and their properties, enhancing research-related skills and scientific temper in biochemistry.

Program Outcome 5 (PO 5: Trans-Disciplinary Knowledge):

- **CO 5:** Students will be understanding coordination compounds, demonstrating trans-disciplinary knowledge by integrating principles of inorganic and coordination chemistry.

Program Outcome 6 (PO 6: Personal and Professional Competence):

- **CO 6:** Students will be able to learn and understand the tetrahedral, square planar, trigonal bipyramidal, and octahedral metal complexes, enhancing their personal and professional competence in inorganic chemistry.

Program Outcome 7 (PO 7: Effective Citizenship and Ethics):

- **CO 7:** Students will understand the synthesis of metal complexes using various methods, contributing to effective citizenship by addressing chemical research ethics and safe laboratory practices.