S. Y. B.Sc. Chemistry
SEMESTER IV
CHEM 2401: Physical and Analytical Chemistry (48 L, 3 Credits)

Course Objectives:-

1. Student should able to understand the thermodynamic of ideal and non-ideal solutions, and its laws.
2. Student able to understand ionic equilibria concept , common ion effect , ionization of weak acid and base ,degree of hydrolysis ,solubility and solubility product.
3. Student able to understand phase equilibrium concept Gibbs phase rule, deviation of Clausius-Clapeyron equation.
4. Student able to understand errors in quantitative analysis.
5. Student able to understand introduction of instruments and its working.
6. Student able to understand pH metry and potentiometry and different chromatographic techniques for analysis.
7. Student able to understand separation methods by using chromatographic techniques. And numerical problems on related topics.

Course Outcomes:-

1. Students should able to know details of thermodynamics of ideal solution, Raoult's law, P-X and T-X diagrams, Azeotropes, partially miscible liquids& steam distillation.
2. Student able to know the different concept applied in analysis.
3. Students should able to know Nernst distribution law, its applications and details about solvent extraction process. Basics of ionic equilibrium, strong & weak electrolytes salt hydrolysis and pH calculations. Concept of common ion, buffer solution solubility product and their applications. Phase equilibrium, Gibbs phase rule, Clausius-Clapeyron equation and phase diagrams of one and two component systems.
4. Studentsshouldable to know errors in analysis, concept of accuracy and types of errors.
5. Studentsshouldable to understand pH & Potentiometric applications and details about chromatography and its types.
6. Studentsshouldable to solve related numerical and problems.
7. Studentsshouldable to solve related numerical and problems.

Section I: Physical Chemistry

1. SOLUTIONS (8 L)

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviationsfrom Raoult's law - non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation ofsolutions, Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution lawand its applications, solvent extraction.

2. Ionic Equilibrium (10 L)

Strong, moderate and weak electrolytes, degree of ionization, factors affectingdegree of ionization, ionization constant and ionic product of water. Ionizationof weak acids and bases, pH scale, Common ion effect. Salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts, applications of solubility product principle.

3) Phase Equilibrium (6 L)

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation ofClausius - Clapeyron equation and its importance in phase equilibrium. Phase diagrams of one-component systems (water and Sulphour) and two component systems involving eutectics, congruent and incongruent melting points (lead- silver, FeCl3-H2O and Na-K only).

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. Errors in Quantitative Analysis (6 L)

Introduction to Error, Accuracy, Precision, Methods of expressing accuracy andprecision, 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 (6 L)

Introduction, pH meter, Glass pH electrode, combination of pH electrode- Complete Cell, Standard Buffer –reference for pH measurement, Accuracy ofpH measurement, Using pH meter –How does it works? pH metric titrations Applications of pH meter. Numerical based on pH metry.

B) Potentiometer (6 L)

Introduction, General Principal, Electrochemical Cell, Reference Electrodes, Liquid Junctions & Potentials, Determination of Concentration from potentialmeasurement, Potentiometric titrations, Numerical based on potentiometry.

3. Chromatography (6 L)

Introduction to chromatography, IUPAC definition of chromatography. Descriptions about different types like, Paper chromatography, Thin Layer Chromatography, Ion exchange Chromatography, Gas permeation Chromatography, Affinity chromatography, Gas

chromatography, Supercriticalfluid chromatography, High Performance Liquid Chromatography, Capillary electrophoresis, Classification of chromatographic methods based on separationmethods and development procedures.

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 Anand

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (SEM IV) **Subject:** Chemistry
Course: Physical and Analytical Chemistry **Course Code:**CHEM2401
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Table Format: 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	3	3	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	3	0	0
CO7	0	0	0	0	0	0	3	0	0

Justification of Mapping:

PO1: Disciplinary Knowledge:

CO1: Students should able to know details of thermodynamics of ideal solution, Raoult's law, P-X and T-X diagrams, Azeotropes, partially miscible liquids& steam distillation.

CO2: Student able to know the different concept applied in analysis.

CO3: Students should able to know Nernst distribution law, its applications and details about solvent extraction process. Basics of ionic equilibrium, strong & weak electrolytes salt hydrolysis and pH calculations. Concept of common ion, buffer solution solubility product and their applications. Phase equilibrium, Gibbs phase rule, Clausius-Clapeyron equation and phase diagrams of one and two component systems.

PO2: Critical Thinking and Problem Solving:

CO2: Student able to know the different concept applied in analysis.

PO3: Social Competence:

CO2: Student able to know the different concept applied in analysis.

PO4: Research-Related Skills and Scientific Temper:

CO4: Studentsshouldable to know errors in analysis, concept of accuracy and types of errors.

CHEM 2402: ORGANIC AND INORGANIC CHEMISTRY
(48 L, 3 Credits)

COURSE OBJECTIVES:

1. Students will be able to remember the carbonyl compounds.
2. Students will be able to understand the reactions shown by aldehydes and ketones
3. Students will be able to remember the heterocyclic compounds.
4. Students will be able to understand the bimolecular essentials for growth.
5. Students will be able to remember the importance of biomolecules.
6. Students will be able to understand the concepts of coordination compounds.
7. Students will be able to remember the terms in carbonyl complexes and analyze the complexes.

COURSE OUTCOMES:

1. Students should be able to know the reactions shown by carbonyl compounds.
2. Students should be able to compare products of aldehydes and ketones.
3. Students should be able to compare reactions shown by five membered heterocyclic compounds.
4. Students should be able to know uses of biomolecules in growth of living things.
5. Students should be able to compare the theories of acids and bases to assign compounds as acidic or basic.
6. Students should be able to know the formation of complexes and their coordination number.
7. Students should be able get the knowledge formation of carbonyl complexes and their geometry.

Section I: Organic Chemistry

1. Chemistry of Aldehydes and Ketones (6 L))

a) Structure of carbonyl groups. b) Nomenclature of Aldehydes and ketones c) Physical properties of aldehydes and ketones d) Preparations of aldehydes from primary alcohol, methyl benzenes, acid chlorides, phenols e) Preparation of ketones from – secondary alcohols, Friedel Craft acieration, nitriles f) Reaction of aldehydes and ketones – (i) Oxidation (ii) reduction – catalytic reduction, metal hydrides – LiAlH4, NaBH4. Clemmenson's reduction, Wolf kishner,Thioketal reduction, (iii) Addition of cyanides (iv) Addition of derivatives of ammonia (v) Addition of alcohols (vi) Cannizzaro reaction (vii) Addition or Grignard reagent (viii) Aldol condensation (ix) Perkins reaction (x) haloform reactions g) Analysis of aldehydes and ketones.

2. Chemistry of Homocyclic and Heterocyclic compounds (6 L))

a) Naphthalene and Anthracene - Numbering of carbon atoms, nomenclature of derivatives, preparation and reactions of naphthalene and anthracene.

b) Heterocyclic compounds - Definition, classification, nomenclature of heterocyclic compounds.

c) Five membered heterocyclic compounds - furan, pyrrole, Thiophene, nomenclature, preparation dorm 1, 4-diketones, reactions sulphonation, FC.Acylation, Diaz coupling, Riemer-Tiemann reaction, catalytichydrogenations.

d) Six membered heterocyclic compounds - Pyridine, structure, preparation from picoline, acetylene, acrolein, reactions nitration, sulphonation, bromination, catalytic hydrogenation.

e) Structure and synthesis of quinoline and Isoquinoline.Ref. 1

3. Introduction of Bio-molecules (12 L)

a) Introduction: What are different Bio molecules found in and associated with living system? How is biochemistry directly concern to life i.e. What is the scope and impact of biochemistry on living system? Importance of biochemistry.

Ref. 2 Relevant pages.

b) Carbohydrates : Definition, classification, reactions of carbohydrates – oxidation, reduction osazone formation, ester formation, isomerization, Killiani Fischer synthesis, Ruff degradation, D/L configuration, configuration of D(+) Glucose, Fischer proof and mutarotation, cyclic structure of glucose-Fischer Haworth and chair configuration. Brief account of maltose, sucrose, lactose, cellobiose, polysaccharides - starch, cellobiose

Ref. 1 section: 34.2–34.4, 34.6–34.9, 34.11, 34.16, 35.1 to 35.9 Pages : 1185 – 1195, 1200

c) Amino acids, proteins, enzymes: i) α-amino acids: Fischer projection, relative configuration, classification, structure of amino acid, properties and reactions of α-amino acids. ii) Proteins : Formation of peptide linkage, feature of peptide linkage, α-helical conformation, β-plated structure, primary, secondary, tertiary and quaternary structure of proteins. iii) Enzymes : General information, co-enzymes, and vitamins hormones, prosthetic groups and their role, enzymes specificity, classification of enzymes with examples.

d) Lipids : General introduction, classification with examples.

Reference Books:

1. Organic Chemistry – 6th Edn. Morrison and Boyd Prentice Hall (2001)
2. Outline of Biochemistry 5th Edn., Conn, Sumpf, Bruening and Roy Doi Johnwiley 1987.

Section II: Inorganic Chemistry

3. Introduction to Coordination chemistry (16 L)

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, Hydrate isomerism, Linkage isomerism, Coordination isomerism, Coordination position isomerism, Geometric isomerism or stereoisomerism, Optical isomerism, Werner Theory of coordination compounds, Sedgwick and Pauli theory and EAN rule, Problems

4. Chemistry of Carbonyls Complexes. (8 L)

Introduction, Definition, bonding in carbonyl complexes, 18 electron rule, M-M bonds in carbonyl complexes, geometries of coordination complexes, COπ acid ligands.

synthesis of carbonyl complexes: direct reaction, reductive carboxylation, photolysis, thermolysis, homogeneous catalysis: hydro-formylation by Cobaltcarbonyl complex, Wacker's process and Monsanto acetic acid process, Wilkinson catalyst.

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 IV) **Subject:** Chemistry
Course: Organic and Inorganic Chemistry **Course Code:** CHEM 2402
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	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: Students should be able to know the reactions shown by carbonyl compounds.
CO2: Students should be able to compare products of aldehydes and ketones.

PO2: Critical Thinking and Problem Solving:
CO2: Application of stereochemistry concepts and molecule configuration demonstrates critical thinking and problem-solving skills.

PO3: Social Competence:
CO3: Knowledge about the uses of oxidizing and reducing agents in organic synthesis contributes to social competence by understanding the practical applications of these agents.

PO4: Research-Related Skills and Scientific Temper:
CO4: Understanding reactions of aliphatic amines enhances research-related skills in organic chemistry reactions.

S.Y.B.Sc Paper III

CHEM 2403: PRACTICAL COURSE- IV (10 P, 2 credit)

Course objectives :

1. To learn basic of chemistry practical from all the discipline of chemistry
2. To learn the estimation of compounds.
3. To know the synthesis of derivatives.
4. To learn the volumetric analysis.
5. To know the preparation of solutions

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: Analytical Chemistry Practical (Any five 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 NKMnO4 solution.
3. To determine the amount of Aspirin from a given tablet. Also calculate absolute error, standard deviation and relative standard deviation with reference to the mean of analysis.

4. To determine the amount of acetic acid in commercial vinegar by titratingwith approx. NaOH solution using selected best indicator.
5. Estimation of Nickel or Aluminum from the given salt solution by using Eriochrome Black T indicator (back titration method)
6. Determination of molecular weight of mono / dibasic acid volumetrically.
7. To perform the pH titration between weak acid and strong base and henceselect the best indicator to locate the equivalence point graphically.
8. Verification of Beer's law using different concentrations of $KMnO_4$ and determine the unknown concentration of $KMnO_4$ by calibration curve method.
9. Identification of metal by paper chromatography in any two mixture containing two / three metal ions like- Ni, Cu, Al, Fe, Co, Mn.
10. To study formation of Fe(III)-thiocyanate complex calorimetrically and determine the effect of metal ion and ligand concentration on complex formation.
11. To determine the amount of copper from the given solution iodometrically.

Reference books:

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

Section II: Inorganic Chemistry Practical (Any five experiments)

1. Inorganic qualitative analysis any simple three mixtures without phosphateand borate.
2. Inorganic Synthesis (any two)
   A) Synthesis and purity of Sodium cobaltinitrate
   B) Green Synthesis of $[Fe(acac)_3]$ complex
   C) Synthesis and purity of $K_3[Al(OX)_3]$
   D) Preparation of coordination complex $[Cu(NH_3)_4]\ SO_4.H_2O$ and find out itspurity.
   E) Preparation of coordination complex $[Ni(NH_3)_6]\ Cl_2$ and find out itspurity.
   F) Preparation of coordination (Oxalato) aluminate complex and find out itspurity.

Reference books:

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

Mapping of Program Outcomes with Course Outcomes

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

Course: Chemistry Practical **CourseCode**:CHE2403

Weightage: 1=weakorlowrelation,2=moderateorpartialrelation,3=strongordirectrelation

	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
CO8	0	0	0	0	0	0	0	3	0

Justification of Mapping:

PO1: Disciplinary Knowledge:

CO1: 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 ability in laboratory.

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 ability in laboratory.

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

CO5: 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

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.

PO 7: Effective Citizenship and Ethics

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 8: Ethical and Legal Awareness

CO 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.