S. Y. B.Sc. (Chemistry)
SEMESTER III

CHEM 2301: Physical and Analytical Chemistry (48 L, 3 Credits)

Course Objectives:-

1. Students should able to understand concept of reaction rate, order of reaction, activation energy.
2. Students should able to understand the chemical thermodynamics and its laws.
3. Students should able to understand free energy, chemical equilibrium and response to different factors.
4. Students should able to understand basic concepts in analytical chemistry and Stoichiometry.
5. Students should able to learn quantitative method and classification of volumetric analysis.
6. Students should able to understand numerical problems on related topics.
7. Students should able to learn different types of physical and analytical techniques.

Course Outcomes :-

1. Student should able to know concept of reaction rate, order of reaction, activation energy and rate theories.
2. Students should able to understand second law of thermodynamics, entropy calculation.
3. Students should able to know concept of free energy, chemical equilibrium and response to different factors.
4. Students should able to know basics of analytical chemistry, concentration methods and calculations in chemical Stoichiometry.
5. Studentsshouldable to understand different types of volumetric analysis, their applications and calculations in them.
6. Studentsshouldable to solve related numerical and problems.
7. Students should able to know different techniques and applied in analysis

Section I: Physical Chemistry

I) Chemical Kinetics (10 L)

Introduction of chemical kinetics. 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 a reaction. Concept of activation energy and its determination from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions Comparison of the two theories.

Numerical problems.

II) Chemical Thermodynamics (6 L)

Second Law of Thermodynamics: Concept of entropy; thermodynamic scale oftemperature, statement of the second law of thermodynamics; molecular and

statistical interpretation of entropy. Calculation of entropy change (Δ S) for reversible and irreversible processes under different conditions. Numerical problems.

Third Law of Thermodynamics: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

III). Free energy and Chemical Equilibrium (8 L)

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 idealgas. Free Energy and equilibrium - Concept, Definition and significance
The reaction Gibbs Energy. Exergonic and endergonic reaction. The perfect gas equilibrium, the general case of equilibrium, the relation between equilibrium constants, molecular interpretation of equilibrium constant. The response of equilibria to conditions- response to pressure, response to temperature, Vant 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.

Some important units of measurements-SI units, distinction between mass andweight, mole, millimole and related calculations, significant figures

Solution and their concentrations- Molar concentrations, Molar analytical Concentrations, Molar equilibrium concentration, percent Concentration, partper million, part per billion, part per thousand, density and specific gravity ofsolutions, Numerical problems

Chemical Stoichiometry – empirical and molecular formulas, Stoichiometry 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,

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

2. Complexometric titration: Principle, Mg- EDTA titration, metal ionindicators, choice of indicators. Applications,

3. Redox titration: Principle, detection of equivalence point using suitableindicators. Titration between oxalic acid and $KMnO_4$. Applications.

4. 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.

5. Iodometric titration: Principle, detection of end point, difference between iodometry and iodiometry, standardization of $Na_2S_2O_3$ solution using $K_2Cr_2O_7$and estimation of iodine. 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 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**: CHEM 2301

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	2	2	0	0	0	0	0	0
CO2	0	3	3	0	0	0	0	0	0
CO3	0	2	3	0	0	0	0	0	0
CO4	0	0	2	3	2	0	0	0	0
CO5	0	0	2	2	3	0	0	0	0
CO6	0	0	0	0	0	0	0	0	0
CO7	0	0	0	0	0	0	0	0	0
CO8	0	0	0	0	0	0	0	0	0

Justification of Mapping

PO1: Disciplinary Knowledge:

CO1: Studentsshouldable to know concept of reaction rate, order of reaction, activation energy and rate theories.

CO2: Studentsshouldable to understand second law of thermodynamics, entropy calculation.

Co3: Studentsshouldable to know concept of free energy, chemical equilibrium and response to different factors

PO2: Critical Thinking and Problem Solving:

CO3: Students should able to understand second law of thermodynamics, entropy calculation.

CO4: Studentsshouldable to know concept of free energy, chemical equilibrium and response to different factors

PO3: Social Competence:

CO4: Studentsshouldable to know basics of analytical chemistry, concentration methods and calculations in chemical Stoichiometry.

CO5: Studentsshouldable to understand different types of volumetric analysis, their applications and calculations in them

CHEM 2302: ORGANIC AND INORGANIC CHEMISTRY (48 L, 3 Credits)

Course Objectives:

1. Students will be able to remember the terms in stereochemistry.
2. Students will be able to understand the stereochemistry of mono substituted cyclohexane.
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: 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 - Bayer's strain theory, heat of combustion, cycloalkanes, factors affecting the stability of conformation, Conformation of cyclohexane
- equatorial and axial bonds, Monosubstituted cyclohexane stability with -CH_3 and-$C(CH_3)_3$ substitutes. Structures of geometrical isomers of dimetylcyclohexane only.

2. Aliphatic and Aromatic amines (6 L)

a) Structure b) Classification c) nomenclature d) physical Properties – salt of amine
e) preparation of amine from – reduction of nitro compounds, reductive amination, reduction of nitriles, Hoffmann degradation of amides f) Reactions of amines - basicity, salt formation, alkylation, conversion into amides, ring substitution in aromatic amines, Hoffmann elimination, reactions with nitrous acid g) Diazonimum salts – preparation and reactions h) Sandmeyer reaction
i) Replacement of nuclear 'H' by – I, -OH and H- j) Analysis of amines.

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) Benzion condensation (ii) Markovnikov and anti-Markovnikov addition reaction (iii) Saytzeff and Hoffmann elimination (iv) SN 1 and SN 2 reactions (v) Pinacol-Pinacolone rearrangement (vi) Beckmann rearrangement.

Reference Books:

1. Organic Chemistry. Morrison and Boyd, 6th Ed Prentice Hall of Indi Prt.Ltd,New Delhi-2001.
2. Outline of Biochemistry 5th Edn, Conn, Stumpf Bruening and Roy Doi JohnWiley 1987.
3. Stereochemistry of carbon compounds, E. L. Eliel
4. Reactions, rearrangements and reagents, S N Sanyal
5. A guide book to Mechanism in Organic Chemistry, Peter Sykes, 6th Edn.

Section II: Inorganic Chemistry

1. Molecular Orbital Theory of diatomic molecules (14 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 orbital's, s-p combinationsof orbital's, p-p combinations of orbital's, p-d combinations of orbital's, d-d combinations, Non-bonding combinations of orbital's, Rules for linear combination of atomic orbital's.

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 treatmentfor hetero-nuclear diatomic molecules, NO molecule, CO molecule, HF molecule.

2. Chemistry d-block (4 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.

3. Acid, base and solvents (6 L)

Properties of solvents, Arrhenius theory, Lowry-Brownsted theory, Solventsystem, 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: **Course Code**: CHEM-2302
Weightage: 1=weakorlowrelation,2=moderateorpartialrelation,3=strongordirectrelation

Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	2	0	0	0	0	0	0
CO2	3	3	0	0	0	0	0	0	0
CO3	3	2	3	0	0	0	0	0	0
CO4	2	2	2	3	0	0	0	0	0
CO5	0	0	0	0	3	0	0	0	0
CO6	0	0	0	0	3	3	0	0	0
CO7	0	0	0	0	0	3	3	0	0

Justification of Mapping:

PO1: Disciplinary Knowledge:
CO1: Students should be able to know the stereochemistry of mono substituted cyclohexane. Apply it for to make the models to study their stability.
CO2: Students should be able to know the configuration and assignment of configuration of optically active molecule.
CO3: Students should be able to compare uses of oxidizing and reducing agents in organic synthesis.

PO2: Critical Thinking and Problem Solving:
CO1: Students should be able to know the stereochemistry of mono substituted cyclohexane. Apply it for to make the models to study their stability.
CO2: Students should be able to know the configuration and assignment of configuration of optically active molecule.

PO3: Social Competence:
CO4: Students should be able to know reactions of aliphatic amines.

CHEM 2303: PRACTICAL COURSE – III

Course Objectives: **(10 P, 2 credit)**

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 aware about experimental and operational skills for measurement of rate and rate constant of chemical reactions which enhance the critical thinking and numerical solving ability in laboratory.

3: Students should able to perform physical chemistry experiment, by knowing the SOPs and able to interpret it graphically.

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

5: Students will able to analyze the organic compounds in terms of qualitative analysis and develop the skills in synthesis of various organic compound.

6: 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.

7: Student will able to apply their experimental skill during use of sophisticated Instruments like potentiometer and pH meter. It helps for development in personal and professional ability.

8: 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 such chemicals in organic synthesis.

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 tocalculate □H of solution.

3. To determine the first order rate constant of acid catalyzed ester hydrolysis.

4. To compare the strengths of HCl and H_2SO_4 by studying kinetics ofhydrolysis

of methyl acetate.

5. To determine the rate constant of base catalyzed ester hydrolysis.

6. To study the standardization and working of potentiometer and determine thepotential and pH of two buffer solutions.

7. To study the standardization and working of pH meter and determine the equivalence point for pH metric titration between strong acid and strong base.

8. To determine the molecular weight of organic liquid by steam distillation.

9. Study of the equilibrium of the reaction by the distribution method.(any one)

a) $I_{2\,(aq)} + I^{-}_{(aq)} \rightleftharpoons I_{2\,(aq)}$

b) $Cu^{2+}_{(aq)} + x\ NH_{3\,(aq)} \rightleftharpoons [Cu(NH_3)_x]^{2+}$

10. Construction of the phase diagram of a binary system (simple eutectic)using cooling curves.

Reference Book:

1 A Senior Practical Physical Chemistry, B. D. Khosla, V. C. Garg & Gulati ,R, Chand & Co.: New Delhi (2011)

2. Practical Physical Chemistry, A M. James, 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 (Six Single compounds)Two compounds per practical. Identification of organic compounds through –

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

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

ii) Phenols (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 crystallisation, M. P. and TLC)

i) Aspirin from salicylic acid

ii) P-Nitro Benzoic acid from P- Nitro Toluene

iii) phthalic anhydride from phthalic acid by sublimation method

iv) Osazone form glucose

v) Quinone form Hydro Quinone

3) Purification of organic liquids by distillation (any two mixtures)

one volatile and one non volatile liquid with boiling point determination.

Reference Book:

1 Organic Qualitative Analysis – A. I. Vogel

Mapping of Program Outcomes with Course Outcomes

Class: S.Y.B.Sc. (SEM III) **Subject:** Chemistry
Course: Chemistry Practical III **Course Code:** CHEM2303
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	2	0	0	0	0	0	0	0
CO2	3	3	0	0	0	0	0	0	0
CO3	3	2	3	0	0	0	0	0	0
CO4	0	0	3	3	0	0	0	0	0
CO5	0	0	0	0	3	0	0	0	0
CO6	0	0	0	0	3	3	0	0	0
CO7	0	0	0	0	0	3	3	0	0
CO8	0	0	0	0	0	0	0	3	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 aware about experimental and operational skills for measurement of rate and rate constant of chemical reactions which enhance the critical thinking and numerical solving ability in laboratory.
CO 3: Studentsshouldable to perform physical chemistry experiment, by knowing the SOPs and able to interpret it graphically.

PO2: Critical Thinking and Problem Solving:
CO 2: Student will able to aware about experimental and operational skills for measurement of rate and rate constant of chemical reactions which enhance the critical thinking and numerical solving ability in laboratory.

PO3: Social Competence:
CO 4: Student will able to perform good laboratory practises through pre-setting of experiments by utilizing their scientific temper with interdisciplinary manner.