DEPARTMENT OF CHEMISTRY,
RABINDRANATH TAGORE UNIVERSITY, HOJAI: ASSAM

Course Title: Introductory Chemistry

MINOR 3rd SEM

MIN- MIN-CHM-3.2

Total Credit: 4 (3 credit Theory + 1 credit Practical)

Distribution of marks: 70 (End Semester) (45T + 25P) + 15 (In-semester) + 15 (HA/S/GD)

Course objective: The objective of this course is to provide introductory ideas on inorganic polymers, structure and stability of metal complexes, in depth knowledge of the mechanism of nucleophilic substitutions, alcohols and phenols, phase equilibrium and surface chemistry.

Theory: 3 credits **Total course hour: 45 hr** **Duration of examination: 2 hr**

Unit 1: Inorganic Polymers (**5L, 8 Marks**)

Types of Inorganic polymers, Comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes, Borazines, Silicates and Phosphazenes and polysulphates.

Unit 2: Stability and Bonding aspects of Metal Complexes (**10L, 12 Marks**)

Crystal Field Stabilization Energy, Octahedral versus tetrahedral coordination, trigonal distortions from octahedral geometry. Jahn-Teller theorem, square planar geometry. Qualitative aspects of ligand field and Molecular orbital theory. Chelate effect. Lability and inertness.

Unit 3: Chemistry of Alkyl and Aryl Halides-II **(7L, 10 Marks)**

Stereochemistry of S_N^1, S_N^2, S_Ni mechanisms, nucleophilic aromatic substitution via SNAr involving benzyne (elimination–addition) and Meisenheimer (addition–elimination) pathways, introductory transition metal-catalyzed couplings (Suzuki, Heck), synthetic applications.

Unit 4: Alcohols, Phenols, and Ethers-II **(8L, 10 Marks)**

Alcohols: Advanced oxidation methods including Swern, Dess–Martin, and TEMPO-mediated oxidations; selective reductions using LAH and $NaBH_4$.

Phenols: Substituent effects on electrophilic aromatic substitution; detailed mechanisms of Reimer–Tiemann, Houben–Hoesch, and Lederer–Manasse reactions; significance of phenol derivatives in chemical and pharmaceutical applications.

Ethers: Limitations of Williamson ether synthesis; acid-catalyzed cleavage of ethers; synthesis and regioselective nucleophilic ring-opening of epoxides.
Concept of phases, components and degree of freedom, Gibbs Phase Rule, Clausius-Claperyon equation and its application to solid liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component system (Water and Sulphur System) and two component system (Bi-Cd system) with applications.

Unit 6: Catalysis and Surface Chemistry (7L, 10 marks)

Surface Chemistry and Catalysis: Adsorption, Physical and chemical adsorption, adsorption isotherms, Freundlich, Langmuir and BET adsorption isotherms, Introduction to catalyst and Catalysis, homogeneous and heterogeneous Catalysis. Enzyme Catalysis.

Practical: 1 credit Total course hour: 30 hr Duration of examination: 3 hr

List of experiments:

1. Separation of organic mixture using solvent extraction (for example benzoic acid and aniline mixture).
2. Separation of organic compounds using sublimation techniques (for example, camphor, naphthalene, benzoic acid).
3. Detection of adulterants in food using organic reactions (for example metalin yellow, vanaspati in ghee)
4. Preparation of benzanilide from nitrobenzene.
5. Iodine catalyzed decomposition of hydrogen peroxide
6. Acid catalyzed hydrolysis of Ethyl acetate
7. To construct the phase diagram for a partially miscible liquid pair (for example phenol-water system).
8. Estimation of Fe (II) by potassium dichromate solution using diphenylamine indicator.
9. Inorganic Preparation
    a. Tetramminecarbonatocobalt (III) ion
    b. Potassium tris (oxalate) ferrate (III)

Learning outcome:

After completion of this course the students will be able to know about inorganic polymers, structure of metal complexes, substitution reaction mechanism involving alkyl and aryl halides, important reactions involving alcohols, phenols and ethers, phase equilibrium and surface chemistry.

1. Vogel's Text Book of Practical Organic Chemistry, 5th Ed., PEARSON.
2. Comprehensive Practical Organic Chemistry: Qualitative Analysis by V. K. Ahluwalia and Sunita Dhingra.
3. Advanced Practical Physical Chemistry by J. B. Yadav.
4. A Text Book of Practical Chemistry by Sudarshan Barua.

Course Title: Introductory Chemistry – IV A (DSE – 4A)

Course Code: MIN-CHM-4.1

Total Credit: 4 (3 credit Theory + 1 credit Practical)

Distribution of marks: 70 (End Semester) (45T + 25P) + 15 (In-semester) + 15 (HA/S/GD)

Course objective: The objective of this course is to provide introductory ideas on inorganic polymers, structure and stability of metal complexes, in depth knowledge of the mechanism of nucleophilic substitutions, alcohols and phenols, phase equilibrium and surface chemistry.

Theory: 3 credits **Total course hour: 45 hr** **Duration of examination: 2 hr**

Unit 1: Inorganic Polymers (5L, 8 Marks)

Types of Inorganic polymers, Comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes, Borazines, Silicates and Phosphazenes and polysulphates.

Unit 2: Stability and Bonding aspects of Metal Complexes (10L, 12 Marks)

Crystal Field Stabilization Energy, Octahedral versus tetrahedral coordination, trigonal distortions from octahedral geometry. Jahn-Teller theorem, square planar geometry. Qualitative aspects of ligand field and Molecular orbital theory. Chelate effect. Lability and inertness.

Unit 3: Chemistry of Alkyl and Aryl Halides-II (7L, 10 Marks)

Stereochemistry of S_N1, S_N2, S_Ni mechanisms, nucleophilic aromatic substitution via SNAr involving benzyne (elimination–addition) and Meisenheimer (addition–elimination) pathways, introductory transition metal-catalyzed couplings (Suzuki, Heck), synthetic applications.

Unit 4: Alcohols, Phenols, and Ethers-II (8L, 10 Marks)

Alcohols: Advanced oxidation methods including Swern, Dess–Martin, and TEMPO-mediated oxidations; selective reductions using LAH and $NaBH_4$.

Phenols: Substituent effects on electrophilic aromatic substitution; detailed mechanisms of Reimer–Tiemann, Houben–Hoesch, and Lederer–Manasse reactions; significance of phenol derivatives in chemical and pharmaceutical applications.

Ethers: Limitations of Williamson ether synthesis; acid-catalyzed cleavage of ethers; synthesis and regioselective nucleophilic ring-opening of epoxides.

Unit 5: Phase Equilibrium (8L, 10 marks)

Concept of phases, components and degree of freedom, Gibbs Phase Rule, Clausius-Claperyon equation and its application to solid liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component system (Water and Sulphur System) and two component system (Bi-Cd system) with applications.

Unit 6: Catalysis and Surface Chemistry (7L, 10 marks)

Surface Chemistry and Catalysis: Adsorption, Physical and chemical adsorption, adsorption isotherms, Freundlich, Langmuir and BET adsorption isotherms, Introduction to catalyst and Catalysis, homogeneous and heterogeneous Catalysis. Enzyme Catalysis.

Practical: 1 credit Total course hour: 30 hr Duration of examination: 3 hr

List of experiments:

1. Separation of organic mixture using solvent extraction (for example benzoic acid and aniline mixture).
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7. To construct the phase diagram for a partially miscible liquid pair (for example phenol-water system).
8. Estimation of Fe (II) by potassium dichromate solution using diphenylamine indicator.
9. Inorganic Preparation
   a. Tetramminecarbonatocobalt (III) ion
   b. Potassium tris (oxalate) ferrate (III)

<u>Course outcome (CO)</u>:

After completion of this course the students will be able to know about inorganic polymers, structure of metal complexes, substitution reaction mechanism involving alkyl and aryl halides, important reactions involving alcohols, phenols and ethers, phase equilibrium and surface chemistry.

Reference:

1. Vogel's Text Book of Practical Organic Chemistry, 5th Ed., PEARSON.
2. Comprehensive Practical Organic Chemistry: Qualitative Analysis by V. K. Ahluwalia and Sunita Dhingra.
3. Advanced Practical Physical Chemistry by J. B. Yadav.
4. A Text Book of Practical Chemistry by Sudarshan Barua.

Course Title: Introductory Chemistry – IVB (DSE-4B)

Course Code: MIN-CHM-4.2

Total Credit: 4 (3 credit Theory + 1 Credit Practical)

Distribution of marks: 70 (End Semester) (45T+25P) + 15 (In-Semester) + 15(HA/S/GD)

Course objective: To provide knowledge and hands on experience of acids-bases, metallurgical processes, chemical reactions involving carbonyl compounds, carboxylic acids and amines, electrochemistry principles and applications.

Theory: 3 credits **Total course hour: 45 hr** **Duration of examination: 2 hr**

Unit-1: Acids and Bases, Oxidation-Reduction and general principles of metallurgy.

(15 L + 20 marks)

Bronsted-Lowry concept of acids base reaction, Solvated proton, relative strength of acids, types of acids-base reactions, leveling solvents, Lewis acid-base concept, classification of Lewis acids, Hard & soft acids and bases (HSAB), Pearson's concept, Bonding in hard-hard and soft-soft combinations, Application of (HSAB) principle, Symbiosis.

Redox equation, standard electrode potential and its application to Inorganic reactions, principles involved in volumetric analysis, principles and applications of Ellingham diagram, General methods of isolation and purification of Electrolytic process and Mond's process, Zone refining.

Unit-2: Carbonyl compounds, Carboxylic acids and Amines **(15 L + 20 marks)**

Carbonyl Compounds: General methods of preparation of carbonyl compounds. Reactions – with HCN, ROH, $NaHSO_3$, amine derivatives. Important name reactions involving carbonyl compounds. Haloform reaction, aldol reaction, Cannizzaro reaction, Reformatsky reaction, Michael addition, Knoevenagel condensation, Perkin reaction, and Wittig reaction.

Carboxylic acids: Preparation carboxylic acids by acid and base mediated hydrolysis of esters. Hell-Vohlard-Zelinsky reaction. Carboxylic acid derivatives: acid chlorides, anhydrides, esters and amides from acids and their interconversion.

Amines: Preparation of amines from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann bromamide reaction. Reactions - Hofmann degradation, qualitative tests for amines, Schotten – Baumann Reaction. Electrophilic substitution: nitration. Diazonium compounds – preparation and Sandmeyer reaction.

Unit-3: Electrochemistry **(10 L + 20 marks)**

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using moving boundary methods. Ionic mobility. Conductometric titrations.

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data.

Unit-4: Solutions **(5 L + 20 marks)**

Thermodynamics of ideal solution: Ideal solutions and Raoult'slaw, deviations from Raoult's law, non-ideal solutions, vapour pressure-composition, temperature-composition curves for ideal and non-ideal solutions, distillation of solution and Lever rule.

Practical: 1 Credit **Total course hour: 30 hr** **Duration of Examination: 3 hr**

List of experiments:

1. Volumetric estimation of
   a) water of crystallization in Mohr's salt by titrating with $KMnO_4$.
      or
   b) Na_2CO_3 and $NaHCO_3$ present together in a mixture
2. Detection of functional groups in organic compounds.
3. Determination of cell constant and hence the specific conductance of an electrolyte.
4. Conductometric titrations
   a) strong acid vs strong base,
      or
   b) Weak acid vs strong base.

Course Outcome (CO): After completion of this course students will be able to understand and apply the concepts of acids-bases, redox reactions involved in metallurgical processes, reactions involving carboxylic acids, amines and electrochemistry in real life applications.

Suggested reading:

1. A Text Book of Organic Chemistry by Arun Bahl and B. S. Bhal, S CHAND.
2. Comprehensive Practical Organic Chemistry: Qualitative Analysis by V. K. Ahluwalia and Sunita Dhingra.
3. Physical Chemistry by Atkins & Paula
4. Principles of Physical Chemistry by Puri, Sharma & Pathania
5. A text book of Physical Chemistry by Negi & Anand
6. Practical Chemistry by Yadav.