240/CHEP/CC301

Core Course (Multidisciplinary) UG Chemistry

Semester-III

COURSE DETAILS:

Course Title	**Chemistry-III**	
Semester	**Semester-III**	
Course Code	**CC-A3**	
Course ID		
Level of Course		
Total Credits	**04 (Lecture: 03, Tutorial: 0, Practical: 01)**	
Total Marks	**100**	
Marks Distribution	**Theory External: 50** **Practical External: 20**	**Theory Internal: 25** **Practical Internal: 05**

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	**Practical (P) Hours per Week: 2**

COURSE OBJECTIVES:

- To understand the properties and chemical behavior of non-aqueous solvents.
- To study the comparative properties, bonding, and reactivity of p-block elements.
- To explore the preparation, properties, and mechanisms of halogenated hydrocarbons, alcohols, phenols, ethers, and carbonyl compounds.
- To analyze key organic reactions, including rearrangements, additions, and oxidations/reductions.
- To develop a mathematical understanding of thermodynamics and its application to chemical equilibrium.
- To apply the principles of equilibrium to predict and control chemical reactions under varying conditions.

COURSE OUTCOMES:

Students will be able to learn:-

- Describe the physical and chemical properties of non-aqueous solvents.
- Compare the properties of p-block elements, explaining bonding trends in boron and carbon families.
- Explain the mechanisms of nucleophilic substitution in alkyl and aryl halides and discuss reactivity trends.
- Analyze the preparation and properties of alcohols, phenols, ethers, and epoxides.
- Demonstrate understanding of carbonyl compounds, their reactivity, and key reactions.
- Apply thermodynamic principles and the law of mass action to chemical equilibrium.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	**Non-aqueous solvents** Physical properties of solvents, Properties and uses of non-aqueous solvents, Self-ionization, physical properties and chemical reactions in non-liquid NH_3 **p-Block Elements** Emphasis on comparative study of properties of p-block elements (including diagonal relationship and excluding methods of preparation). **Boron family (13th group)**:- Diborane – properties and structure (as an example of electron-deficient compound and multicentre bonding), Borazine – chemical properties and structure Trihalides of Boron – Trends in lewis acid character, structure of aluminum (III) chloride. **Carbon Family (14th group):** Catenation, p π– d π bonding (an idea), silicates, silicones – general methods of preparations, properties and uses.	11
II	**Chemistry of Halogenated Hydrocarbons** **Alkyl halides**: Methods of preparation and properties, nucleophilic substitution reactions-SN^1, SN^2 and SN^i mechanisms with stereochemical aspects, effect of solvent and energy profile diagrams, nucleophilic substitution *vs.* elimination. **Aryl halides**: Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; SNAr, Benzyne mechanism. **Alcohols:** preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Hydrogen bonding, Acidic nature, Bouveault-Blanc Reduction, Pinacol-Pinacolone rearrangement.	11
III	**Phenols:** Preparation and properties; Acidity and affecting factors, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions. **Ethers and Epoxides**: Preparation and reactions with acids. Reactions of epoxides with alcohols and $LiAlH_4$. **Carbonyl Compounds** Structure, reactivity, preparation and properties; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism. Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, oxidations and reductions (Clemmensen, Wolff Kishner, $LiAlH_4$). Addition reactions of α, β-unsaturated carbonyl compounds: Michael addition.	12
IV	**Chemical Thermodynamics and Chemical equilibrium** Mathematical treatment of thermodynamics, Reversible and irreversible processes, First and Second Laws of Thermodynamics, Thermochemistry, Thermodynamic functions: enthalpy, entropy, and	11

	Gibbs free energy, Relationships between thermodynamic functions, Partial molar quantities, Dependence of thermodynamic parameters on composition, Gibbs-Duhem equation, Chemical potential. **Chemical equilibrium:** Law of mass action: Describing the relationship between the concentrations of reactants and products at equilibrium. Equilibrium constants (K_p, K_c, K_x, and K_n): Discussing their definitions, units, and calculations. Effect of temperature on equilibrium: Analyzing the temperature dependence and its implications for reaction conditions. Le-Chatelier principle: Explaining the principle and its applications in predicting the response of equilibrium systems to changes in conditions.	
V	**Practicals:** 1. Systematic qualitative analysis of organic compounds possessing monofunctional groups (Alcohols, Phenols, Carbonyl, -COOH). (Including Derivative Preparation). 2. Estimation of aniline by any one of the following methods: a) Acetylation b) Bromate-bromide method. 3. Preparation of azodye with aniline and 2-Naphthol. 4. Acetylation of one of the following amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and one of the following phenols (β -naphthol, vanillin, salicylic acid). 5. Benzolyation of one of the following amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and one of the following phenols (β-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction. 6. Determination of the enthalpy change of a reaction using a calorimeter. 7. Determination of the heat of neutralization of a strong acid with a strong base. 8. Measurement of enthalpy of fusion of a solid. 9. Inorganic Preparations: • Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$ • Cis and trans $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III) • Tetraamminecarbonatocobalt (III) ion • Potassium tris(oxalate)ferrate(III)	**30**

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks

External Assessment: 20 Marks (02 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End-Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

RECOMMENDED BOOKS

1. "Non-Aqueous Solvents" by J.J. Lagowski
2. "Inorganic Chemistry: Principles of Structure and Reactivity" by James E. Huheey, Ellen A. Keiter, and Richard L. Keiter
3. "Inorganic Chemistry" by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr
4. "Concise Inorganic Chemistry" by J.D. Lee
5. "Inorganic Chemistry" by Puri, Sharma, and Kalia
6. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
8. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I.K.International.
10. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016),Organic Chemistry, 12th Edition, Wiley.
11. "Vogel's Textbook of Quantitative Chemical Analysis" by A.I. Vogel (Adapted by G.H. Jeffery)

UG chemistry

240/CHEP/CC401

Core Course (Multidisciplinary)

Semester-IV

COURSE DETAILS:

Course Title	**Chemistry-IV**	
Semester	**Semester-IV**	
Course Code	**CC-A4**	
Course ID	**240/CHE/CC/401**	
Level of Course		
Total Credits	**04 (Lecture: 03, Tutorial: 0, Practical: 01)**	
Total Marks	**100**	
Marks Distribution	**Theory External: 50** **Practical External: 20**	**Theory Internal: 25** **Practical Internal: 05**

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	**Practical (P) Hours per Week: 2**

COURSE OBJECTIVES:

- To study the structures, properties, and acid strengths of group 15, 16, and 17 elements.
- To understand the general trends and properties of 3d transition elements.
- To explore theories of coordination chemistry, including VBT and CFT.
- To analyze the electronic spectra and magnetic properties of metal complexes.
- To learn the preparation, properties, and key reactions of carboxylic acids and their derivatives.
- To understand electrochemical principles and their industrial applications.

COURSE OUTCOMES:

Students will be able to learn:-

- The trends in electronic configuration, variable valency, and complex formation of 3d transition metals.
- To apply VBT and CFT to explain the stability, geometry, and distortions of coordination complexes.
- The electronic spectra, selection rules, and magnetic behavior of transition metal complexes.
- The preparation, properties, and mechanisms of reactions involving carboxylic acids and derivatives.
- To use electrochemical principles to solve problems related to conductance, EMF, and industrial applications.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	**Nitrogen Family (15th group)** Oxides – structures of oxides of N, P. oxyacids – structure and relative acid strengths of oxyacids of Nitrogen and phosphorus. Structure of white, yellow and red phosphorus. **Oxygen Family (16th group)** Oxyacids of sulphur – structures and acidic strength H_2O_2 –structure, properties and uses. **Halogen Family (17th group)** Basic properties of halogen, interhalogens, types properties, hydro and oxyacids of chlorine – structure and comparison of acid strength. **Transition Elements (3d series)** General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes.	12
II	**Coordination Chemistry** Valence Bond Theory (VBT), Advantages and Drawbacks of VBT, Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for Oh and Td complexes, Tetragonal distortion of octahedral geometry, Jahn-Teller distortion, Square planar coordination. **Electronic spectra and Magnetic properties of Transition metal complexes** Selection rules for d-d transition, spectroscopic ground states, Spin only formula, L-S coupling, correlation of μ_{spin} and μ_{eff} values, orbital contribution to magnetic moments,	11
III	**Carboxylic acids and their derivatives** General methods, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides. Comparative study of nucleophilic substitution at acyl group, interconversion of acid derivatives by nucleophilic acyl substitution. Mechanism of acidic and basic hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hoffmann-bromamide degradation and Curtius rearrangement.	11
IV	**Electrochemistry** Conductivity of electrolytes, Equivalent and molar conductivity, Kohlrausch's law, Debye-Hückel-Onsager equation, Ionic velocities, mobilities, and transference numbers, Applications of conductance measurements, Quantitative aspects of Faraday's laws of electrolysis, Applications of electrolysis in metallurgy and industry, Electromotive force of a cell, Nernst equation, Standard electrode potentials,	11

	Concentration cells, Applications of EMF measurements	
V	**Practicals:** 1. *S*-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid). 2. Hydrolysis of amides and esters. 3. To determine the conductance of a given solution using a conductivity meter. 4. To study the effect of concentration on the conductance of a solution. 5. To determine the dissociation constant (Ka) of a weak acid using conductometry. 6. Gravimetric Analysis: • Estimation of nickel (II) using Dimethylglyoxime (DMG). • Estimation of copper as CuSCN • Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$. • Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminiumoxinate).	**30**

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Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (02 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

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