

Bachelors with Chemistry as Major/Minor

2nd Semester

Title of the course: Fundamentals of Chemistry and Chemical Analysis-II

Course Code:CHM222J/NC**Credits:**Theory-4, Lab-2

Theory (4 credits: 60 Hours)

Max. Marks: 100, Min Marks: 36

Course Objectives:

- To introduce general trends in chemistry of p- block elements.
- To understand the scenarios Involving Alkenes, alkynes and Alkyl Halides
- To have knowledge aromaticity and aromatic substitution.
- To provide a good platform to students to understand concepts of thermodynamics.

Learning Outcomes:

On completion of the course, the student should be able to:

- comprehend various aspects of p block elements
- understand basic concepts of organic reaction mechanisms.
- describe the basic principles of thermodynamics.

Unit I: Bonding and Chemical behaviour of p Block Elements

(15 Hours)

Boranes: topological classification, bonding in diborane. STYX convention of bonding in boron clusters, inert pair effect. Chemical behavior, structure and bonding in Boron-Nitrogen (Borazine) and Nitrogen-Phosphorus compound (phosphonitrilic halides). Structure and bonding in silicates(rings, chains, sheets and network). Chemical behavior of oxides and oxoacids of phosphorus, sulphur and chlorine, peroxyacids of sulphur. Structure of Pseudohalogens, polyhalides, interhalogen compounds. Clathrate compounds of noble gases, Structure and bonding in fluorides, oxides and oxyfluorides of xenon.

Unit II: Reaction Mechanism in Organic Chemistry-I

(15 Hours)

Substitution and elimination reactions of alkyl halides and alcohols: Mechanistic details of S_N1 and S_N2 ; E1 and E2 reactions. Hoffman and Saytzev's rules, Effects of structure of alkyl halides/ alcohols, nature of nucleophiles, leaving groups and effect of solvent. Substitution versus Elimination. Mitsunobu reaction.

Addition Reactions of alkenes and alkynes: Mechanistic details including regioselectivity and stereochemical implications of halogenation, hydrohalogenation, hydroboration, epoxidation, Prevost and Woodward hydroxylation. Acidic character, hydration and Catalytic/ metal-ammonia reductions of alkynes.

Unit III: Reaction Mechanism in Organic Chemistry -II

(15 Hours)

Aromaticity: Requirements of aromaticity. Huckel's rule and its significance. Explanation using molecular orbital diagram of benzene. Homo and Antiaromaticity, Aromaticity of non-benzenoid compounds like pyrrole, thiophene, furan and aromatic ions (3, 5 and 7-membered rings).

Aromatic electrophilic substitution: General mechanism; formation of sigma and pi complexes. The second substitution: role of activating and deactivating groups, orientation of

benzene. Mechanisms of Gattermann, Huben-Hoesch, Veils-Meir Haack and Riemer-Tieman reactions.

Aromatic nucleophilic substitution:

Discussion of S_N -unimolecular, S_N2Ar and benzyne mechanisms.

Unit-IV: Fundamentals of Thermodynamics

(15 Hours)

Thermodynamic functions: State and path functions and their differentials. Thermodynamic processes. Concept of heat and work.

The first law of thermodynamics: The formulation of the first law of thermodynamics, Heat capacity, heat capacities at constant volume and constant pressure and their relationship. Calculation of ΔU & ΔH for the expansion of ideal gases under isothermal and adiabatic conditions.

The second law of thermodynamics: Need for the law, and different statements of the law. Carnot cycle and its efficiency, Carnot theorem. The thermodynamic scale of temperature. Concept of entropy, entropy as a function of V & T , and as a function of P & T . Clausius inequality; entropy as criteria for spontaneity and equilibrium. Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, ΔG & ΔA as criteria for thermodynamic equilibrium and spontaneity.

Third law of thermodynamics: Nernst heat theorem, third law of thermodynamics, concept of residual entropy.

Books Recommended:

1. J.D. Lee, "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th edition.
2. B.R. Puri, , L.R. Sharma, and, K.C. Kalia, "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
3. R. L. Madan, , "Chemistry for Degree Students, B. Sc. First Year", S. Chand Publishing, New Delhi, India, 2011, 3rd edition
4. Shriver & Atkins, Inorganic chemistry, 5th edition.
5. Chandra, S., "Comprehensive Inorganic Chemistry" New Age International Publishers, India, 2018, 1st edition.
6. Prakash, S., Tuli, G.D., Basu, S.K. and Madan, R.D., "Advanced Inorganic Chemistry", S. Chand Publishing, New Delhi, India, 2000, Vol 1.
7. J. E. Huheey, Inorganic chemistry: principles of structure and reactivity, 5th edition.
8. Advanced General Organic Chemistry: A Modern Approach; S.K. Ghosh; 3rd Revised Edn., New Central, 2010.
9. Organic Chemistry; R.T. Morrison, R.N. Boyd, S. K. Bhattacharjee; 7th Edn., Pearson India, 2011.
10. Organic Chemistry; P.Y. Bruice; 8th Edn., Pearson Education, 2017.
11. Advanced Organic Chemistry; Dr. Jagdamba Singh and LDS Yadav; Pragati edition, 2017.
12. Principles of Physical Chemistry; B.R. Puri, L.R. Sharma and L.S. Pathania; 47th Edn., Vishal Pubs & Co, 2017.

- Physical Chemistry; T. Engel, P. Reid,;3rd Edn., Pearson India, 2013.
- Elements of Physical Chemistry, Peter Atkins and Julio de Paula, 7th Edition, Oxford University Press, 2016.
- Physical Chemistry, Concepts and Models, Volume III, Nabakumar Bera, Subhasree Ghosh, Paulami Ghosh, Techno world.
- Atkins' Physical Chemistry, Peter Atkins, Julio de Paula & James Keeler, 11th Edition, Oxford University Press, 2018.
- An Introduction to Chemical Thermodynamics, R. P. Rastogi and R. R Misra, 6th Edition, Vikas Publishing House Pvt. Ltd. 2018.

Practical (2 credits: 60 Hours)

Max. Marks: 50, Min Marks:18

Section A: Titrimetry

- Determination of vitamin C content in a commercially available Vitamin C tablet.
- Determination of calcium content in chalk as calcium oxalate by permanganometry.
- Determination of ferrous ions by dichromate method.

Section B: Synthesis & Functional group Analysis

- Functional Group Identification: Aromatic hydrocarbons, unsaturation, carboxylic acids, carbonyl compounds, phenols, alcohols, amines, amides, nitro compounds.
- Preparation, recrystallization, percent yield and identification (melting point) of the following reactions products.*
 - Bromination of Acetanilide/Phenol
 - Benzoylation of Acetanilide/Phenol

* Any other feasible single stage synthesis

Section C: Thermochemical Analysis

- Determination of heat capacity of calorimeter for different volumes.
- Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide
- Determination of enthalpy of ionization of acetic acid.

Books Recommended:

- Vogel's; text book of Quantitative Inorganic Analysis (revised); Bassett, J.; Denney, R.C.; Jeffery, G. H and Mendham, J.; 6th ed.; ELBS; 2007.
- Comprehensive Practical Organic Chemistry: Qualitative analysis Ahluwalia, V.K. &Sunita Dhingra; Universities Press, India, 2004.
- Advanced Practical Organic Chemistry; N. K. Vishnoi; 3rdEdn; Vikas Publishing, 2009.
- Advanced Practical Physical Chemistry; J.B. Yadav; Krishna Prakashan Media (P)Limited, 2015.
- Selected Experiments in Physical Chemistry; Mukherjee N.G.& Ghosh, J.N.; S. Chand & Sons.
- Advanced Physical Chemistry Experiments; J. N. Gurtu, A. Gurtu, PragatiPrakashan, 2008.
- Experiments in Physical Chemistry; Das, R. C, and Behra, B.; Tata McGraw Hill.