

Department of Chemistry
Nrupathunga University, Bengaluru

Academic year 2021-22 onwards

B Sc / B Sc (Honors) Chemistry

Semester I

Title of the course:

- 1. DSC-1: Analytical and Organic Chemistry-I**
 - 2. DSC-Lab-1: Analytical and Organic Practicals-1**
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Theory Course: DSC-1: Analytical and Organic Chemistry-I

Course Outcomes (COs)

At the end of the course the student should be able to:

1. Learn the concepts of chemical analysis, accuracy, precision and statistical data treatment
2. Prepare the solutions after calculating the required quantity of salts in preparing the reagents/solutions and dilution of stock solution.
3. Know the concept of volumetric and gravimetric analysis and deducing the conversion factor for determination
4. Handle toxic chemicals, concentrated acids and organic solvents and practice safety procedures.
5. Understand the concepts of Organic reactions and techniques of writing the movement of electrons, bond breaking, bond forming
6. Learn the Concept of aromaticity, resonance, hyper conjugation, etc.
7. Understand the preparation of alkanes, alkenes and alkynes, their reactions, etc.
8. Understand the mechanism of addition, substitution and elimination reactions.

Number of Theory Credits	Number of lecture hours/ semester
4	56
DSC I: Analytical and Organic Chemistry – I	
Unit – 1	14 h
Basic laboratory practices, calibration of glassware (pipette, burette and volumetric flask), Sampling (solids and liquids), weighing, drying, dissolving. Acid treatment. Rules of work in analytical laboratory, General rules for performing quantitative determinations (volumetric and gravimetric). Safety in Chemical laboratory. Rules of fire prevention and accidents. First aid. Precautions to be taken while handling toxic chemicals, concentrated/fuming acids and organic solvents.	
Language of analytical chemistry: Definitions of analysis, determination, measurement, techniques and methods. Classification of analytical techniques.	

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<p>Choice of an analytical method. Significant figures.</p> <p>Errors and treatment of analytical data: Limitations of analytical methods – Errors: Determinate and indeterminate errors, absolute error, relative error, minimization of errors. Statistical treatment of finite samples -mean, median, range, standard deviation and variance. External standard calibration - regression equation (least square method), correlation coefficient (R^2).</p> <p>Numerical problems</p> <p>Accuracy, precision, sensitivity, selectivity, method validation. Figures of merit of analytical methods and limit of detection (LOD), Limit of quantification (LOQ), linear dynamic range (working range).</p> <p>Titrimetric analysis: Basic principle of titrimetric analysis. Classification, Preparation and dilution of reagents/solutions. Equivalent masses of compounds. Normality, Molarity and Mole fraction. Use of $N_1V_1 = N_2V_2$ formula, Preparation of ppm level solutions from source materials (salts), conversion factors. Numerical problems</p>	
Unit - 2	14 h
<p>Acid-base titrimetry: Titration curves for strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations. Titration curves, Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity.</p> <p>Complexometric titrimetry: Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations, Application-determination of hardness of water.</p> <p>Precipitation titrimetry: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate- Volhard's and Mohr's methods and their differences.</p> <p>Gravimetric Analysis: Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, Co-precipitation, post-precipitation. Advantages of organic reagents over inorganic reagents, reagents used in gravimetry (8-hydroxy quinoline (oxine) and dimethyl glyoxime (DMG) Numerical problems.</p>	
Unit - 3	14 h
<p>Classification and nomenclature of organic compounds (mono and bifunctional, non-aromatic), Hybridization, Shapes of organic molecules, Influence of hybridization on bond properties.</p> <p>Nature of bonding in Organic molecules</p> <p>Formation of Covalent bond, localized and delocalized, conjugation and cross conjugation, concept of resonance, electronic displacements: Inductive effect, Electromeric effect, Resonance and Hyper conjugation, cross conjugation explanation with examples. Concept of aromaticity, Huckel rule, anti-aromaticity, non-aromatic explanation with examples. Strengths of organic acids and bases: Factors affecting</p>	

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<p>pK_a values-explanation based on inductive and resonance effects. Relative strength of aliphatic and aromatic carboxylic acids-Acetic acid and chloroacetic acid, acetic acid and propionic acid, acetic acid and benzoic acid, Relative strength of aliphatic and aromatic amines- methylamine and aniline.</p> <p>Mechanisms of Organic Reactions</p> <p>Notations used to represent electron movements and directions of reactions- curly arrows, formal charges. Types of bonds breaking- homolytic and heterolytic. Types of reagents-Electrophiles, nucleophiles. Types of organic reactions - substitution, addition, elimination, rearrangement, explanation with examples.</p> <p>Chemistry of Aliphatic hydrocarbons, Carbon-Carbon Sigma bonds</p> <p>Preparation of alkanes: Wurtz reaction, Wurtz-Fittig reaction, Corey House reaction, Free radical substitution, Halogenation- relative reactivity and selectivity</p> <p>Nucleophilic substitution at saturated carbon. Mechanism of S_N1 and S_N2 reactions with suitable examples. Energy profile diagrams, Stereochemistry and factors affecting S_N1 and S_N2 reactions, substrate, leaving group, effect of solvent, nature and strength of the nucleophile, Nucleophilicity versus basicity</p>	
<p>Unit - 4</p>	<p>14 h</p>
<p>Carbon-carbon pi bonds</p> <p>Formation of alkenes and alkynes by elimination reaction. Mechanism of E₁, E₂, reaction. Saytzeff and Hofmann eliminations. Addition of HBr to propene, Free radical addition of HBr to propene. Addition of halogens to alkenes-carbocation and halonium ion mechanism. Stereospecificity of halogen addition. Ozonolysis mechanism - ozonolysis of propene. Addition of hydrogen halides to alkenes, mechanism, regioselectivity and relative rates of addition. Hydrogenation, hydration, hydroxylation and epoxidation of alkenes, explanation with examples, 1, 2 and 1,4- addition reactions in conjugated dienes. Diels-Alder reaction, Allylic and benzylic bromination and mechanism in propene, 1-butene, 1-toluene and ethylbenzene.</p> <p>Aromatic Electrophilic substitution reactions. Mechanisms, σ and π complexes, Halogenation, Nitration, Sulphonation, Friedel Crafts alkylation and acylation with their mechanism. Activating and deactivating groups. Orientation influence (Cl, NO₂, CH₃, NH₂, OH)</p> <p>Aromatic nucleophilic substitution reaction: S_NAr mechanism. Generation of Benzyne with mechanism. <i>Ips</i>o substitution. Example-Conversion of 2,4 dinitrochlorobenzene to 2,4 dinitrophenyl hydrazine</p>	

Text Books for reference:

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J .D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd.(2007).
2. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
3. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

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4. Organic Reaction mechanism by V. K. Ahluwalia and K. Parashar (Narosa Publishers).
 5. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers)
 6. Organic chemistry by Paulo Vurkanis Bruice Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
 7. A text book of Organic Chemistry by Arun Bahl and B. S Bahl (S.Chand publications).
 8. Reaction mechanism and reagents in organic chemistry by G.R.Chatwal (Himalaya publishing house).
 9. Chemistry for Degree students B. Sc semester-I Inorganic/Organic by R L Madan (S Chand publications).
 10. Finar, I. L. Organic Chemistry (Volume I), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
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Practical Course: DSC Lab-1: Analytical and Organic Practicals-1

Course Outcomes (Cos):

After studying the course, the student will be able to

1. Understand the safety practices in the Chemistry Laboratory
2. Develop awareness regarding toxicity of chemicals
3. Know the importance of calibration of glassware, pipette, burette and volumetric flask
4. Prepare standard/working solutions, standardization of solutions and determination of the respective analytes
5. Select suitable solvent for purification of organic compounds
6. Gain an insight to the mechanism behind the reaction and the significance of catalysts
7. Learn the importance of green methods over conventional methods and proficiently handle the byproducts and disposal of waste
8. Enthuse students to conduct experiments by arousing the curiosity which would help them in learning basics and advanced concepts through simulation-based labs.

Number of practical Credits	Number of practical hours / semester
2	56

PART-A (Analytical Chemistry)

1. Safety Practices in the Chemistry Laboratory, knowledge about common toxic chemicals and safety measures in their handling, cleaning and drying of glass wares.
2. Calibration of glassware, pipette, burette and volumetric flask.

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3. Determination of sodium carbonate and sodium bicarbonate in a mixture.
4. Determination of alkali present in soaps/detergents
5. Determination of iron(II) using potassium dichromate
6. Determination of oxalic acid using potassium permanganate solution
7. Standardization of EDTA solution and determination of hardness of water

Virtual Experiments

8. Determination of Fe^{2+} as Fe_2O_3
9. Gravimetric estimation of Barium
10. Gravimetric estimation of Nickel

PART-B (Organic Chemistry)

1. Selection of suitable solvents for Purification/Crystallization of organic compounds.
2. Simple Distillation
3. Preparation of acetanilide from aniline using Zn/acetic acid (Green method).
4. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture.
5. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method)
6. Synthesis of diazoamino benzene from aniline (conventional method).
7. Preparation of dibenzalacetone (Green method).

Virtual Experiments

8. Separation of Compounds by Column Chromatography
9. Detection of Functional Groups
10. Diels Alder reaction between furan and maleic acid (Green method).

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