Curriculum Framework

Course structure of Chemistry

Second Year – NHEQF Level- 5

[w.e.f. ACADEMIC SESSION 2026-27]

Course Category	Chemistry (B.Sc. 2nd Year) (Semester-III)				
	Subject/Title	Paper Name	No. of paper	Credits	
				T	P
Major-I (One Subject) Major	DSC (Major)-III Chemistry	Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry (Major)	1	4	-
	DSC (Major)-III Practical Chemistry	Practical - Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry (Major)	1	-	1
Minor-I (One Subject)	DSC (Minor)-III Chemistry	Solutions, Conductance, Electrochemistry & Functional Group Organic Chemistry (Minor)	1	3	-
	DSC (Minor)-III Practical Chemistry	Practical - Solutions, Conductance, Electrochemistry & Functional Group Organic Chemistry (Minor)	1	-	1
Discipline Specific - SEC	DSEC (Major)-IV Chemistry	Green Chemistry and Pesticide Chemistry (DSEC-Major)	1	3	-
M.D/I.D (Minor)	M.D/I.D (M)-III Environmental Chemistry	Environmental Pollution and Toxicology (MD/ID)	1	3	-
	M.D/I.D (M)-III Practical Environmental Chemistry	Practical-Environmental Chemistry-III (MD/ID)	1	-	1
AEC (Language based courses)	Indian, Modern, Regional Language-I	-	1	2	-
VAC/AEC	AEC-Indian Knowledge System Or VAC-Culture, traditions and moral values	-	1	2	-
Total			9	17	3

NHEQF Level 5	***Student on exit after successfully completing Second year (i.e., securing minimum required 80 credits + 4 Credits in*** one vocational course/skills-enhancement course of 4 credits***) will be awarded "Undergraduate Diploma" of two year, in related field/discipline/subject.***
IKS- Indian Knowledge System- AEC	
Culture, Traditions and Moral Values- VAC	
Students are required to study both courses — *Indian Knowledge System (IKS)* and *Culture, traditions and moral values* — during the 3rd and 4th semesters. However, they will have the flexibility to study one course in each semester.	
IMR Language- 'Indian, Modern, Regional Language'- Hindi, Sanskrit and English (Student have to study 2 different languages in the second year with one language in one semester and other language in another semester). One additional course titled **"Heritage of Indian Languages"** shall be offered, which students may opt for **in lieu of any one prescribed language course**, subject to the applicable regulations of the programme.	
The department may offer a 3-credit Discipline specific SEC Major course as either a fully theory-based or fully practical-based module.	
Note: Student will continue with the same Discipline specific major & Minor in the second year (III & IV Semester) as studied in the first year (I & II semester) of the FYUP.	

B.Sc. Second Year (III Semester)
DSC (Major)-III
Chemistry (Theory)
Paper Name: Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry

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Credits: 04
Theory: 60 Hours
Section A: Physical Chemistry

Unit I. Solutions (10 Hours)

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law– non- ideal solutions. Vapour pressure- composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Unit II. Phase Equilibrium (8 Hours)

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).

Unit III. Conductance (8 Hours)

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 Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit IV. Electrochemistry (10 Hours)

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: *G*, *H* and *S* from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations –qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry

Unit V. Preparations & reactions of the following functional groups (10 Hours)

Carboxylic acids and their derivatives:

Carboxylic acids (aliphatic and aromatic) *Preparation:* Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell–Vohlard-Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Up to 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. *Reactions:* Comparative study of nucleophilicity of acyl derivatives.
Reformatsky Reaction, Perkin condensation.
Amines and Diazonium Salts:
Amines (Aliphatic and Aromatic):
Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.
Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO2, Schotten –Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.
Diazonium salts: *Preparation:* from aromatic amines. R*eactions:* conversion to benzene, phenol, dyes.

Unit VI. Amino Acids, Peptides and Proteins (7 Hours)

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.
Reactions of Amino acids: ester of –COOH group, acetylation of–NH_2 group, complexation with Cu2+ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

Unit VII. Carbohydrates (7 Hours)

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Reference Books:

• Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
• Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
• Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
• Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
• Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
• Morrison, R. T. & Boyd, R.N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
• Finar, I.L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
• Finar, I.L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
• Nelson, D.L. & Cox, M.M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W.H. Freeman.
• Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

B.Sc. Second Year (III Semester)
DSC (Major)-III
Chemistry (Practical)
Paper Name: Practical - Solutions, Phase Equilibrium, Conductance, Electrochemistry & Functional Group Organic Chemistry

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Note: The practical of the DSC (Major)-III Chemistry Practical course is Skill-based.

Credits: 01

Theory: 30 Hours

Section A: Physical Chemistry

Distribution

Study of the equilibrium of one of the following reactions by the distribution method:

$I_2(aq) + I^-(aq) \longrightarrow I_3^-(aq)$

$Cu^{2+}(aq) + xNH_2(aq) \longrightarrow [Cu(NH_3)x]^{2+}$

Phase equilibria

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

b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.

c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductance

I. Determination of cell constant

II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

III. Perform the following conductometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

Potentiometry: Perform the following potentiometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry

1. Systematic Qualitative Analysis of Organic Compounds containing functional groups (-COOH, phenolic, aldehydic, ketonic, amide, amines) and preparation of their derivatives.
2. Separation of amino acids by paper chromatography.
3. Determination of the concentration of glycine solution by formylation method.
4. Titration curve of glycine
5. Action of salivary amylase on starch
6. Effect of temperature on the action of salivary amylase on starch.
7. Differentiation between a reducing and a non-reducing sugar.

Reference Books:

- Vogel, A. I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Text book of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Khosla, B. D.; *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

B.Sc. Second Year (III Semester)
DSC (Minor)-III
Chemistry (Theory)
Paper Name: Solutions, Conductance, Electrochemistry & Functional Group Organic Chemistry

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Credits: 03
Theory: 45 Hours
Section A: Physical Chemistry

Unit I. Solutions (8 Hours)

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law– non- ideal solutions. Vapour pressure- composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Unit II. Conductance (7 Hours)

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 Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit III. Electrochemistry (8 Hours)

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: *G*, *H* and *S* from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations –qualitative treatment (acid-base and oxidation-reduction only).

Section B: Organic Chemistry

Unit IV. Preparations & reactions of the following functional groups (8 Hours)

Carboxylic acids and their derivatives:

Carboxylic acids (aliphatic and aromatic) *Preparation:* Acidic and Alkaline hydrolysis of esters. *Reactions:* Hell–Vohlard-Zelinsky Reaction.

Carboxylic acid derivatives (aliphatic): (Up to 5 carbons)

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. *Reactions:* Comparative study of nucleophilicity of acyl derivatives.

Reformatsky Reaction, Perkin condensation.

Amines and Diazonium Salts:

Amines (Aliphatic and Aromatic):

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten –Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines. R*eactions:* conversion to benzene, phenol, dyes.

Unit V. Amino Acids, Peptides and Proteins (8 Hours)

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of –COOH group, acetylation of–NH_2 group, complexation with Cu2+ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

Unit VI. Carbohydrates (6 Hours)

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Reference Books:

• Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).

• Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).

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• Finar, I.L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

• Nelson, D.L. & Cox, M.M. *Lehninger's Principles of Biochemistry 7th Ed.,* W.H. Freeman.

• Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

B.Sc. Second Year (III Semester)
DSC (Minor)-III
Chemistry (Practical)
Paper Name: Practical - Solutions, Conductance, Electrochemistry & Functional Group Organic Chemistry

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Note: The practical of the DSC (Minor)-III Chemistry Practical course is Skill-based.

Credits: 01

Theory: 30 Hours

Section A: Physical Chemistry

Distribution

Study of the equilibrium of one of the following reactions by the distribution method:

$I_2\,(aq) + I^-\,(aq) \longrightarrow I_3^-\,(aq)$

$Cu^{2+}(aq) + xNH_2\,(aq) \longrightarrow [Cu(NH_3)_x]^{2+}$

Conductance

I. Determination of cell constant

II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

III. Perform the following conductometric titrations:

i. Strong acid vs. strong base

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Potentiometry

Perform the following potentiometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Potassium dichromate vs. Mohr's salt

Section B: Organic Chemistry

1. Systematic Qualitative Organic Analysis of Organic Compounds possess in mono functional groups (-COOH, phenolic, aldehydic, ketonic, amide, amines) and preparation of one derivative.
2. Separation of amino acids by paper chromatography
3. Determination of the concentration of glycine solution by formylation method.
4. Titration curve of glycine
5. Action of salivary amylase on starch
6. Effect of temperature on the action of salivary amylase on starch.
7. Differentiation between a reducing and a non-reducing sugar.

Reference Books:

- Vogel, A. I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Text book of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman,1960.
  Khosla, B. D.; Garg, V.C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

B.Sc. Second Year
(III Semester)
Chemistry (DSEC (Major)-IV, Theory)
Paper Name: Green Chemistry and Pesticide Chemistry

Note: The Chemistry Discipline Specific Skill Enhancement Course (DSEC (Major)-IV, Theory); Green Chemistry and Pesticide Chemistry course is Skill-based.

Credits: 03

Theory: 45 Hours

Unit I. Introduction of Green Chemistry (12 Hours)

Introduction: Definitions of Green Chemistry. Brief introduction of twelve principles of Green Chemistry with examples, special emphasis on atom economy, reducing toxicity, green solvents, Green Chemistry and catalysis and alternative sources of energy, Green energy and sustainability.

Unit II. Real world Cases in Green Chemistry (17 Hours)

Use of surfactants in supercritical carbon dioxide for precision cleaning and dry cleaning, replacing toxic solvents like perchloroethylene, the design of environmentally safe marine antifoulants, the development of right-fit pigments such as synthetic azo pigments to replace hazardous heavy-metal pigments, and the green synthesis of biodegradable polymers like poly lactic acid (PLA) from renewable resources such as corn, CO_2 as an eco-friendly industrial solvent, synthesis of greener pharmaceuticals, production of biodiesel and alternative fuels, catalytic and solvent-free reactions, and the design of recyclable and biodegradable materials.

Unit III. Pesticide Chemistry (16 Hours)

General introduction to pesticides (natural and synthetic), Types: Insecticides, Herbicides, benefits and adverse effects, changing concepts of pesticides, structure activity relationship. Biopesticides, uses and future perspectives Pesticidal poisoning, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines: Gammexene, Organophosphates (Malathion, Parathion, pyrethroids), Carbamates (Carbofuran and carbaryl); Quinones. Pheromones, repellents and rodenticides.

Reference Books:

- Anastas, P. T. & Warner, J.K. *Green Chemistry-Theory and Practical*, Oxford University Press (1998).
- Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
- Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, New York, 1978.

B.Sc. Second Year
(III Semester)
Chemistry (M.D/I.D. (M)-III, Theory)
Environmental Chemistry
Paper Name: Environmental Pollution and Toxicology

Credits: 03
Theory: 45 Hours

Unit I. Waste Classification **(10 Hours)**

Solid waste (municipal, industrial, agricultural), Hazardous waste (toxic, corrosive, reactive, flammable), Biomedical waste (infectious, pathological, sharps), E-waste (electronic components, heavy metals), Radioactive waste (low-level, high-level), Plastic waste and microplastics, Waste characteristics (toxicity, persistence, degradability), Sources and generation of waste, Waste segregation and labeling.

Unit II. Industrial Pollution **(10 Hours)**

Types of industries (petrochemical, textile, pharmaceutical, mining), Sources of industrial pollution, Industrial effluents (organic waste, dyes, acids, heavy metals), Air pollutants (SO_2, NO_x, CO, particulate matter, VOCs), Water pollution from industries, Soil contamination, Thermal pollution, Noise pollution from industries, Occupational exposure hazards, Industrial accidents and case studies.

Unit III. Heavy Metals & Hazardous Chemicals **(12 Hours)**

Mercury: sources, methylmercury formation, Minamata disease, Lead: sources, neurological and developmental effects, Cadmium: sources, Itai-itai disease, Arsenic: groundwater contamination, carcinogenic effects, Chromium, nickel, and other toxic metals, Persistent Organic Pollutants (POPs): DDT, PCBs, dioxins, Properties of POPs (persistence, bioaccumulation, transport), Pesticides (organochlorines, organophosphates, carbamates), Industrial chemicals and solvents, Emerging contaminants (pharmaceuticals, PFAS, microplastics, nanoparticles).

Unit IV: Environmental Toxicology **(13 Hours)**

Definition, scope, and importance of toxicology, Branches of toxicology (environmental, occupational, forensic), Classification of toxic substances (organic, inorganic, biological, radioactive), Sources of toxicants (natural and anthropogenic), Routes of exposure (inhalation, ingestion, dermal), Types of toxic agents (carcinogens, mutagens, teratogens, endocrine disruptors), Dose-response relationship (graded and quantal response), LD_{50}, ED_{50}, NOAEL, LOAEL, Threshold and non-threshold limits, Acute, chronic, sub-chronic toxicity, Local vs systemic toxicity, Factors influencing toxicity.

Reference Books:

- K. Maiti, Handbook of Methods in Environmental Studies Vol. 1: Water and Wastewater Analysis, 2004, 2nd Edition
- S. K. Maiti, Handbook of Methods in Environmental Studies: Air, Noise, Soil and Overburden Analysis, 2016, 1st Edition
- S. K. Panigrahi, L. Mohanty, Environmental Engineering Laboratory Manual, 2023, 1st Edition
- N. N. Basak, Laboratory Manual for Environmental Engineering, 2017, 2nd Edition
- M. R. Gidde, Environmental Engineering Laboratory Manual, 2013, 1st Edition
- William C. Lipps, Ellen Burton Braun-Howland, Terry E. Baxter, Standard Methods for the Examination of Water and Wastewater, 2023, 24th Edition
- E. W. Rice, R. B. Baird, A. D. Eaton, Standard Methods for the Examination of Water and Wastewater, 2017, 23rd Edition
- M. Alice Ottoboni, Patricia Frank, The Dose Makes the Poison: A Plain Language Guide to Toxicology, 2011, 3rd Edition
- S. C. Bhatia, Handbook of Industrial Pollution and Control, 2002, 1st Edition
- S. C. Bhatia, Managing Industrial Pollution, 2003, 1st Edition
- Des W. Connell, Gregory J. Miller, Chemistry and Toxicology of Pollution, 2022, 2nd Edition
- Richard J. Watts, Hazardous Wastes: Sources, Pathways, Receptors, 1998, 1st Edition.

B.Sc. Second Year
(III Semester)
Chemistry (M.D/I.D. (M)-III, Practical)
Environmental Chemistry
Paper Name: Practical-Environmental Chemistry-III

Note: The practical of the Chemistry (M.D./I.D., Practical) of Environmental Chemistry course is Skill-based.

Credits: 01

Practical: 30 Hours

Perform some of the experiments from the given list. Additional relevant practicals may also be performed depending on the resources available in the institution.

1. Study and classify different types of waste samples such as municipal, industrial, and agricultural waste based on their physical characteristics and sources.
2. Perform segregation of mixed waste into biodegradable, recyclable, and hazardous categories using standard labeling and identification methods.
3. Measure the pH of an industrial wastewater sample using a digital pH meter to assess its acidity or alkalinity.
4. Estimate the concentration of heavy metals such as lead or others in water using colorimetric or simple analytical methods.
5. Detect arsenic contamination in groundwater samples using standard chemical test kits or field methods.
6. Determine the presence of chromium or other toxic metals in industrial effluents through basic laboratory analysis.
7. Carry out water quality monitoring by measuring parameters such as turbidity, conductivity, and temperature.
8. Determine the moisture content of a given solid waste sample by drying it in an oven and calculating weight loss.
9. Analyze the biodegradable and non-biodegradable fractions of waste through manual sorting and percentage estimation.
10. Detect and separate microplastics from water or soil samples using filtration and microscopic observation techniques.
11. Estimate total suspended solids (TSS) in wastewater by filtration and drying method to assess pollution load.
12. Measure dissolved oxygen (DO) in a water sample using Winkler's method to evaluate water quality.
13. Conduct a noise level measurement in an industrial or roadside area using a sound level meter and analyze the results.
14. Perform extraction and basic analysis of pesticide residues from contaminated water or soil samples.
15. Study the dose-response relationship of a toxic substance using experimental data or simulation models.
16. Demonstrate bioaccumulation by modelling pollutant transfer through a simple food chain experiment.

Reference Books:

- S. K. Maiti - Handbook of Methods in Environmental Studies Vol. 1: Water and Wastewater Analysis, 2004, 2nd Edition
- S. K. Maiti - Handbook of Methods in Environmental Studies: Air, Noise, Soil and Overburden Analysis, 2011, 1st Edition
- S. K. Panigrahi & L. Mohanty - Environmental Engineering Laboratory Manual, 2023 - 1st Edition
- N. N. Basak, Laboratory Manual for Environmental Engineering, 2017, 2nd Edition
- M. R. Gidde - Environmental Engineering Laboratory Manual, 2013, 1st Edition
- APHA, AWWA, WEF - Standard Methods for the Examination of Water and Wastewater, 2017, 23rd Edition
- Sudha Goel - Laboratory Manual for Environmental Chemistry, 2017, 1st Edition.