GUJARAT TECHNOLOGICAL UNIVERSITY

5 SEMESTER – OLD PAPER – S22 TO S26 – QUESTION BANK

Subject Name & Code: Advance Environmental Instrumentation- 3151302

Chapter 1: Introduction to instrumental method of analysis

Repeated Questions:

1. Importance of Advanced Environmental Instrumentation:

- **Q.** Discuss/Explain the significance/need/importance of "Advanced Environmental Instrumentation" in the environmental engineering field. **(WINTER 2022, 4 Marks; SUMMER 2023; WINTER 2023, 3 Marks; SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks)**

Other Important Questions:

1. Need and Applications of Analytical Instruments:

- **Q.** Highlight the applications of instruments in various analytical field. **(WINTER 2024, 3 Marks)**
- **Q.** Discuss uses of Spectroscopy in Environmental Engineering. **(WINTER 2024, 4 Marks)**
- **Q.** Enlist advance environmental instruments with its applications. **(WINTER 2025, 4 Marks)**
- **Q.** Enlist applications of various Advanced Environmental Instrumentations. **(WINTER 2023, 7 Marks)**
- **Q.** Highlight the need of analytical instrument in environmental engineering field. **(SUMMER 2026)**

2. Instrumental Methods and Standard Methods of Analysis:

- **Q.** What is the importance of standard methods in instrumental analysis? **(WINTER 2024, 3 Marks)**
- **Q.** State different instrumental method of analysis useful for analysis of the following compounds: (i) metals (ii) inorganic ions (iii) volatile organic compound (iv) nonvolatile organic compound. **(SUMMER 2024, 3 Marks)**

Chapter 2: Spectroscopic Methods of Analysis

Repeated Questions:

1. Beer-Lambert's Law:

- **Q.** State/Derive/Explain Beer-Lambert's Law. **(SUMMER 2022, 4 Marks; SUMMER 2023, 3 Marks; WINTER 2023, 4 Marks; SUMMER 2024, 7 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 7 Marks)**

2. Fundamentals of Spectroscopy and the Electromagnetic Spectrum:

- **Q.** Define Spectroscopy and discuss behaviour of molecules in various EMR / fundamental principles of Spectroscopy. **(WINTER 2022, 3 Marks; WINTER 2024, 3 Marks; WINTER 2025, 3 Marks)**
- **Q.** Draw the electromagnetic spectrum indicating different spectral regions with wavelengths and frequencies. [Diagram required – refer to the original question paper] **(WINTER 2023, 7 Marks OR; WINTER 2025)**
- **Q.** Discuss the classification/types of spectrum. **(WINTER 2022, 3 Marks; SUMMER 2026, 3 Marks)**

3. UV-Visible Spectrophotometer:

- **Q.** Explain the instrumentation/working principle/block diagram of UV-Visible spectrophotometer. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 7 Marks; SUMMER 2026)**

4. Atomic Absorption Spectroscopy (AAS):

- **Q.** Explain the principle/instrumentation/working of Atomic Absorption Spectroscopy/Spectrophotometer (AAS). **(SUMMER 2022, 7 Marks OR; SUMMER 2023, 3 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 4 Marks; WINTER 2024, 4 Marks; WINTER 2025, 7 Marks; SUMMER 2026, 7 Marks)**

5. IR Spectroscopy:

- **Q.** Explain the working principle/block diagram/components of IR Spectroscopy. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks; SUMMER 2023, 7 Marks OR; SUMMER 2023, OR; SUMMER 2025, 7 Marks; SUMMER 2026, 4 Marks)**

6. Raman Spectroscopy:

- **Q.** Explain Raman Spectroscopy / working principle / types of scattering. **(SUMMER 2023, 4 Marks; WINTER 2024, 4 Marks)**

7. Detectors in Spectroscopy:

- **Q.** Enlist types of detectors used in Spectroscopy / IR Spectroscopy and explain any one / Flame Ionization Detector. **(WINTER 2022, 7 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 7 Marks; WINTER 2025, 7 Marks OR)**

8. Comparison of Spectroscopic Techniques:

- **Q.** Differentiate UV-Visible Spectroscopy/Spectrophotometer and Atomic Absorption Spectroscopy (AAS). **(WINTER 2022, 4 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 7 Marks)**

9. Mass Spectroscopy:

- **Q.** Explain principle/instrumentation of Mass Spectroscopy. **(WINTER 2023, 7 Marks OR; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Fundamentals of Light and Spectroscopy:

- **Q.** Discuss the Stefan-Boltzmann law with its applications. **(SUMMER 2025, 3 Marks)**
- **Q.** Explain the different types of electronic transitions in molecules. **(SUMMER 2025, 4 Marks)**

- **Q.** Explain the various factors affecting the absorption spectral bands in organic compounds. **(SUMMER 2025, 3 Marks)**
- **Q.** What wavelength range is characteristics of (i) visible radiation (ii) ultraviolet radiation (iii) infrared radiation. **(SUMMER 2024, 3 Marks)**
- **Q.** Define scattering, absorption & emission, with reference to optical instruments. **(SUMMER 2026)**

2. Beer-Lambert's Law:

- **Q.** Enlist advantages and limitations of Beer-Lambert's Law. Discuss applications of Beer-Lambert's Law in Environmental Engineering. **(WINTER 2024, 7 Marks)**

3. UV-Visible Spectrophotometer and Colorimeter:

- **Q.** List components of UV-visible Spectrophotometer. Explain each component. **(SUMMER 2023, 7 Marks OR)**
- **Q.** List various types of light sources used for different types of spectrophotometer. **(WINTER 2023, 4 Marks)**
- **Q.** Differentiate between Single beam and Double Beam UV-Visible Spectrophotometer. **(SUMMER 2024, 4 Marks OR)**
- **Q.** Explain the working principle and operation of each unit of Colorimeter with sketch. [Diagram required – refer to the original question paper] **(SUMMER 2024, 7 Marks)**

4. IR Spectroscopy:

- **Q.** Explain fundamental modes of molecular vibrations. **(SUMMER 2022, 3 Marks)**
- **Q.** Describe thermal detectors used in IR spectrophotometer. **(SUMMER 2022, 4 Marks)**
- **Q.** List components of Infrared Spectrophotometer. Explain any two components. **(SUMMER 2023, OR)**
- **Q.** List various types of molecular vibrations due to irradiation of low energy light. Explain them with neat sketch. [Diagram required – refer to the original question paper] **(SUMMER 2026)**

5. Flame Photometry and Atomic Emission Spectroscopy (AES):

- **Q.** Explain the working principle of flame photometer with neat diagram. [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks)**
- **Q.** List components of Flame photometer. Explain each component. **(SUMMER 2024, 4 Marks OR)**
- **Q.** State the major process involved in AES with neat sketch. [Diagram required – refer to the original question paper] **(WINTER 2023, 4 Marks OR)**

6. Applications of Spectrophotometric Techniques:

- **Q.** Write applications of Absorption Spectrophotometer and Flame Photometer. **(SUMMER 2023)**
- **Q.** Discuss application of Atomic Absorption Spectrophotometer in environmental engineering field. **(SUMMER 2025, 4 Marks)**
- **Q.** Give applications of AAS and AES. **(WINTER 2025, OR)**

7. Numerical Problems:

- **Q.** Calculate molar absorptivity of a solution containing 2.5×10^{-5} M of a substance if in a 2 cm cell at 400 nm is 56%. [Data truncated in source – refer to the original question paper] **(SUMMER 2025, 1 Mark)**
- **Q.** Define the term (i) Wave number and (ii) Refractive Index. Calculate the energy of the photon of wavelength 600 nm. **(WINTER 2022, 3 Marks)**

Chapter 3: Turbidimetry and Nephelometry

Repeated Questions:

1. Visual and Instrumental Methods of Turbidity Measurement:

- **Q.** Differentiate between visual and instrumental method of turbidity measurement. **(WINTER 2022, 7 Marks; SUMMER 2024; SUMMER 2026)**
- **Q.** Explain measurement of turbidity by instrumental method / nephelometer / Nephelo turbidity meter with neat sketch. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks OR; SUMMER 2023, 7 Marks; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks OR)**

2. Turbidimetry and Nephelometry:

- **Q.** Differentiate Turbidimetry and Nephelometry with proper diagrams. [Diagram required – refer to the original question paper] **(WINTER 2023, 7 Marks; WINTER 2025, OR)**

Other Important Questions:

1. Significance and Interferences:

- **Q.** Highlight the environmental significance of turbidity. **(SUMMER 2025, 3 Marks)**
- **Q.** Explain the interferences involved with analysis of turbidity. How to eliminate them? **(WINTER 2024, 3 Marks OR)**

2. Visual Method:

- **Q.** Explain measurement of turbidity by visual method with neat sketch of the instrument. [Diagram required – refer to the original question paper] **(SUMMER 2025, 3 Marks OR)**

Chapter 4: Chromatography

Repeated Questions:

1. Classification and Chromatographic Parameters:

- **Q.** Classification of chromatography / modern classification with examples. **(SUMMER 2022, 3 Marks; SUMMER 2024; WINTER 2025, 4 Marks)**
- **Q.** Chromatographic parameters: retention time, retention volume, capacity factor, resolution, peak asymmetry, mobile phase, elution, stationary phase, eluent, eluate, distribution coefficient. **(SUMMER 2022, 3 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 7 Marks OR; SUMMER 2025, 4 Marks; SUMMER 2025, 4 Marks OR; WINTER 2025, 3 Marks; SUMMER 2026, 4 Marks OR)**

2. High Performance Liquid Chromatography (HPLC):

- **Q.** Explain principle/instrumentation/working of HPLC with neat diagram/sketch/components/applications. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; WINTER 2022, 7 Marks; SUMMER 2023, 3 Marks; SUMMER 2023, 4 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 4 Marks; SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 4 Marks; SUMMER 2026, 7 Marks OR)**

3. Gas Chromatography (GC):

- **Q.** Explain working/principle/components/applications/columns/sampling/merits/demerits of Gas Chromatography. **(SUMMER 2022, 7 Marks; WINTER 2022, 4 Marks; SUMMER 2023, 3 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 3 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks OR; SUMMER 2025, 7 Marks; SUMMER 2026; SUMMER 2026, 7 Marks)**

4. Ion Chromatography and Ion Exchange:

- **Q.** Ion Chromatography: principle/working/application. **(SUMMER 2022, 7 Marks OR; WINTER 2022, 3 Marks OR; SUMMER 2023, 4 Marks)**
- **Q.** Factors affecting chromatographic separation / ion exchange chromatography. **(SUMMER 2022, 4 Marks OR; SUMMER 2026, 3 Marks)**

5. Detectors in Chromatography:

- **Q.** Types of detectors used in chromatography / table of chromatography types, detectors and applications. [Diagram required – refer to the original question paper] **(WINTER 2023, 3 Marks OR; WINTER 2024, 4 Marks OR; WINTER 2025, 7 Marks; SUMMER 2026, 4 Marks)**

Other Important Questions:

1. Principles and Types of Chromatography:

- **Q.** Which principle is involved in Normal Phase and Reverse Phase chromatography? **(SUMMER 2022, 7 Marks)**
- **Q.** Give the difference between adsorption and partition chromatography. **(WINTER 2022, 4 Marks OR)**
- **Q.** Discuss the principle of Column Chromatography in detail. **(SUMMER 2023, 4 Marks)**
- **Q.** Discuss the types of columns used in Chromatography. **(WINTER 2025, 3 Marks OR)**
- **Q.** What is chromatogram? Explain its interpretation. **(WINTER 2024, 3 Marks OR)**
- **Q.** Give significance of chromatographic analysis in environmental field. **(SUMMER 2022, 3 Marks OR)**

2. HPLC:

- **Q.** Differentiate between isocratic and gradient elution technique. **(SUMMER 2022, 3 Marks)**
- **Q.** Differentiate between HPLC and LC. **(SUMMER 2022, 4 Marks)**

- **Q.** Enlist the types of detectors used in high performance liquid chromatography and explain principle of each with neat sketch. [Diagram required – refer to the original question paper] **(WINTER 2024, 7 Marks)**

3. Ion Exchange Chromatography:

- **Q.** Give brief account on resins used in ion exchange chromatography. **(SUMMER 2022, 4 Marks OR)**
- **Q.** Explain the principle of ion-exchange chromatography. **(WINTER 2025, 3 Marks)**

4. Gas Chromatography (GC):

- **Q.** Discuss the application of Gas Chromatography in environmental engineering field. **(SUMMER 2025, 4 Marks OR)**
- **Q.** Which types of columns are used in gas chromatography? Explain them with applications. **(SUMMER 2026, 7 Marks)**

Chapter 5: Miscellaneous Methods

Repeated Questions:

1. Dissolved Oxygen (DO) Measurement:

- **Q.** Explain in detail sensor method for determination of dissolved oxygen / DO probe / DO electrode. **(SUMMER 2022, 3 Marks; WINTER 2022, 7 Marks OR; WINTER 2023, 7 Marks; WINTER 2025, 7 Marks OR; SUMMER 2026, OR)**
- **Q.** Give significance of DO in environment. **(WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks OR)**

2. TOC Analyzer:

- **Q.** TOC analyzer: applications/significance/classification/oxidation methods/measurement. **(SUMMER 2022, 3 Marks OR; WINTER 2022, 3 Marks OR; WINTER 2022, 4 Marks; SUMMER 2023, 7 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 3 Marks OR; SUMMER 2026, OR)**

3. pH Meter:

- **Q.** pH meter / pH electrode: working principle/components/applications. **(WINTER 2022, 7 Marks; SUMMER 2023, 7 Marks; SUMMER 2024; SUMMER 2025, 4 Marks; SUMMER 2026, OR)**

4. Ion Selective Electrode (ISE):

- **Q.** Ion Selective Electrode (ISE): applications/principle/types/components/advantages/disadvantages. **(SUMMER 2022, 3 Marks OR; WINTER 2022, 3 Marks OR; SUMMER 2023, 3 Marks OR; WINTER 2023, 7 Marks OR; SUMMER 2024, 7 Marks OR; WINTER 2024, 4 Marks OR; WINTER 2025, 7 Marks; SUMMER 2026, OR)**

5. Conductivity Meter:

- **Q.** Conductivity/conductance/resistance/cell constant/conductivity meter. **(WINTER 2022, 7 Marks OR; WINTER 2022, 4 Marks OR; WINTER 2023, 3 Marks; SUMMER 2025, 3 Marks; SUMMER 2025, 3 Marks OR; WINTER 2025, 4 Marks; SUMMER 2026, 7 Marks)**

6. Potentiometry, Polarography and Reference Electrodes:

- **Q.** Potentiometry/Polarography: definition/applications/advantages. **(WINTER 2022, 3 Marks; SUMMER 2023, 3 Marks; SUMMER 2023, 7 Marks OR; WINTER 2023, 4 Marks OR; WINTER 2024, 3 Marks)**
- **Q.** Standard Hydrogen Electrode (SHE) with neat sketch. [Diagram required – refer to the original question paper] **(WINTER 2023, 4 Marks; WINTER 2025, OR)**

7. Online Sensors:

- **Q.** Online sensors: types and explanation. **(SUMMER 2024, 3 Marks OR; WINTER 2024; SUMMER 2026)**

Other Important Questions:

1. Dissolved Oxygen (DO):

- **Q.** Give significance of DO in environment and explain in details of DO probe (electrode). **(SUMMER 2022, 7 Marks OR)**
- **Q.** Explain the online DO meter with neat sketch. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks OR)**

2. TDS, Conductivity and Water Quality Parameters:

- **Q.** Explain how TDS and conductivity are related to each other? **(WINTER 2024, 4 Marks)**
- **Q.** Differentiate between BOD, COD, TOC. **(WINTER 2024, 7 Marks)**

3. Continuous Monitoring Systems:

- **Q.** Discuss Continuous Effluent Monitoring system in detail. **(SUMMER 2025, 7 Marks)**
- **Q.** Discuss Continuous Emission Monitoring system in detail. **(SUMMER 2025, 7 Marks OR)**

Chapter 6: Errors and Treatment of Statistical Data

Repeated Questions:

1. Statistical Treatment of Data:

- **Q.** Explain statistical techniques to treat data with random errors. **(WINTER 2024, 4 Marks; SUMMER 2025, 3 Marks)**

2. Accuracy and Precision:

- **Q.** Accuracy and Precision: explain/differentiate with examples. **(WINTER 2022, 3 Marks; SUMMER 2023, 4 Marks; SUMMER 2024, 4 Marks OR)**

3. Types of Errors:

- **Q.** Types of errors with at least one example of each / determinate and indeterminate errors / constant and proportional error. **(SUMMER 2022, 7 Marks; WINTER 2022, 4 Marks; SUMMER 2023, 4 Marks OR; SUMMER 2024, 7 Marks OR; WINTER 2024, 4 Marks OR; SUMMER 2025, 3 Marks OR; WINTER 2025, OR)**

Other Important Questions:

1. Statistical Terms and Definitions:

- **Q.** Explain the term with examples (i) Standard Deviation (ii) Relative Deviation. **(SUMMER 2022)**
- **Q.** Define the following terms in detail: (i) Mean (ii) Median (iii) Range (iv) Average Deviation (v) Relative average deviation (vi) Standard deviation (vii) Co-efficient of variation. **(SUMMER 2024)**
- **Q.** Define: Variance, standard deviation & mean. **(SUMMER 2023, 4 Marks OR)**
- **Q.** Define: (I) Standard deviation (II) Co-efficient of Variation (III) True Value. **(WINTER 2025, OR)**
- **Q.** Write down the expressions to find: Average deviation, relative average deviation, standard deviation, coefficient of variance, variance and Students' T. **(SUMMER 2026)**

2. Comparison and Importance of Statistical Analysis:

- **Q.** Discuss about methods for comparing results. **(SUMMER 2022, 4 Marks OR)**
- **Q.** Write a short note on importance of statistical analysis of laboratory data. **(WINTER 2022, 7 Marks)**

3. Numerical Problems:

- **Q.** Find the variance for the following data: 57, 64, 43, 67, 49, 59, 44, 47, 61, 59. **(WINTER 2024)**
- **Q.** Find the absolute and relative errors. The actual value is 135.68 mm and the measured value is 129.66 mm. **(WINTER 2024, 3 Marks OR)**

Uncategorised Questions / Missing or Illegible Texts

Question text is missing or illegible in the source for the entries below; marks and papers are as shown in the source.

- **Q.** [Question text missing/illegible in source – refer to the original question paper] **(SUMMER 2024, 3 Marks OR)**
- **Q.** [Question text missing/illegible in source – refer to the original question paper] **(WINTER 2025, 3 Marks)**
- **Q.** [Question text missing/illegible in source – refer to the original question paper] **(WINTER 2023)**
- **Q.** [Question text missing/illegible in source – refer to the original question paper] **(SUMMER 2026, OR)**

****