

ANALYTICAL INSTRUMENTATION
(AEIE 4241)

Time Allotted : 3 hrs

Full Marks : 70

*Figures out of the right margin indicate full marks.**Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.**Candidates are required to give answer in their own words as far as practicable.***Group – A**
(Multiple Choice Type Questions)1. Choose the correct alternative for the following: **10 × 1 = 10**

- (i) If I_0 & I indicate the intensities of incident and emitted light by a sample respectively, then the absorbance A is expressed as,
 (a) $A = I_0 / I$ (b) $A = I / I_0$
 (c) $A = \log_{10}(I_0 / I)$ (d) $A = \log_{10}(I / I_0)$.
- (ii) When electron transition takes place from excited triplet state to the lower energy singlet state, the phenomena is known as
 (a) phosphorescence (b) fluorescence
 (c) resonant fluorescence (d) all of these may happen.
- (iii) In atomic absorption spectroscopy the commonly used radiation source is
 (a) hydrogen lamp (b) xenon- arc lamp
 (c) tungsten-filament lamp (d) hollow cathode lamp.
- (iv) Aerosol is formed by
 (a) scintillation counter (b) bolometer
 (c) nebulizer (d) graphite furnace.
- (v) In chromatography, the ratio of the concentration of the species in the stationary phase to the concentration of the species in the mobile phase is the
 (a) capacity factor (b) partition coefficient
 (c) selectivity factor (d) retention volume.
- (vi) pH value of milk is
 (a) 4 (b) 7 (c) 5 (d) 6.
- (vii) The lamp which emits radiation in visible range is
 (a) hollow cathode lamp (b) tungsten-filament lamp
 (c) plasma excitation source (d) electrodeless discharge lamp.

- (viii) Katharometer cell is used to measure
 (a) pH of liquid (b) conductivity of liquid
 (c) thermal conductivity of gas (d) potential difference.
- (ix) X-ray diffraction grating type monochromator obeys the law of
 (a) Beer's (b) Bragg's
 (c) Lambert's (d) Nernst's.
- (x) By heat reaction method gas can be estimated upto
 (a) 0.01% (b) 0.001% (c) 1% (d) 0.1%.

Group – B

2. (a) What is Curie-Weiss law for magnetic susceptibility? How is this law applied to determine the concentration of oxygen in a thermomagnetic type oxygen analyzer?
 (b) Explain the working principle of Zirconia cell type oxygen analyzer.
(2 + 6) + 4 = 12
3. (a) What is thermal conductivity? Deduce the expression for sensitivity of thermal conductivity gas analyzer.
 (b) Describe the construction and working of Katharometer cells.
 (c) How the concentration of known component gas of binary mixture be found using thermal conductivity type gas analyzer.
(2 + 2) + 4 + 4 = 12

Group – C

4. (a) What do you mean by pH? Explain the working of Calomel reference electrode in the process of pH measurement?
 (b) Explain the significance of Polarograph. With schematic diagram describe the construction and working of dropping mercury electrode (DME)?
5 + (2 + 5) = 12
5. (a) Describe the electrode less conductivity cell construction.
 (b) What is Half cell Potential? Describe about the reference electrode. Differentiate between metal and membrane electrode. Describe membrane electrode operation.
3 + (1 + 3 + 2 + 3) = 12

Group – D

6. (a) State and derive Lambert-Beer's law of absorption of electromagnetic radiation.
- (b) With a neat diagram explain the operation of a dual beam type spectrophotometer for the analysis of liquid sample concentration.

(2 + 6) + 4 = 12

7. (a) Show the arrangement for inductively coupled plasma excitation source used in atomic spectroscopy and explain the operation of it.
- (b) Derive Bragg's law of X-ray diffraction. What is the basic principle of a mass spectrometer? Mention some application fields of it.

4 + (5 + 3) = 12

Group – E

8. (a) What are retention time, dead time and capacity factor in chromatography?
- (b) How the efficiency of a chromatographic column can be increased? What is resolution of a chromatographic column?
- (c) On a 122 cm chromatography column, the retention times for the mobile phase, Heptane and Octane were 0.9 min, 1.22 min and 1.43 min respectively. The base widths of the bands in the chromatogram were 0.14 min for Heptane and 0.20 min for Octane. Find out the selectivity factor and resolution of the column for the Heptane/Octane band.

5 + 2 + 5 = 12

9. (a) Briefly explain the principle of absorption type and partition type liquid chromatography. What is AFM in microscopic technique?
- (b) Draw the scheme of high pressure liquid chromatography (HPLC). Which types of pumps are used in HPLC?

(5 + 3) + (2 + 2) = 12