*Name* : .....

*Roll No.* : .....

*Invigilator's Signature* : .....

**CS/M.Tech(AEIE)/SEM-2/EIEM-201/2013**

# 2013
# INSTRUMENTAL METHODS AND ANALYSIS

*Time Allotted* : 3 Hours *Full Marks* : 70

*The figures in the margin indicate full marks.*
*Candidates are required to give their answers in their own words as far as practicable.*

Answer any five questions.

1. a) Define spectroscopy.

   b) Briefly describe the objectives of sample handling system.

   c) Describe a suitable method for measurement of $CO_2$ in air. 2 + 5 + 7

2. a) Why is it required to combine a standard electrode with half-cell for measurement in an electrochemical cell ?

   b) Derive Nernst equation for an electrochemical cell.

c) Calculate $E_{cell}$ for a galvanic cell based on the following half-reactions at 25°C :

$FeO_4^{2-} + 8H^+ + 3e^- = Fe^{3+} + 4H_2O$ $\quad E^\circ = +2\cdot20\,V$

$O_2 + 4H^+ + 4e^- = 2H_2O$ $\quad E^\circ = +1\cdot23\,V$

Where

$[FeO_4^{2-}] = 2\cdot0 \times 10^{-3}\,M$ $\quad pH = 5\cdot2$

$[Fe^{3+}] = 1\cdot0 \times 10^{-3}\,M$ $\quad [O_2] = 1\cdot0 \times 10^{-5}$

4 + 4 + 6

3. a) Derive Beer-Lambert law and establish relation between Absorbence and Transmittance.

b) If the molar absorptivity for iron (II)-1, 10-phenanthroline complex is 12000 litre/mol/cm and the minimum detectable absorbence is 0·001 for a 1·00 cm path length, then find the minimum detectable molar concentration.

c) Describe a dual beam dual detector type UV analyzer.

5 + 3 + 6

4. a) Describe the principle of operation of an Infra-red absorption type analyzer.

b) Write the differences between IR and UV analyzers.

c) Write the uses of UV analyzer. 8 + 4 + 2

5. a) Write the main functions of mass spectroscopy.

   b) Describe the princip0le of operation of a magnetic deflection type mass spectrometer.

   c) Establish the relation between time and mass to charge ratio for a Time of Flight type Mass Spectrometer.

   2 + 8 + 4

6. a) How are *X*-rays obtained in different ways ?

   b) Draw a schematic of an *X*-ray tube and describe it.

   c) Explain how *K*α and *K*β lines arise in *X*-ray spectroscopy.

   d) Write the conditions of *X*-ray diffraction and establish Bragg's law.

   e) Calculate the short wavelength limit for an *X*-ray tube operated at 50 kV. 2 + 4 + 3 + 3 + 2

7. a) Describe the construction of a hollow cathode lamp. What are the advantages/disadvantages of a multi-element lamp ?

   b) Describe a double-beam atomic absorption spectrophotometer.

   Between the choice of a single beam and a double beam atomic absorption spectrophotometers, give reasons for opting for the latter. 7 + 7

8. a) Explain with a diagram how a mixture of two compounds is separated by column elution chromatography.

   b) Define partition coefficient and retention time.

   c) Draw a schematic of an apparatus of HPLC and explain its operation. 5 + 3 + 6