

B.E. (Inst. & Electronics Engg.) 3rd Examination 2019
2nd Semester

Subject: Analytical Instrumentation

Time: Three Hours

Full Marks: 100

Group A

Answer any five questions

1. What is band broadening in a gas chromatograph? What are the measures taken to reduce it? Why particle size of the support material is crucial for efficient separation of the components in a gas mixture? 1+2+2
2. How do the following open tubular columns differ? Give a comparative chart. 5
a) WCOT, b) PLOT, c) SCOT
3. How is the efficiency of a chromatographic column expressed? Explain with plate theory. 5
4. With a diagram, explain the principle of operation of a flame ionization detector. Compare the advantages and disadvantages with a thermal conductivity detector. 4+1
5. Draw the block diagram of a mass spectrometer. Describe the principle of operation of discrete type electron multiplier for use as the detector in a mass spectrometer. 2+3
6. Explain the principle of operation of a quadrupole type mass analyzer? 5

Group B

Answer any five questions

7. In ethanol, acetone has a molar absorptivity of $2.75 \times 10^3 \text{ Lcm}^{-1}\text{mol}^{-1}$ at 366 nm. What range of concentrations could be determined if the percent transmittances of the solutions are to be limited to a range of 10% to 90%, and a 1.25 cm cell is to be used? 5
8. Convert 700 nm to wavenumber. Name two radiation sources for the IR region and discuss their features. 1+2+2
9. Explain the principle of operation of a photomultiplier tube. 5
10. Discuss briefly the theory of Raman spectroscopy. 5
11. With a diagram, discuss in short the principle of operation of a FTIR spectrometer. 5
12. For a dispersive type grating, how many lines per millimeter would be required in order for the first-order diffraction line at $\lambda = 615 \text{ nm}$ to be observed at a reflection angle of -15° when the angle of incidence is 45° ?

Group C

Answer any five questions

13. Explain with a diagram the working principle of an electrochemical cell. Write the schematic representation. 5
14. What is liquid junction potential and what is the function of a salt bridge? Mention the difference between activity and concentration. 1+2+2

15. Describe the commonly used reference electrodes used in electrochemical analysis. 4
16. Write down the Nernst equation and explain the different terms. Why dissolved oxygen in water is required to be measured in process plants and how is it measured? 2+3
17. Briefly explain the construction and working principle of a combination type pH meter. What is the composition of glass in the glass electrode? 4+1
18. Mention one application where oxygen analysers are used. Briefly describe the zirconia oxygen analyser. 1+4

Group D

Answer any five questions

19. Write down the Hagen Poiseuille equation for the pressure drop of a fluid in a capillary and explain the terms. Define the following terms and mention the units:
- i) absolute viscosity
 - ii) kinematic viscosity 2+3
20. With a diagram, briefly explain the principle of operation of a continuous type NMR spectrometer. What is the difference in the 'FT' version? 4+1
21. What is screening constant in NMR? How chemical shift data from NMR spectrometer is useful to the chemists for obtaining chemical structure of compounds? 4+1
22. What is cell constant in a conductivity meter? Explain the working principle of an electrodeless conductivity meter. 1+4
23. Explain with a diagram the arrangement of a dual beam type turbidity meter. 5
24. What is relative humidity? Discuss any one method for the measurement of relative humidity. 1+4