

B.E. (Inst. & Electronics Engg.) 3rd Year Examination 2025
1st Semester

Subject: Analytical Instrumentation

Time: Three Hours

Full Marks: 100

Group A

Answer any five questions

1. What are the roles of stationary phase, mobile phase and support material in the column of a gas chromatograph? 5
2. How is the efficiency of a chromatographic column expressed? Explain with plate theory and obtain the expression for the number of plates and height equivalent of theoretical plate. 5
3. A substance is found to have the retention time 18.60 min on a 30.0 cm column. An unretained species passes through the column in 1.30 min. The peak width at the base is 1.02 min. Find the number of plates in the column. 5
4. a) Describe the electron detector in a mass spectrometer. 2
 b) Calculate the resolution of a mass spectrometer required to resolve peaks for the two molecules with Mol. Wt. 27.1432 and 27.14347. 3
5. Describe briefly the operation of a quadrupole mass analyzer. 5
6. Explain with a diagram the operation of a flame ionization detector. 5

Group B

Answer any five questions

7. A solution that is 3.27×10^{-3} M in X had a transmittance of 0.134 when measured in a 2.00 cm. cell. What concentration of X would be required for the transmittance to be increased by a factor of 3 when a 1.00 cm. cell was used? 5
8. What is the difference between a continuous and line source used in a spectrophotometer? Explain the principle of operation of a hollow cathode lamp. 1+4
9. Explain the principle of operation of Nerst Glower and Globar Source. $2\frac{1}{2} \times 2$
10. Discuss the principle of operation of a flame atomizer used in atomic spectroscopy. 5
11. Discuss briefly the principle of operation of 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 $\lambda = 625$ nm to be observed at a reflection angle of -30° 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. 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

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15. Describe the commonly used reference electrodes used in electrochemical analysis. 4
16. Write down the Nernst equation and explain the different terms. Mention the features and differences between potentiometry, voltametry and amperometry. 2+3
17. Briefly explain the construction and working principle of a combination type pH meter. What is the composition of the 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. Define the following terms and mention the units: 2+2+1
 - i) absolute viscosity
 - ii) apparent viscosity
 - iii) kinematic viscosity
20. With a diagram, explain the principle of operation of capillary tube viscosity meter. 5
21. What is cell constant in a conductivity meter? Explain the working principle of an electrodeless conductivity meter. 1+4
22. Explain with a diagram the arrangement of a dual beam type turbidity meter. 5
23. How chemical shift data from NMR spectrometer is useful to the chemists for obtaining chemical structure of compounds? 5
24. What is relative humidity? Discuss a scheme of measurement of dew point. 1+4