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Third Semester B.E. Degree Examination, Dec.2023/Jan.2024

Unit Operations

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Define Fluid. Explain the different types of fluids with the help of plots of shear stress – strain behaviour of fluids. (10 Marks)
- b. State and derive Bernoulli's equation. (10 Marks)

OR

- 2 a. With a neat sketch, explain Reynolds experiment. (10 Marks)
- b. Water flows through a pipe AB of 1.2m diameter at 3m/s and then passes through a pipe BC of 1.5m diameter. At C the pipe branches into CD and CE. The branch CD has a diameter of 0.8m and carries $\frac{1}{3}^{\text{rd}}$ of flow in AB. The velocity in branch CE is 2.5m/s. Find the discharge in AB, Velocity in BC, Velocity in CD and the diameter of CE. (10 Marks)

Module-2

- 3 a. With a neat sketch, explain the working of reciprocating pump. (10 Marks)
- b. Derive the discharge equation for venturimeter. (10 Marks)

OR

- 4 a. With a neat sketch, explain the working of Rotary drum filtration. (08 Marks)
- b. Define the different Crushing laws. (06 Marks)
- c. With a neat sketch, explain the working of ball mill. (06 Marks)

Module-3

- 5 a. Derive an expression for steady state heat conduction through composite wall. (10 Marks)
- b. A 300mm OD pipe is covered with 2 layers of insulation ($K_1 = 0.105$ and $K_2 = 0.07$ W/mK). The better insulating material is on the outside and has 40mm thickness. The other insulating material has 50mm thickness. The inner and outer surface temperature of the insulation are 623K and 323K. Estimate i) Heat loss per meter length ii) Heat loss per m^2 of the outer insulation surface iii) Temperature of the surface between the layers. (10 Marks)

OR

- 6 a. With a neat sketch, explain the construction of 1 – 2 shell and tube heat exchanger. (10 Marks)
- b. Write a note on the following : (10 Marks)
 - i) Drop wise condensation
 - ii) Film wise condensation
 - iii) Fouling factor
 - iv) Critical thickness of insulation.

Module-4

- 7 a. Derive an expression for steady state diffusion of A through non diffusing B. (10 Marks)
 - b. In an $\text{O}_2 - \text{N}_2$ gas mixture at 101.325 KPa and 298K, the concentrations of O_2 at 2 faces, 2mm apart are 10% and 20% (by volume) respectively. Calculate the rate of diffusion of O_2 for i) When N_2 is non diffusing ii) Equimolar counter diffusion of 2 gases. (10 Marks)
- Data : $D_{AB} = 1.81 \times 10^{-5} \text{ m}^2/\text{S}$.

OR

- 8 a. With a neat sketch, explain how do you measure the diffusivity. (10 Marks)
b. Write a note on the following :
i) Mass transfer coefficient ii) Types of diffusion. (10 Marks)

Module-5

- 9 a. With a neat sketch, explain the working of Tray Dryer. (10 Marks)
b. A liquid mixture has a relative volatility of $(\alpha) = 2.5$. Compute Vapor Liquid Equilibrium data (VLE) for the liquid mixture. The above mentioned liquid mixture is to be fed to the distillation column for separation. Feed is a liquid at its bubble point with 50 mol % more volatile component. The product contains 95 mol% more volatile component and the residue contains 10 mol %. More volatile component reflux $R = 2.5$. Calculate the number of theoretical plates required and also the position of feed plate using McCabe Thick method. (10 Marks)

OR

- 10 a. Explain the factors to be considered for the selection of solvent used in extraction process. (10 Marks)
b. With a neat sketch, explain the working of Flash distillation. (10 Marks)

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