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18BT33

Third Semester B.E. Degree Examination, Feb./Mar. 2022

**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. Explain in brief Reynolds Experiment, with a neat sketch. (10 Marks)  
b. State and prove Pascal's law. (10 Marks)

OR

- 2 a. A lubricating oil flows in a 10cm diameter pipe at  $1\text{ms}^{-1}$ . Determine whether the flow of oil is laminar as turbulent. For lubricating oil,  $\mu = 0.1\text{Ns/m}^2$  and density is  $930\text{kg/m}^3$ . Also calculate the transition and turbulent velocities. (08 Marks)  
b. Briefly explain Cyclones with a neat diagram. (12 Marks)

**Module-2**

- 3 a. With a neat sketch, derive an expression for coefficient of discharge of Venturimeter. (10 Marks)  
b. Explain the Construction principle and working of Centrifugal pumps. (10 Marks)

OR

- 4 a. Water is flowing at a rate of  $500\text{cm}^3/\text{s}$  through an orifice of 25mm diameter installed in a 75mm diameter pipe. What will be the difference in the level on mercury manometer connected across the meter? The coefficient of orifice meter is 0.65. (10 Marks)  
b. Derive an expression for the critical speed of a ball mill. (10 Marks)

**Module-3**

- 5 a. Derive an expression for heat conduction through a composite wall. (10 Marks)  
b. Derive an expression for logarithmic mean temperature difference for a heat exchangers. (10 Marks)

OR

- 6 a. Discuss in detail about shell and tube heat exchanger. (10 Marks)  
b. Derive an expression for heat transfer through a thick walled hollow cylinder if inside radius  $r_1$  and outside radius  $r_2$  and length L with a thermal conductivity K. (10 Marks)

**Module-4**

- 7 a. What is Diffusion? Give the statement and mathematical expression for Fick's law explaining each term. (08 Marks)  
b. Show that for equimolar counter diffusion  $D_{AB} = D_{BA}$ . (12 Marks)

OR

- 8 a. What is Diffusivity? Show that  $N_A = J_A + X_A(N_A + N_B)$ . (08 Marks)  
b. In an oxygen nitrogen gas mixture of 101.3 KPa and 298K, the concentrations of oxygen at two phases 2mm apart are 10 and 20% by volume respectively. Calculate the flux of diffusion of oxygen for the cases, where i) Nitrogen is non-diffusing ii) There is equimolar counter diffusion of two gases.

Data : Diffusivity of  $\text{O}_2$  in  $\text{N}_2$  is  $1.81 \times 10^{-5}\text{m}^2/\text{s}$ . (12 Marks)

**Module-5**

- 9 a. Explain Boiling point diagram, with a neat sketch. (10 Marks)  
b. Briefly explain in detail about differential distillation. (10 Marks)

**OR**

- 10 a. The Picric acid is to be extracted with benzene as extraction solvent. Aqueous solution contains 0.2 mol of picric acid per liter. Calculate the quantity of benzene required to be contacted with 15 litres of aqueous solution in order to form a benzene solution containing 0.02 mol of picric acid per litre. Also calculate the percent extraction of picric acid.

Data :  $K = C_E / C_R = 0.505$ .

$C_E$  = Concentration of picric acid in benzene mol/ℓ.

$C_R$  – Concentration of picric acid in water, mol/ℓ.

(10 Marks)

- b. Define the following :

- i) Equilibrium moisture content.
- ii) Critical moisture content.
- iii) Dew point.
- iv) Absolute humidity.
- v) Constant rate period.

(10 Marks)

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