CBCS SCHEME

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18BT33

Third Semester B.E. Degree Examination, Jan./Feb. 2023
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 Pascal's law and derive an expression for the measurement of pressure at any point in a fluid at rest. **(12 Marks)**

b. Oil of specific gravity 0.75 is pumped from a tank over a hill through 0.6 m pipe with the pressure at the top of hill maintained at 1.75×10^5 N/m^2. Height of the hill is 80 m above the surface of oil in the tank and oil is pumped at the rate of 0.6 m^3/s. If the head loss from the tank to the summit is 5 m. What hp must the pump supply to the liquid? Pump is with an efficiency of 80 %. **(08 Marks)**

OR

2 a. Define Newton's law of viscosity and explain different types of fluids with examples. **(08 Marks)**

b. State and derive the Bernoulli's equation incorporating the correction for kinetic energy and friction factor. **(08 Marks)**

c. A pipe through which water is flowing is having diameters 20 cm and 10 cm at the cross section ① and ② respectively. The velocity of water at section ① is given as 4 m/s. Find the velocity heat at section ① and ②, also the rate of discharge. **(04 Marks)**

Module-2

3 a. With a neat sketch, explain the working of,
(i) Centrifugal pump and
(ii) Reciprocating pump. **(12 Marks)**

b. A horizontal venturimeter with the inlet diameter of 20 cm and the throat diameter 10 cm is used to measure the flow of oil of specific gravity 0.8. Discharge of oil through the venturimeter is 60 ℓ/s. Find the reading of oil mercury differential manometer. Take $C_V = 0.98$. **(08 Marks)**

OR

4 a. State and explain the differential laws of crushing. **(06 Marks)**

b. Calculate the operating speed of ball mill from the following :
Diameter of ball mill = 500 mm ; Diameter of ball = 40 mm
Operating speed is 50% of critical speed of mill. **(06 Marks)**

c. With a neat sketch explain the working of ball mill. **(08 Marks)**

Module-3

5 a. Derive an expression for the steady state heat conduction through a composite wall. **(08 Marks)**

b. Derive an expression for critical thickness of insulation for heat transfer through a solid cylinder. **(08 Marks)**

c. Calculate the rate of heat loss (Q) through a wall of red brick (K = 0.7 W/mK), 5 m in length, 4 m in height and 250 mm in thickness. If the wall surface are maintained at 373 K and 303 K respectively. **(04 Marks)**

OR

6 a. With a neat sketch, explain the construction and working of 1 – 1 type shell and tube heat exchanger. List all the parts. **(10 Marks)**

b. Crude oil flows at a rate of 1000 kg/h through inside pipe of DPHE and is heated from 303 K to 363 K Kerosene enter at 473 K and flows in annular space. If the temperature approach is 10 K, determine the area of heat transfer in co-current flow and also find the flow rate of kerosene. **(10 Marks)**

Module-4

7 a. Derive the expression for equimolar counter diffusion of gases A and B under steady state condition. **(12 Marks)**

b. In an O_2 - N_2 gas mixture at 101.3 KPa and 298 K, the concentrations of oxygen at two phases 2 mm apart are 10% and 20% by volume respectively. Calculate the flux of diffusion of oxygen for the following :

(i) Nitrogen is non-diffusing.

(ii) Equimolar counter diffusion of two gases.

Diffusivity of O_2 in N_2 is 1.81×10^{-5} m^2/s. **(08 Marks)**

OR

8 a. Explain the Dhitman's two film theory. **(08 Marks)**

b. Explain the measurement of diffusivity of A in B using Arnold's cell. **(08 Marks)**

c. Methane diffuses at steady state through the tube containing helium. At point ①, partial pressure of methane is 55 KPa and at point ② it is 15 KPa. Points ① and ② are 30 mm apart. Total pressure is 101.3 KPa and temperature is 298 K. Calculate the flux of methane at steady state for equimolar counter diffusion. Take $D_{AB} = 6.75 \times 10^{-5}$ m^2/s. **(04 Marks)**

Module-5

9 a. Explain the different types of distillation. **(06 Marks)**

b. Explain the factors considered for the selection of solvent used in extraction process. **(06 Marks)**

c. Calculate the equilibrium composition of liquid and vapour phases for a mixture of methyl alcohol and water at a temperature of 323 K and under a pressure of 40 KPa. Assume both liquid and vapour behave ideally.
Vapour pressure of methanol at 323 K is 53.32 KPa.
and Vapour pressure of water at 323 K is 12.33 KPa. **(08 Marks)**

OR

10 a. Explain the steps considered to determine the number of theoretical plates in distillation column by McCabe Thiele's method. **(10 Marks)**

b. Feed containing 40 mole% benzene and 60 mol% toluene is to be distilled in a fractionating column to get top product containing 90 mol% benzene and bottom product with 10 mol% benzene. Reflux ratio is 3 K mol / K mol of product. Feed is liquid at its bubble point. Find the number of theoretical plates needed.

x	0	0.1	0.2	0.3	0.4	0.5	0.8	0.9	1.0
y	0	0.21	0.375	0.5	0.6	0.7	0.9	0.95	1.0

(10 Marks)

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