U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2024 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 23BT4PCHMT / 22BT4PCHMT **Max Marks: 100**
Course: Heat and Mass Transfer

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

				CO	PO	Marks
			UNIT – I			
1	a)		Define Fourier's law of heat conduction. Derive the steady state equation for heat conduction through cylinder.	*CO2*	*PO1*	**10**
	b)		A furnace is constructed with 225 mm thick of fire brick, 120 mm of insulating brick and 225 mm of the building brick. The inside temperature is 1200 K and the outside temperature is 330 K. Find the heat loss per unit area and the temperature at the junction of the fire brick and insulating brick. Data : k for fire brick = 1.4 W/(m·K) k for insulating brick = 0.2 W/(m·K) k for building brick = 0.7 W/(m·K)	*CO*3	*PO2*	**10**
			OR			
2	a)		Define LMTD and explain the reason for which this concept is introduced in heat exchanger design.	*CO2*	*PO1*	**04**
	b)		Draw neat diagram of shell and tube heat exchanger. Name any 5 parts.	*CO* 2	*PO1*	**06**
	c)		A pipe 88 mm O.D. is insulated with a 50 mm thickness of an insulation having a mean thermal conductivity of 0.087 W/(m·K) and 30 mm thickness of an insulation, having mean thermal conductivity of 0.064 W/(m·K). If the temperature of the outer surface of the pipe is 623 K and the temperature of the outer surface of insulation is 313 K, calculate the heat loss per meter of pipe.	*CO*3	*PO2*	**10**
			UNIT - II			
3	a)		Discuss the operation and advantages of a multiple effect evaporator.	*CO* 2	*PO1*	**08**

	b)	An evaporator is operating at atmospheric pressure. It is desired to concentrate a feed from 5 % solute to 20 % solute (by weight) at a rate of 5000 kg/h. Dry saturated steam at a pressure corresponding to the saturation temperature of 399 K (126°C) is used. The feed is at 298 K (25°C) and the boiling point rise, i.e., (B.P.R.) is 5 K. The overall heat transfer coefficient is 2350 W/(m^2 ·K). Calculate the economy of the evaporator and the area of heat transfer to be provided. **Data:** Treating the solution as a pure water and neglecting the B.P.R., the latent heat of condensation of steam at 399 K is 2185 kJ/kg. Latent heat of the evaporation of water at 101.325 kPa and 373 K = 2257 kJ/kg. Specific heat of feed = 4.187 kJ/(kg·K).	***CO3***	***PO2***	**12**
		UNIT – III			
4	a)	Explain two film theory of mass transfer.	***CO1***	***PO1***	**04**
	b)	Derive the flux equation for steady state diffusion of A through nondiffusing/stagnant B.	***CO2***	***PO1***	**06**
	c)	In an oxygen-nitrogen gas mixture at 101.3 kPa and 298 K, the concentrations of oxygen at two planes 2 mm apart are 20 and 10% by volume respectively. Calculate the flux of diffusion of oxygen for the cases there is equimolar counter diffusion of the two gases. Diffusivity of O_2 in N_2 is 1.81×10^{-5} m^2/s.	***CO3***	***PO2***	**10**
		UNIT – IV			
5	a)	Explain simple distillation with a neat sketch.	***CO2***	***PO1***	**08**
	b)	A mixture of benzene and toluene containing 60 mole % benzene is to be separated to give a product of 95 mole % benzene and a bottom product containing 10 mole % benzene. The feed enters a column at its bubble point. It is proposed to operate the column with reflux ratio of 2.5. It is required to find the number of theoretical plates needed and the position of feed plate.	***CO3***	***PO2***	**12**

x	0	0.05	0.1	0.3	0.5	0.7	0.9	1
y	0	0.13	0.21	0.5	0.7	0.83	0.95	1

		OR				
6	a)	With neat sketch, explain aqueous two phase extraction. List the major applications in biotechnology.	***CO1***	***PO1***	**10**
	b)	A liquid mixture containing 40 mole % methanol and 60 mole % water is fed to a differential distillation at atmospheric pressure, with 60 mole % of the liquid is distilled. Find the composition of the composited distillate and the residue.	***CO3***	***PO2***	**10**

x	0.05	0.1	0.2	0.3	0.4	0.5
y	0.27	0.42	0.57	0.66	0.73	0.78

		UNIT – V				
7	a)	Elucidate the mechanism of crystallization. Why the solution need to supersaturate? Justify.	***CO1***	***PO1***	**08**
	b)	Tabulate the different types of adsorbents and their applications.	***CO1***	***PO1***	**06**
	c)	Define leaching. Explicate the leaching operation with an example.	***CO2***	***PO1***	**06**

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