U.S.N.										

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

Autonomous Institute Affiliated to VTU

December 2023 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 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.

		UNIT - I	CO	PO	Marks
1	a)	Explain the construction and working principle of kettle type shell and tube heat exchanger with a neat diagram.	CO1	PO1	**10**
	b)	A furnace is constructed with 230 mm thick of fire brick, 115 mm of insulating brick and then 230 mm of building brick. The inside temperature of the furnace is 1213 K and the outside temperature is 318 K. The thermal conductivities of fire brick, insulating brick and building brick are 6.047, 0.581 and 2.33 W/m K. Estimate the heat lost per unit area and the temperature at the interfaces.	CO3	PO2	**10**
		OR			
2	a)	Determine the heat transfer coefficient for fluid flowing through a tube having inside diameter 40mm at a rate of 5500 kg/h. Assume that the fluid is being heated. Data: Properties of fluid at mean bulk temperature: Viscosity of flowing fluid = 0.0004 N.s/m^2 Density of flowing fluid = 1.07 g/cm^3 Specific heat of flowing fluid = 2.72 kJ/kg K Thermal conductivity of flowing fluid = 0.256 W/m K Make use of Dittus-Boelter equation.	CO3	PO2	**10**
	b)	Derive the equation for log mean temperature difference for countercurrent flow in a heat exchanger.	CO2	PO1	**10**
		UNIT - II			
3	a)	Dry steam at 373 K condenses on the outside surface of a horizontal pipe of 25mm O.D. The pipe surface is maintained at 357 K by circulating water through it. Determine mean heat transfer coefficient, heat transfer per unit length of pipe and condensate rate per unit length of pipe. Properties of condensate at the film temperature of 350 K are: ρ = 974 kg/m^3, μ = 306 × 10^{-6} kg/ m.s, k = 0.668 W/m.K, λ = 2225 kJ/kg, Assume that condensate film is laminar.	CO2	PO1	**10**

<table>
<tr><td></td><td></td><td>b)</td><td>Describe the construction and working principle of horizontal tube evaporator. State its advantages and disadvantages.</td><td>CO2</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - III</td><td></td><td></td><td></td></tr>
<tr><td></td><td>4</td><td>a)</td><td>In an oxygen-nirogen gas mixture at 101.3 kPa and 298 K, the concentrations of oxygen at two planes 2mm apart are 20% and 10% 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 the two given gases. Diffusivity of oxygen in nitrogen is 1.81×10^{-5} m^2/s.</td><td>CO3</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Explicate the two-film theory for mass transfer with suitable diagram. Derive equation for overall mass transfer coefficient and explain controlling film concept.</td><td>CO2</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - IV</td><td></td><td></td><td></td></tr>
<tr><td></td><td>5</td><td>a)</td><td>Elucidate the triangular diagram for partially miscible solvent system taking suitable example for liquid – liquid extraction. Mention the factors for selection of extracting solvent.</td><td>CO2</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>The vapour-pressure of n-hexane (A) and n-octane (B) are given in the following table at 101.3 kPa pressure. Assume that Raoult's and Dalton's laws apply. Compute the vapour-liquid equilibrium compositions and construct a T-x-y plot for the system.
Data:
<table>
<tr><td>T, K</td><td>341.7</td><td>352.4</td><td>366.3</td><td>380.2</td><td>394.1</td><td>398.6</td></tr>
<tr><td>p^o_A, kPa</td><td>101.3</td><td>136.6</td><td>196.3</td><td>283.9</td><td>399.9</td><td>455.9</td></tr>
<tr><td>p^o_B, kPa</td><td>16.1</td><td>23.1</td><td>37.1</td><td>57.8</td><td>87.2</td><td>101.3</td></tr>
</table></td><td>CO3</td><td>PO2</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>6</td><td>a)</td><td>A feed of 60 mole% hexane and 40 mole% octane is fed to a pipe still through a pressure reducing valve into a flash disengaging chamber. The vapour and liquid leaving the chamber are assumed to be in equilibrium. If 50 mole% of feed is vaporized, find the equilibrium composition of the top and bottom products. Equilibrium data is given below:
<table>
<tr><td>x</td><td>1</td><td>0.69</td><td>0.4</td><td>0.192</td><td>0.045</td><td>0</td></tr>
<tr><td>y</td><td>1</td><td>0.932</td><td>0.78</td><td>0.538</td><td>0.1775</td><td>0</td></tr>
</table></td><td>CO3</td><td>PO 2</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Illustrate the working principle of simple distillation with a neat diagram. Derive Rayleigh's equation.</td><td>CO2</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>UNIT - V</td><td></td><td></td><td></td></tr>
<tr><td></td><td>7</td><td>a)</td><td>Differentiate physical adsorption from chemical adsorption. Describe in detail adsorption isotherms.</td><td>CO 1</td><td>PO1</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>Sketch and explain rate of drying curve. Discuss the process of nucleation and crystal growth in crystallization.</td><td>CO 1</td><td>P 1</td><td>10</td></tr>
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