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

**Autonomous Institute Affiliated to VTU**

## August 2024 Supplementary Examinations

**Programme: B.E.** **Semester: IV**
**Branch: Biotechnology** **Duration: 3 hrs.**
**Course Code: 19BT4DCUO2** **Max Marks: 100**
**Course: Unit Operations 2**

**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) | 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. | *CO* 3 | *PO2* | **10** |
| | b) | Derive the equation for Log mean temperature difference for countercurrent flow in a heat exchanger. | *CO* 2 | *PO1* | **10** |
| | | **OR** | | | |
| 2 | a) | Calculate the inside heat transfer coefficient for fluid flowing at a rate of 300 $cm^3/s$ through a 20mm inside diameter tube of heat exchanger.<br>Data: Viscosity of flowing fluid = 0.8 $Ns/m^2$<br>Density of flowing fluid = 1.1 $g/cm^3$<br>Specific heat of fluid = 1.26 kJ/ Kg K<br>Thermal conductivity of fluid = 0.384 W/m K<br>Viscosity at wall temperature = 1 N s/ $m^2$<br>Length of heat exchanger = 5 m | *CO* 3 | *PO2* | **10** |
| | b) | Explain the construction and working principle of double pipe heat exchanger with a neat diagram. | *CO* 2 | *PO1* | **10** |
| | | **UNIT-II** | | | |
| 3 | a) | Describe the construction and working principle of horizontal tube evaporator. State its advantages and disadvantages. | *CO* 2 | *PO1* | **10** |
| | b) | A vertical plate, 30 by 30 cm, is exposed to steam at atmospheric pressure. The plate is at 371 K. Calculate the mean heat transfer coefficient and the heat transfer rate and mass of steam condensed per hour. Properties of condensate at the film temperature are: $\rho$ = 960 $kg/m^3$, $\mu = 2.82 \times 10^{-4}$ kg/ m s, k = 0.68 W/m K, $\lambda$ = 2225 kJ/kg, Saturation temperature of steam = 373 K. Assume that condensate film is laminar. | *CO* 3 | *PO2* | **10** |
| | | **UNIT-III** | | | |
| 4 | a) | Hydrochloric acid (A) at 283 K diffuses through a thin film of water (B) 4 mm thick. The Concentration of A at location 1 on one boundary of the film is 12 weight % (density $\rho_1$ = 1060.7 $kg/m^3$) and on other boundary, at location 2, is 4 weight % (density $\rho_2$ = 1020.15 $kg/m^3$). The diffusivity of HCL in water is $2.5 \times 10^{-9}$ $m^2/s$. Calculate the flux of diffusion of A assuming water to be non-diffusing. | *CO* 3 | *PO2* | **10** |

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| | b) | Explicate the two-film theory for mass transfer with suitable diagram. Derive equation for overall mass transfer coefficient and explain controlling film concept. | ***CO*** 2 | ***PO1*** | **10** |
| | | **UNIT-IV** | | | |
| 5 | a) | 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.<br>Data:<br>T, K: 341.7, 352.4, 366.3, 380.2, 394.1, 398.6<br>$p^o_A$, kPa: 101.3, 136.6, 196.3, 283.9, 399.9, 455.9<br>$p^o_B$, kPa: 16.1, 23.1, 37.1, 57.8, 87.2, 101.3 | ***CO*** 3 | ***PO2*** | **10** |
| | b) | Illustrate the working principle of simple distillation with a neat diagram. Derive Rayleigh's equation. | ***CO*** 2 | ***PO1*** | **10** |
| | | **OR** | | | |
| 6 | a) | Derive the operating lines for rectifying and stripping sections for Fractional distillation with suitable diagrams. | ***CO*** 2 | ***PO1*** | **10** |
| | b) | How is supercritical fluid extraction different from aqueous two phase extraction? Describe protein purification by different types of ATPE. | ***CO*** 2 | ***PO1*** | **10** |
| | | **UNIT-V** | | | |
| 7 | a) | Discuss the process of nucleation and crystal growth in crystallization. What are the methods by which super-saturation can be obtained? | ***CO*** 2 | ***PO1*** | **10** |
| | b) | Differentiate Physical adsorption from Chemical adsorption. Describe in detail adsorption isotherms. | ***CO*** 1 | | **10** |

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