Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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IV SEMESTER B.TECH. (CHEMICAL ENGINEERING)
MAKE-UP SEMESTER EXAMINATIONS, JUNE 2019
SUBJECT: MASS TRANSFER-I [CHE 2203]
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

☑ Answer **ALL** the questions. ☑ Missing data may be suitably assumed.

1A.	Derive the expression to calculate flux for diffusion of A through Non-diffusing B.	**4**
1B.	Oxygen (A) is diffusing in a mixture of oxygen (A) –nitrogen (B) at 1 std atm, 298 K. Concentration of oxygen at planes 2 mm apart are 20 and 40 mole % respectively. Nitrogen is non-diffusing. Diffusivity of oxygen in nitrogen is $1.89*10^{-5}$ m^2/s. Calculate the flux of oxygen.	**3**
1C.	Explain film theory of interfacial mass transfer along with governing equations?	**3**
2A	With appropriate schematic sketch, material balance equations and graphical construction, explain how would you calculate the number of ideal stages in a multistage countercurrent operation when transfer occurs from E to R?	**3**
2B.	Derive the relation between overall mass transfer coefficient and local mass transfer coefficient $\frac{1}{K_y} = \frac{1}{k_y} + \frac{m}{k_x}$	**3**
2C.	Consider a system in which component A is being transferred from a gas phase to a liquid phase. The equilibrium relation is given by $y_A = 0.75 x_A$, x_A and y_A are the mole fractions of A in liquid phase and gas phase respectively. At one point on the equipment, the gas contains 20 mole % A and liquid 4 mole % A. Gas film mass transfer coefficient k_y at this point is 10 kmol/(hr.m^2.Δy_A) and 50% of the resistance in the gas film. Calculate (a) Find the overall mass transfer coefficient K_Y (b) Mass transfer flux , N_A (c) Interfacial concentration, x_{Ai} and y_{Ai}	**4**
3A.	Gas containing 2% by volume of benzene vapors enters the absorber column at the rate of 0.01075 kmol/s. 90% removal of benzene is required. The scrubbing wash oil is to enter at 26^0C, containing 0.005 mole fraction benzene.	**5**

	The equilibrium data for the system is given below: Moles of benzene/ mole of wash oil (X) — Moles of benzene/mole of dry gas (Y): 0 — 0 0.02 — $2.45*10^{-3}$ 0.04 — $4.83*10^{-3}$ 0.08 — $9.34*10^{-3}$ 0.12 — $13.57*10^{-3}$ 0.16 — $17.54*10^{-3}$ 0.2 — $21.27*10^{-3}$ Determine the number of theoretical stages required for 1.5 times the minimum ratio.	
3B.	Explain flooding and channeling operating difficulties in packed tower	**2**
3C.	Explain working principle of the sieve plate tower absorption column	**3**
4A.	Explain physical and chemical adsorption briefly	**4**
4B.	An aqueous solution containing a valuable solute is colored by small amounts of an impurity. Before crystallization, the impurity is to be removed by adsorption on a decolorizing activated carbon which adsorbs only insignificant amount of the principal solute. The equilibrium data is given below: Colour units/kg solution (Y): 8.6, 6.3, 4.3, 1.7, 0.7 Colour units/kg carbon (X): 1000, 825, 663, 395, 223 It is desired to reduce the colour to 5% of its original value of 10 units/kg of solution using activated carbon. Determine the amount of fresh carbon required per 1000 kg solution. Determine the minimum amount of fresh carbon required per 1000 kg of solution for (a) A single stage operation (b) A two stage cross current operation	**6**
5A.	Derive relation between gas phase humidity and wet bulb temperature. $\frac{(H-H_w)}{(T-T_w)} = -\frac{h_{coeff-gas}}{k_Y \lambda_S}$ Clearly state the assumptions and label the notations used.	**4**
5B.	An air-water vapour mixture at 1 atmosphere has a dry bulb temperature of 64.5^0C and wet bulb temperature of 31.1^0C. If Latent heat of vaporization is 579.4 kcal/kg, saturation humidity is 0.031 and psychrometric ratio is 0.225 kcal/(kg.K). Compute the air humidity.	**3**
5C.	Define absolute humidity and humid heat	**3**