Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, Dec 2022

Course: Mass Transfer-II | **Semester: V**

Program: B. Tech CERP | **Time 03 hrs.**

Course Code: CHCE-3029 | **Max. Marks: 100**

Instructions:

SECTION A (20 Marks)

S. No.		Marks	CO
Q.1	Explain the equilibrium in the gas-liquid system. Why lower temperature is preferred for gas absorption	**4**	**CO1**
Q.2	What are the important criteria for solvent selection in liquid-liquid extraction?	**4**	**CO1**
Q.3	Explain the process variables which affect the rate of mass transfer in "solid-liquid extraction" operation.	**4**	**CO1**
Q.4	Discuss the physical mechanism of drying.	**4**	**CO1**
Q.5	Describe the different types of adsorption isotherms observed for various adsorbent-adsorbate pairs.	**4**	**CO1**

SECTION B (40 Marks)

Q.1	A feed having 12 mol% solute is to be scrubbed at a rate of 7000 m^3/h (27°C; 1 atm) with a pure solvent. The target removal of the solute is 95 %. The flow rate of the solvent is 160 kmol/h. If the equilibrium relationship is $y = 0.5\,x$, Determine the number of ideal trays required (a) using Kremser equation	**10**	**CO2**
Q. 2	A stream of waste-water containing 4% benzoic acid is to be extracted with benzene at a rate of 2000 kg/h in order to remove 96% of the solute. If water and benzene are assumed to be mutually immiscible and the distribution coefficient at given temperature is $$K = {}^{w_w}/_{w_b} = 1.8$$ Determine the minimum rate of benzene required for countercurrent separation of the mixture and the number of stages required if 1.3 times the minimum solvent is used.	**10**	**CO2**
Q.3	In a laboratory test run, the rate of drying was found to be 5×10^{-4} kg/m^2.s when the moisture content reduced from 0.4 to 0.1. The critical moisture content of the material	**10**	**CO3**

	is 0.08 on a dry basis. A tray drier is used to dry 100 kg (dry basis) of the same material under identical conditions. The surface area of the material is 0.04 m^2/kg of the dry solid. Calculate the time required to reduce the moisture content of the solids from 0.3 to 0.2		
Q.4	Derive a general expression for Langmuir isotherm. Adsorption of a pure gas A (molecular weight = 65) on activated carbon follows the Langmuir isotherm. $$q = \frac{6.4\,p}{1 + 1.53\,p}; \qquad p \text{ in } kPa \text{ and } q \text{ in } mmol/g$$ Estimate the maximum quantity of gas (in kg adsorbate per kg carbon) that can be adsorbed.	**10**	**CO3**
Section C (40 Marks)			
Q. 1	Warm moist air (dry-bulb temperature = 85°C; wet-bulb temperature = 46°C) enters a tower at a rate of 5000 kg/h.m^2. It is to be cooled and dehumidified to a wet-bulb temperature of 31°C using water available at 26°C. The overall gas phase mass transfer coefficient is estimated to be 2300 kg/h.m^2. The water rate is 1.25 times the minimum. Calculate the height of the cooling tower.	**20**	**CO4**
Q. 2	Ammonia is to be scrubbed from an air stream before it can be discharged in the atmosphere in a small packed tower by contacting it with a solvent. The feed gas is 2 % ammonia by volume, and 96 % of it is to be absorbed. The total gas rate is 150 m^3/h at 25 °C and 1.1 bar absolute pressure. The liquid enters the column at a rate of 1.80 kmol/h. Determine the overall gas phase mass transfer units and packed height if the column is 1 ft in diameter. Given: the overall mass transfer coefficient, $K_G = 3.5 \times 10^{-4}\ kmol/(m^2)(s)(\Delta P, bar)$; The effective gas-liquid contact area = 102 m^2 per m^3 of packed volume; $k_y\bar{a} = 130 \frac{kmol}{(m)^3(h)(\Delta y)}$ Slope of the equilibrium line, m = 0.17	**20**	**CO4**