Name: Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, Dec 2020

Course: Mass Transfer-II **Semester: VI**
Program: B. Tech CERP **Time 03 hrs.**
Course Code: CHCE-3005 **Max. Marks: 100**

Instructions:

SECTION A (30 Marks)

S. No.		Marks	CO
Q.1	Which one of the following is the correct expression for overall gas-phase mass transfer coefficient? (a) $\frac{1}{K_y}=\frac{1}{k_y}+\frac{m}{k_x}$ (b) $\frac{1}{K_y}=\frac{m}{k_y}+\frac{1}{k_x}$ (c) $\frac{1}{K_y}=\frac{1}{m\,k_y}+\frac{1}{k_x}$ (d) $\frac{1}{K_y}=\frac{1}{k_y}+\frac{1}{m\,k_x}$	**5**	**CO1**
Q.2	What is the physical significance of the absorption factor A? (a) It is the ratio of liquid flow rate to gas flow rate. (b) It is the ratio of the slopes of the equilibrium line and the operating line. (c) It is the ratio of the individual gas-phase to liquid-phase mass transfer coefficients. (d) It is the fractional absorption of the feed gas.	**5**	**CO1**
Q.3	What are the different types of solid-liquid extraction systems? Explain with suitable examples.	**5**	**CO2**
Q.4	What should generally be the minimum fractional density difference between the lighter phase and heavier phase in order to ensure the smooth phase separation in liquid-liquid Extraction? (A) 20% (B) 10 % (C) 5 % (D) 1%	**5**	**CO2**
Q.5	In a cooling tower, T_{wi} = inlet water temperature, T_{wo} = outlet water temperature, T_{Gi}= inlet air temperature, T_{Go}= outlet air temperature and T_{as}= adiabatic saturation temperature of air. Then the 'approach' is (A) $T_{wo}-T_{wi}$ (B) $T_{wo}-T_{as}$ (C) $T_{as}-T_{Go}$ (D) $T_{wo}-T_{Gi}$	**5**	**CO4**

Q.6	Adsorption capacity of a regenerated bed compared to the fresh bed is generally (A) slightly less (B) slightly more (C) half of that of the fresh bed after the first generation (D) double of that of the fresh bed	**5**	**CO5**
SECTION B (50 Marks)			
Q. 1	It is required to design a packed tower to treat 1200 m^3/h of an air stream containing 10 mole % SO2 at 60°C and 1 atm total pressure. It is necessary to recover 95 % of the SO2 using fresh water as solvent. If the mole fraction of SO2 in exit water is 0.1195, estimate the flow rate of water in the packed column.	**10**	**CO1**
Q. 2	A cooling tower is required to cool warm water from 42°C to 29°C at a rate of 7000 kg/h. The inlet air has a dry-bulb temperature of 31°C and a wet bulb temperature of 22°C. The enthalpy of the inlet air is 64.3 kJ/kg dry air. Estimate the flow rate of the air if the enthalpy of exit air stream is (a) 180 kJ/kg (b) 200 kJ/kg	**10**	**CO4**
Q. 3	Explain a typical drying rate curve with a neat diagram.	**10**	**CO3**
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**	**CO5**
Q. 5	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**
Section C (20 Marks)			
Q. 1	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	**20**	**CO1**

	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		