Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, Dec 2021

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	Describe the gas absorption operation. Explain any two industrial examples.	**4**	**CO1**
Q.2	Discuss the important criteria for solvent selection in liquid-liquid extraction.	**4**	**CO1**
Q.3	Explain the different physico-chemical mechanism involved in solid-liquid extraction.	**4**	**CO1**
Q.4	Explain the working principle of cooling tower. How cooling tower operation is different from other mass transfer operation?	**4**	**CO1**
Q.5	Explain the difference between constant drying rate and falling drying rate with a neat diagram	**4**	**CO1**

SECTION B (40 Marks)

Q.1	Derive the expression to estimate the number of ideal stages in a multistage cross-flow liquid-liquid extraction unit.	**10**	**CO2**
Q. 2	Derive the expression for height of cooling tower operating in countercurrent manner.	**10**	**CO2**
Q.3	Calculate the total drying time to dry a wet solid on a tray dryer under cross-flow of hot air from 30 % initial moisture to 1 % final moisture. The solid loading is 35 kg dry solid per m^2 tray area. The constant drying rate is N_c = 4.5 kg/m^2. h. The critical moisture is 10 % and the equilibrium moisture is 0.2 %. The final rate may be considered linear in moisture content.	**10**	**CO3**
Q.4	Calculate the minimum quantity of clay adsorbent required to reduce the colour concentration of 50 units to 1 colour unit from one thousand kilograms of a waste oil. The adsorbent has an effective specific surface area of 25 m^2/kg, and the surface mass transfer coefficient (k_L) is 5.2×10^{-6} m/s (on the solid-phase concentration basis). The density of oil is 950 kg/m^3. The equilibrium relationship is $Y = 4.2 \times 10^{-4} X^*$, where Y is number of 'colour units' per kg oil and X is number of 'colour units' per kg clay in equilibrium.	**10**	**CO3**

Section C (40 Marks)			
Q. 1	A cooling tower is to be designed to cool water from 45 ºC to 30 ºC by countercurrent contact with air of dry-bulb temperature 30 ºC and wet bulb temperature of 25 ºC. The water rate is 5500 kg/h. m^2 and the air rate is 1.25 times the minimum. Determine the tower height if overall transfer coefficient mass transfer coefficient is $K_{Y'}\bar{a} = 2500\ {kg}/_{h.m^3}$. Comment on the expected outlet water temperature from the tower in winter when the dry-bulb temperature is 20 ºC and wet-bulb temperature drops down to 15 ºC, the other parameters remaining unchanged.	**20**	**CO4**
Q. 2	A solute is removed from a gas stream by using an existing absorption tower filled to 8.6 m by IMTP. The tower diameter is considered suitable for the required service, but the water rate has to be calculated. The feed gas has 3.5 mol% of the solute and the exit gas may have 0.05 mole% of it. The solubility of the solute is given by Henry's law: $y = 2.53x$. Following data are available: superficial gas velocity at the top of the column = 0.8 m/s; total pressure = 1 atm; temperature = 26ºC; overall gas-phase mass transfer coefficient, $k_G \bar{a} = 7050 kg/(h)(m^3)(\Delta p, bar)$; molecular weight of the solute = 30. Determine the liquid flow rate and HETP of the packing	**20**	**CO4**