Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, April/May 2018

Course: Mass Transfer -II | **Semester: VI**
Program: B.Tech, CE+RP | **Max. Marks: 100**
No. of Pages: 03 | **Time: 03 hrs**

Note: Assume suitable and necessary data if required and justify

SECTION A (Marks 20**) (**Attempt **all** questions**)**

Q 1	Discuss the selection criteria of a solvent for liquid-liquid extraction process.	**4 M**	**CO1**
Q 2	Derive the operating line equation for counter current absorption.	**4 M**	**CO2**
Q 3	What is adsorption isotherm? Give equations for Langmuir and Freundlich adsorption isotherms.	**4 M**	**CO3**
Q 4	Justify the statement "Drying and evaporation are not the same unit operation".	**4 M**	**CO4**
Q 5	Define Relative humidity and humid volume?	**4 M**	**CO5**

SECTION B (Marks: 40)

(Answer **all** the questions and **any one** in question **no. 6)**

Q 6

If 8000 kg/h of an acetic acid (C) - water (A) solution, containing 30% acid, is to be counter currently extracted with isopropyl ether (B) to reduce the acid concentration to 2% in the solvent-free raffinate product, determine the number of theoretical stages if 20000 kg/h of solvent is used.

Equilibrium Data:

Water layer (100 kg)			Isopropyl ether layer (100 kg)		
Acetic acid	Water	Isopropyl ether	Acetic acid	Water	Isopropyl ether
0.69	98.1	1.2	0.18	0.5	99.3
1.41	97.1	1.5	0.37	0.7	98.9
2.89	95.5	1.6	0.79	0.8	98.4
6.42	91.7	1.9	1.93	1.0	97.1
13.30	84.4	2.3	4.82	1.9	93.3
25.50	71.1	3.4	11.40	3.9	84.7
36.70	58.9	4.4	21.60	6.9	71.5
44.30	45.1	10.6	31.10	10.8	58.1
46.40	37.1	16.5	36.20	15.1	48.7

OR

10 M | **CO1**

	Acetic acid (c) is to be extracted from a 45% aqueous solution using isopropyl ether (B) as the solvent at 20 °C. The feed rate is 1500 kg/h and the raffinate must not contain more than 2.5% acid. If the solvent supplied to the extractor has 0.5% acetic acid in it, calculate the minimum solvent rate. The liquid-liquid equilibrium data at 20 °C are given below. Water layer (raffinate), mass % | Ether layer (extract), mass% A | B | C | A | B | C 0.981 | 0.012 | 0.0069 | 0.005 | 0.993 | 0.0018 0.971 | 0.015 | 0.0141 | 0.007 | 0.989 | 0.0037 0.955 | 0.016 | 0.0289 | 0.008 | 0.984 | 0.0079 0.917 | 0.019 | 0.0642 | 0.01 | 0.971 | 0.0193 0.844 | 0.023 | 0.133 | 0.019 | 0.933 | 0.0482 0.711 | 0.034 | 0.255 | 0.039 | 0.847 | 0.114 0.589 | 0.044 | 0.367 | 0.069 | 0.715 | 0.216 0.451 | 0.106 | 0.443 | 0.108 | 0.581 | 0.311 0.371 | 0.165 | 0.464 | 0.151 | 0.487 | 0.362		
Q 7	Discuss in brief with neat sketch the adsorption wave.	**10 M**	**CO3**
Q 8	Differentiate between Packed bed column and Plate column	**10 M**	**CO2**
Q 9	List out various types of cooling towers and discuss their selection criteria in detail.	**10 M**	**CO5**
	SECTION-C (Marks: 40) **(**Question **No. 10** compulsory. Answer **any one** in question **No. 11)**		
Q 10	An aqueous solution containing valuable solute is coloured by small amounts of an impurity. It is to be decolourised by adsorption of an impurity on an adsorptive carbon. The equilibrium data obtained by stirring various amounts of adsorbent with original solution at constant temperatures are as follows: Kg carbon/kg solution | 0 | 0.001 | 0.004 | 0.008 | 0.02 | 0.04 Equilibrium colour | 9.6 | 8.6 | 6.3 | 4.3 | 1.7 | 0.7 The original solution has a colour concentration of 9.6 measured on an arbitrary scale and it is desired to reduce the colour to 10% of its original value. Determine the quantity of fresh carbon required per 1000 kg of solution for single stage adsorption.	**20 M**	**CO3**

Q 11	Derive the relation to determine the time needed for constant drying and falling rate period of the batch drying operations. **OR** A porous solid is dried in a batch dryer under constant drying conditions. Five hours are required to reduce the moisture content from 25 to 6%. The critical moisture content was found to be 14% and the equilibrium moisture 4%. All the moisture contents are on the dry basis. Assuming that the rate of drying during falling rate period is proportional to the free moisture content, how long should it take to dry a sample of same solid from 20 to 6% under the same drying conditions?	**20 M**	**CO4**