BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B. TECH **SEMESTER : V**
BRANCH: CHEMICAL/CHEMICAL P&P **SESSION : MO/2022**

SUBJECT: CL319 MASS TRANSFER OPERATIONS -II

TIME: 3:00 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Write the two applications of liquid-liquid extraction operation.	[2]	1	1
Q.1(b)	Describe the effects of temperature, agitation, and particle size on the rate of solid-liquid extraction operation.	[3]	1	2
Q.1(c)	Nicotine (C) in a water (A) solution containing 5% nicotine is to be extracted with kerosene (B) at 20°C. Water and kerosene are essentially insoluble. Determine the percentage extraction of nicotine if 100 kg of feed solution is extracted with three theoretical stages using 50 kg pure solvent in each stage. Equilibrium relation is given as $y'^*=0.923x'$, where y'^* is the equilibrium value of kg nicotine/kg kerosene, and x' is the corresponding value of kg nicotine/kg water.	[5]	1	3
Q.2(a)	Define the absolute humidity of water vapor-air system.	[2]	2	1
Q.2(b)	Describe the natural draft cooling tower with a neat diagram.	[3]	2	2
Q.2(c)	An air (B)-water-vapor (A) sample has a dry bulb temperature 55°C. If the mixture shows 29.6% relative humidity at 1 std. atmospheric pressure, calculate: (a) Absolute humidity, (b) Molar humidity, (c) Saturation humidity, (d) Humid volume, and (e) Enthalpy of the mixture Given: Vapor pressure of water at 55°C = 0.155 atm Heat capacity of water vapor = 1884 J/(kg.°C) Heat capacity of dry air = 1005 J/(kg.°C) Latent heat of vaporization = 2502300 J/kg	[5]	2	3
Q.3(a)	Show the types of moisture content on the drying rate curve.	[2]	3	1
Q.3(b)	Write the conditions to use the lab drying tests data for design a large-scale drier.	[3]	3	1
Q.3(c)	In a laboratory drying test with a solid material the relation for the falling rate period was obtained as $dX/d\theta = -0.8(X-0.05)$, where X is the moisture content on dry basis and θ the time in hours. The critical moisture content is 1.4 kg moisture per kg of dry material. Calculate the equilibrium moisture content and the time required for drying the material from $X_1 = 4$ to $X_2 = 0.1$.	[5]	3	3
Q.4(a)	Write four differences between physical and chemical adsorption.	[2]	4	1
Q.4(b)	Batch tests were performed in the laboratory using solutions of phenol in water and particles of granular activated carbon (R-5). The equilibrium data at room temperature are shown in below table. If Langmuir isotherm is fitted to the data points, determine the isotherm parameters.	[3]	4	3

C_e (kg of phenol/m^3 of solution)	0.322	0.117	0.039	0.0061	0.0011
q_e (kg phenol/kg carbon)	0.150	0.122	0.094	0.0590	0.0450

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Q.4(c) Given the following data for physical adsorption of nitrogen on alumina at -183°C, compute the BET surface area in m^2/g. The density of nitrogen at -183°C is 0.751 g/cm^3. [5] 4 3

P/P_o	0.01	0.08	0.15	0.30	0.44
V, cm^3/g at STP	75	100	120	140	180

Q.5(a) Define McCabe ΔL law of crystal growth. [2] 5 1

Q.5(b) Explain followings with neat sketch: (i) symmetric membrane, (ii) Asymmetric membrane, (iii) composite membrane [3] 5 2

Q.5(c) Illustrate the pervaporation operation for the separation of ethanol-water mixture with a neat diagram. Write two other applications of pervaporation operation. [5] 5 3

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