Ref. No. : Ex/FTBE/T/413/2019

Name of the Examinations: B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING FOURTH YEAR FIRST SEMESTER - 2019

Subject : MASS TRANSFER OPERATION II **Time : 3 Hours** **Full Marks : 100**

Part I

Use Separate Answer scripts for each Part

Answer any three Questions. All Questions carry equal marks. Steam Tables and Psychrometric Charts may be used.

1(a)What is the difference between dry and wet bulb temperatures? How can wet bulb temperature of a body be measured? 3+5

(b) Estimate for air at 75^0C dry bulb temperature and 20% relative humidity, the

(i) Humidity in kg water per kg dry air.

(ii) Wet Bulb temperature

(iii) Dew point

(iv) Humid heat and

(v) Humid volume 12

2(a). What is meant by dew point of an air-water vapour mixture? How is the total enthalpy of an air-water vapour mixture calculated? 2+3

(b) Air originally at 15^0C and 75% saturation is heated to 50^0C and then passed consecutively over two shelves in a tray dryer. In passing over each shelf, the air regains its original percentage of relative humidity but is reheated again to 50^0C by heaters between the shelves. Assuming that the material on each shelf reaches the wet bulb temperature and the heat losses can be neglected, determine the temperature of the material on each shelf and the rate of removal of water (kg/s) if 3 m^3/min of moist air enter the dryer. 15

3(a) What are the main characteristics of drying in the constant rate and falling rate period?

(b) A cabinet dryer is to be used for drying a food product. The product has an initial moisture content of 75% (wet basis) and requires 12 mins to reduce the moisture content to a critical level of 30% (wet basis). Determine the final moisture content of the solid if a total drying tine of 18 mins is used. 8+ 12

4(a) What are the effects of air velocity, air temperature, air humidity and thickness of solid being dried on the constant rate of drying? 10

[Turn over

(b) Deduce an expression for the time of drying in the falling rate period for the case where the rate of drying is a linear function of the free moisture content. 10

5(a) With a neat diagram describe the operation of a tray dryer. 10.

(b) Show with an illustration that the moisture content of a solid can be free and bound at the same time. 10

6. Deduce an expression for the total time of drying in a freeze dryer. 20

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B.E. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING
FOURTH YEAR FIRST SEMESTER EXAM 2019
Mass Transfer Operation II

Time: 3 hrs. Full Marks : 100

Part – II

(Answer question no. 1 and any two from the rest questions; 10 + 20 x 2 = 50)

1. With the help of neat sketch show how you can achieve operating lines for rectifying section and stripping section associated with MaCcabe-Thiele method for calculation of number of trays in a tray distillation tower. Show how the alignment of feed line changes with 'q-value'. 6+4

2. Calculate and plot bubble point – dew point diagram and equilibrium curve for a mixture of benzene and toluene at a total pressure of 1 atm. The vapour pressure of benzene and toluene are shown in the following table. Assuming that mixtures of these materials follow Raoult's law.
Table: vapour pressure of benzene and toluene 12+8

Temperature (^{0}C)	Vapour pressure (mmHg)	
	Benzene	Toluene
80.1	760	-
85	877	345
90	1016	405
95	1168	475
100	1344	557
105	1532	645
110	1748	743
110.6	1800	760

3. (a) Derive Rayleigh Equation.
(b) A feed of 40 mole percent hexane and 60 mole percent octane is fed into a still through a pressure reducing valve and then into a flash disengaging chamber. The vapour and liquid leaving the chamber are assumed to be in equilibrium. If the fraction of the feed converted to vapour is 0.5, find the composition of the top and bottom products. The following table gives the equilibrium data for this system. 6+14

Mole fraction of hexane in liquid , x	1.00	0.69	0.40	0.192	0.045	0.00
Mole fraction of hexane in vapour, y	1.00	0.932	0.78	0.538	0.1775	0.00

4. Derive the relation among mole fractions (x and y) and relative volatility (α) for a two component system. What do men by 'total reflux'? With neat sketch explain the mechanism of mass transfer action at any sieve plate of a distillation tower . Explain the following terms (a) entrainment (b) splashing and foaming, related to tower distillation. 3+3+8+6

5. A continuous distillation tower is to be designed to separate 50,000 lb/hr of a mixture of 50% benzene and 50% toluene into an overhead (top) product containing 97% benzene and a (bottom) product containing 98% toluene. These percentages are by weight. A reflux ratio of 4 moles to 1 mole of product is to be used. Determine the rate of production of overhead product as well as bottom product, the no. of ideal plates required for the tower and position of the feed plate. The feed is a mixture of two-third vapour and one-third liquid . You may assume relative volatility (α) to be 2.16 in this case. 20