

Instructions : Use Separate Answer scripts for each Part

PART I (60 Marks)

Answer any three questions. All questions carry equal marks.

Psychrometric charts and Steam Tables may be used.

1. (a). What is the difference between absolute and relative humidity of an air-water vapour mixture? Explain your answer with mathematical expressions. How can enthalpy of an air-water vapour mixture be calculated? 6+4

(b). Air entering a dryer has a dry bulb temperature of 65°C and dew point of 28°C . Using humidity chart, determine the absolute humidity, relative humidity humid heat and humid volume of air-water vapour mixture in SI units. 10

2. (a). Derive an equation for wet bulb temperature line found on psychrometric chart. What is Lewis number? 13 + 2

(b) Ambient air at 27°C and 53% RH is heated to 170°C . Determine the percent relative humidity and wet bulb temperature of heated air. 5

3.(a). Discuss either Liquid Diffusion theory or Capillary Movement theory on moisture movement through solids during drying in the falling rate period. 6

(b). Show that the rate of drying in the constant rate period can either be expressed with heat transfer coefficient or mass transfer coefficient. 14.

4. (a). Deduce an expression for rate of drying in the falling rate period when the rate is a linear function of X i.e. ratio of moisture content of a solid. 5

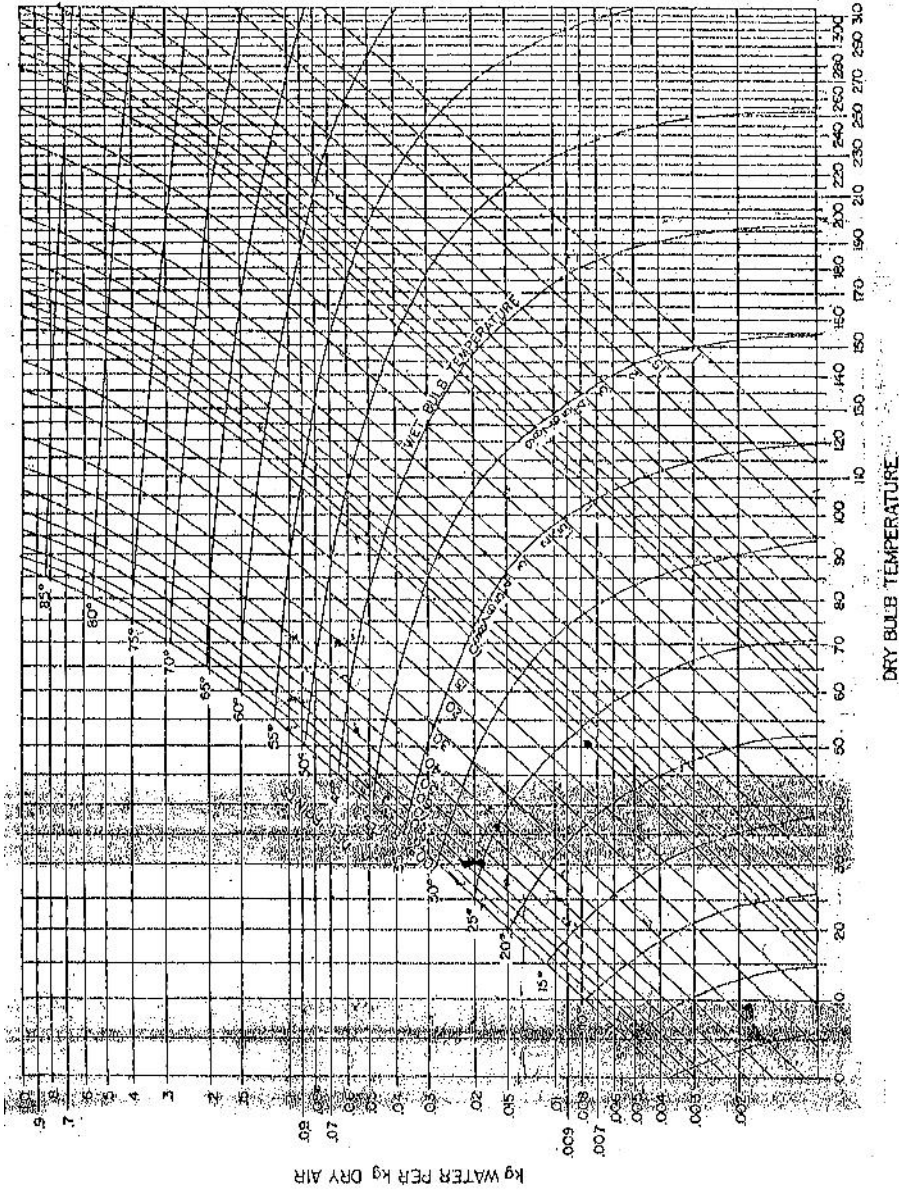
(b). A wet granular food material is being dried in a pan, 0.5 by 0.5 m and 30 mm deep. The sides and bottom of the tray can be considered to be insulated. Heat transfer is by convection from an air stream flowing parallel to the solid surface at a velocity of 7 m/s. The air is at a temperature of 73°C and has a humidity of 0.02 kg water/ kg dry air. Estimate the rate of drying in the constant rate period. 15

5. (a) With the help of triple point diagram of water, explain the principle of freeze drying. 5

(b). State any five differences between conventional drying and freeze drying. 5

(c) With a neat diagram explain the operation of a tray dryer. 10

6. With neat diagrams explain the principle of operation of a (a) spray dryer (b) fluidised bed dryer.



PSYCHROMETRIC CHART
- METRIC UNITS

BACHELOR OF ENGINEERING (F.T.B.E) EXAMINATION, 2018

(4th Year -1st Semester)**Mass Transfer Operation-II**

Time: 3 hrs.

Full Marks : 100

Part-II (40 Marks)

[Answer any four questions, Marks 4 x 10 =40]

1. Calculate and plot boiling point and equilibrium curve for benzene and toluene mixture based on the data available from the following table and assuming that mixtures of these materials follow Raoult's law . Total pressure of the ambience is 1 atm. (10)

Table: vapour pressure of benzene and toluene

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

2. Find a relation between x and y involving ' α ' (relative volatility). Derive Rayleigh equation to calculate composition of the distillate during a batch (differential) distillation process . What are 'dew point curve' and 'bubble point curve' for a two component liquid system . (3+5+2=10)
3. A feed of 45 mole percent heptane and 55 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. (10)

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. Develop operating lines for rectifying section and stripping section of a tray distillation tower following Maccabe-Thiele method. Show with proper diagram the effect of feed composition on feed line as well as on the flow pattern of fluid through feed plate for distillation tower. (6+4)
5. A continuous distillation tower is to be designed to separate 30,000lb/hr of a mixture of 40% benzene and 60% 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 3.5 moles to 1 mole of product is to be used. Determine the no. of ideal plates and position of the feed plate , if the feed is a mixture of two-thirds vapour and one-third liquid . You may assume relative volatility (α) to be 2.16 in this case. (10)

END