Name: _____ Student ID _____

Prince of Songkla University
Faculty of Engineering

Exam: Final Exam, Semester II **Academic Year: 2005 – 06**
Date: March 5, 2006 **Time: 13:30 – 16:30**
Subject: 230-392 – Basic Chemical Engineering II **Room: R201**

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Instructions: There are a total 6 questions. The exam is Closed Book and students are allowed to bring one sheet of A4 (front and back). The points for each problem are not distributed evenly. Place your name and the student ID number on every page. Students are allowed to use only a pen or pencil and a calculator. No exams are allowed to leave the room.

Points Distribution (For Grader Only)		
Question	Points Value	Score
1	10	
2	20	
3	25	
4	20	
5	10	
6	15	
Total	100	

Exam prepared by
Ram Yamsaengsung
February 28, 2006

PLEASE CHECK TO MAKE SURE THAT
YOU HAVE ALL 4 PAGES OF THE EXAM BEFORE BEGINNING
(not including the cover sheet).
GOOD LUCK!

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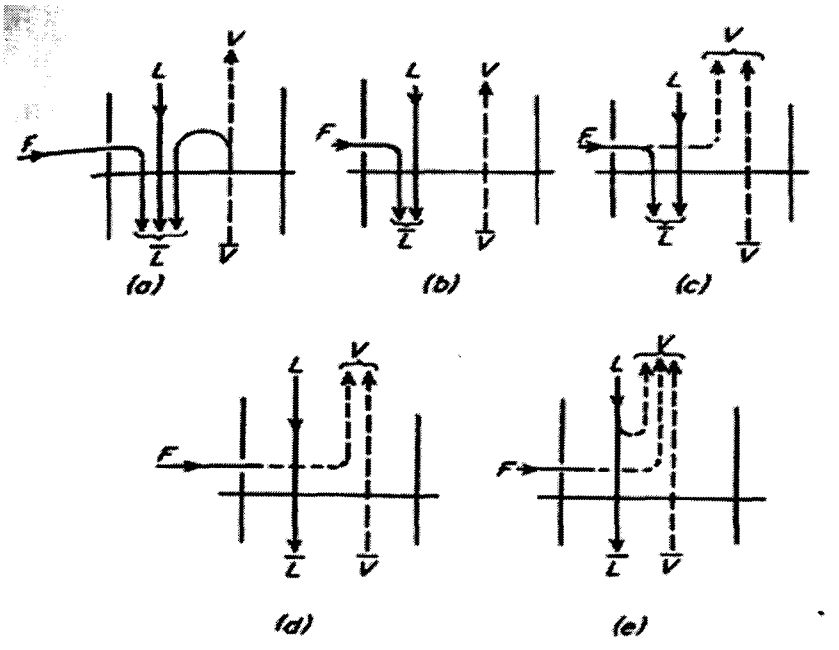
1. From the figure below, if F = 100 moles, L = 70 moles, and V = 80 moles, answer the following questions.
   (a) Indicate the types of feed into the column and what is the approximate value of q for each of the feed?
   (b) For case (b), what is the value of $\overline{L}$ and $\overline{V}$.
   (c) For case (c), if f equals 0.6, what is the value of $\overline{L}$ and $\overline{V}$. **(10 points)**



2. A mixture of 80 mole percent benzene and 20 mole percent toluene is subjected to flash distillation at a pressure of 1 atm. The vapor-liquid equilibrium curve and boiling-point diagram are shown in Figs. 18.2 and 18.3. (a) What is the composition of the liquid and vapor leaving the separator if f, the fractional vaporization is 0.60? (b) What is the temperature in the separator? (c) If the feed is 120 moles, determine the number of moles of benzene in the vapor phase leaving the separator unit. (d) If the feed concentration is kept constant, how would you increase the mole fraction of benzene in the vapor phase? (e) Would the number of moles in the vapor phase increase or decrease if you increase the mole fraction of benzene? Explain. **(20 points)**

3. A plant must distill a mixture containing 70 mole percent methanol and 30 mole percent water. The overhead product is to contain 99.00 mole percent methanol and the bottom product 0.02 mole percent. The feed is saturated vapor. The number of moles of D obtained is one-third the number of moles of reflux returning to the column. The reflux is at its bubble point. (a) Calculate the minimum number of plates and determine at which plate should the feed enter? (b) Name one way to decrease the number of plates required. **(25 points)**

4. By extraction using n-hexane, soybean oil is extracted from crushed soybeans. If 2,500 lb of crushed soybeans (n-hexane free) enters the continuous countercurrent extraction system per day, what is the amount of n-hexane required per day to extract 98% of all the oil in the soybeans? What is the number of ideal stages required if the unextracted soybeans contain 20% oil by weight and the extract solution contains 30 lb of soybean oil per 100 pounds of n-hexane? The fresh solvent contains 0.005 lb of soybean oil per lb of solvent entering. From experiments, it is shown that 0.5 lb of n-hexane per pound of oil-free pulp is retained as it is transferred from stage to stage. **(20 points)**

5. From Fick's first law of diffusion for a Binary mixture, show how to derive the following equation:

$$J_A = \frac{D_v \rho_M}{B_T}(y_{Ai} - y_A)$$

State all necessary assumptions and under which conditions is this equation applicable. **(10 points)**

6. In a jackfruit drying operation, 1000 lb of jackfruit is to be dried in an oven from 90% moisture content (d.b.) to 5% moisture content (d.b.) at a temperature of 180°F. If the operation takes 20 hours, what will be the total cost of the operation if the cost of energy is \$85/kW? The latent heat of vaporization of water at 180°F is 990.2 Btu/lb. Assume that energy required to heat the jackfruit is negligible compared to the heat of vaporization. **(15 points)**

Bonus: How much should you sell a 50 g bag of jackfruit for in order to make a 100% profit? The cost of peeled jackfruit is \$2 per pound. The cost of packaging is \$0.05. (10 points)

Conversions and Constants:

1 Btu = 1.05587 kJ
1 m^3 = 264.17 gal (US)
$\lambda_{methanol}$ = 7,700 cal/gmol
1 lb = 453.6 g

1 kW = 1 kJ/s
1 atm = 760 mmHg
ρ_{water} = 1,000 kg/m^3

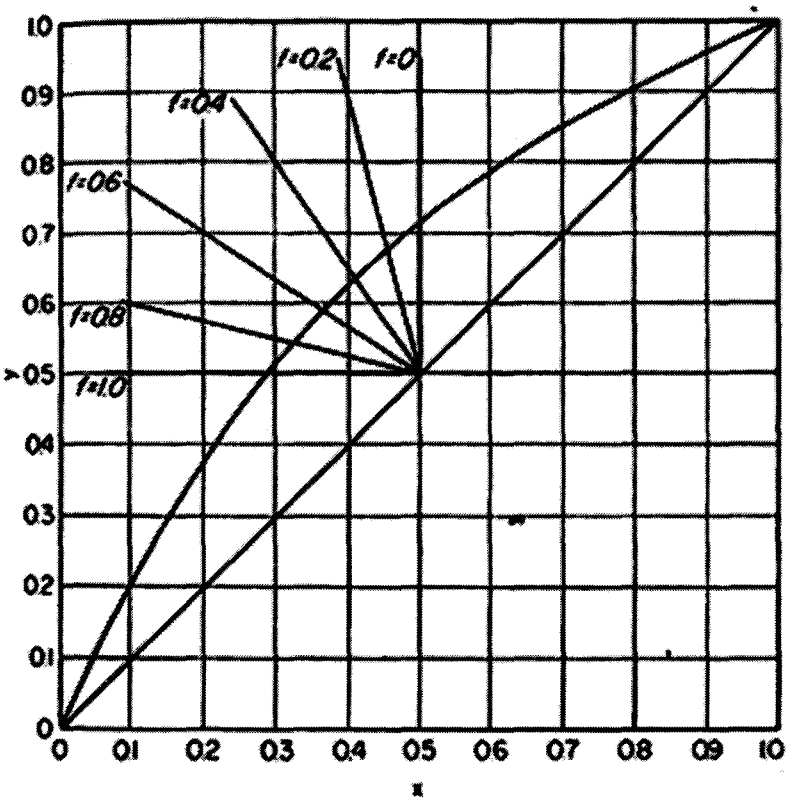


FIGURE 18.2
Equilibrium curve, system benzene-toluene. Graphical construction for Example 18.1.

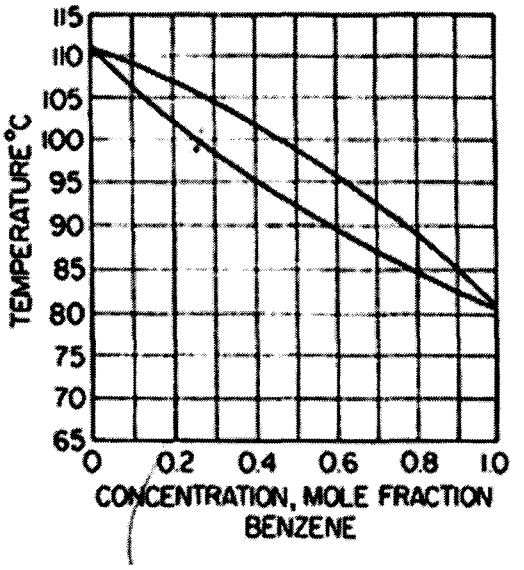
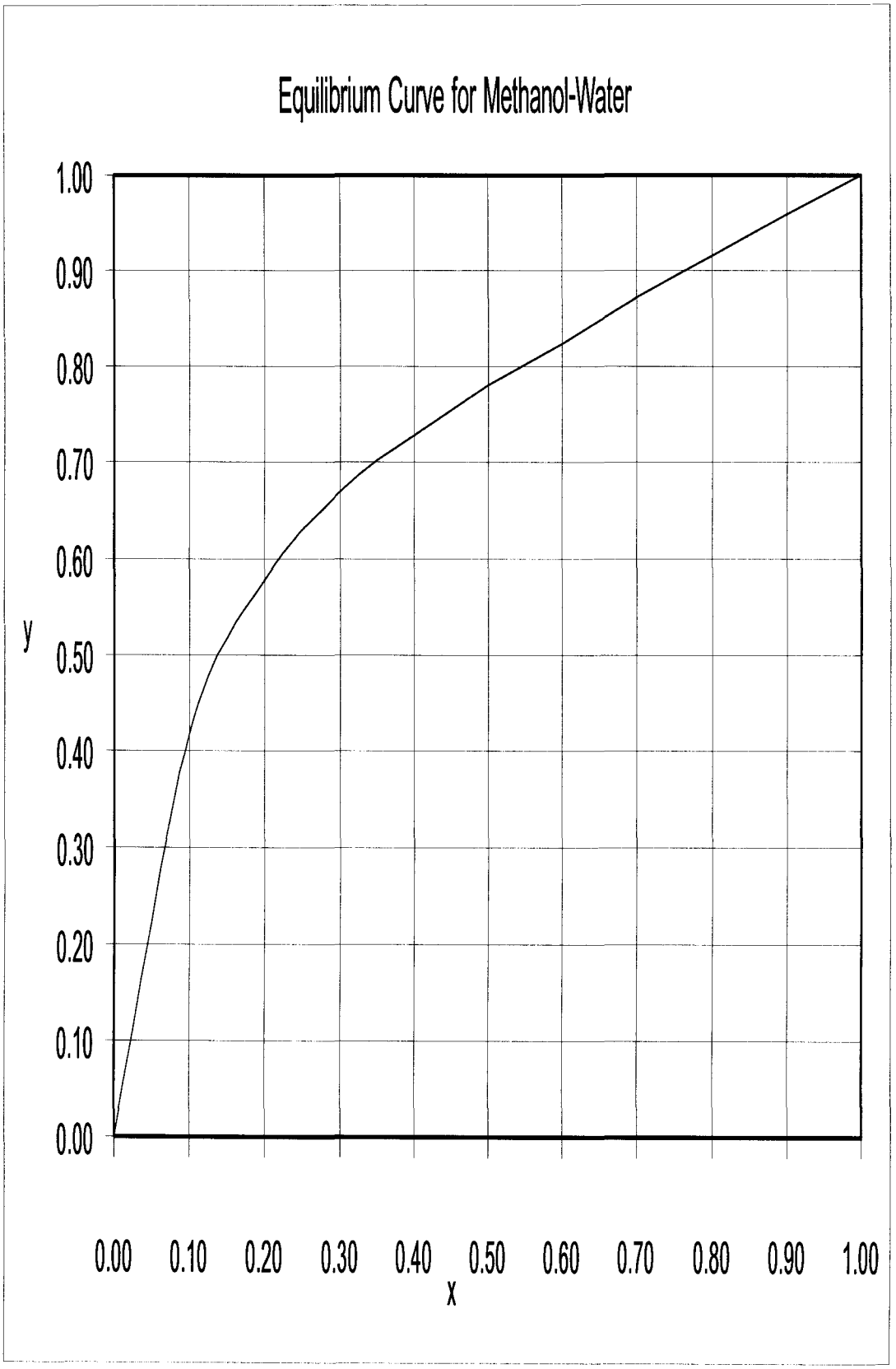


FIGURE 18.3
Boiling-point diagram (system benzene-toluene at 1 atm).


Equilibrium Curve for Methanol-Water
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
y
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
x