Name: _____ **Student ID** _____

Prince of Songkla University
Faculty of Engineering

Exam: Final Exam, Semester II **Academic Year: 2003 – 04**
Date: February 24, 2004 **Time: 13:30 – 16:30**
Subject: 230-392 – Basic Chemical Engineering II **Room: R200**

Instructions: There are a total 6 questions. The exam is Closed Book and students are allowed to bring one sheet of A4 (front only). 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 19, 2004

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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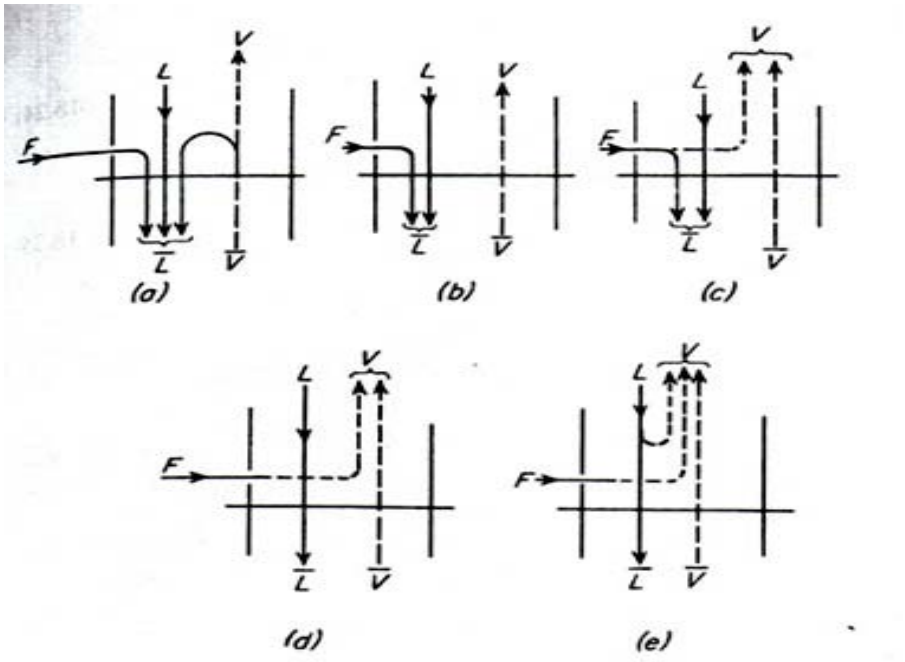
1. From the figure below, if F = 80 moles, L = 80 moles, and V = 100 moles, answer the following questions.
   (a) Indicate the types of feed into the column and what is the approximate value of *q* for each of the feed?
   (b) For case (b), what is the value of $\overline{L}$ and $\overline{V}$.
   (c) For case (c), if *f* equals 0.3, 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 0.40? (b) What is the temperature in the separator? (c) If the feed is 80 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? Explain. **(20 points)**

3. A plant must distill a mixture containing 60 mole percent methanol and 40 mole percent water. The overhead product is to contain 99.00 mole percent methanol and the bottom product 0.05 mole percent. The feed is two-thirds liquid and one-third vapor. The number of moles of D obtained is one-half 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 1500 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 90% of all the oil in the soybeans? What is the number of ideal stages required if the unextracted soybeans contain 45% oil by weight and the extract solution contains 30 lb of soybean oil per 100 pounds of n-hexane? The fresh solvent contains 0.002 lb of soybean oil. 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:

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

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

6. In a wood-drying operation, 8000 lb of wood is to be dried from 80% moisture content (d.b.) to 10% moisture content (d.b.) at a temperature of 180°F. If the operation takes 7 days, what will be the total cost of the operation if the cost of energy is $70/kW? The latent heat of vaporization of water at 180°F is 990.2 Btu/lb. Assume that energy required to heat the wood is negligible compared to the heat of vaporization. **(15 points)**

Conversions and Constants:

1 Btu = 1.05587 kJ	1 kW = 1 kJ/s
1 m^3 = 264.17 gal (US)	1 atm = 760 mmHg
$\lambda_{\text{methanol}}$ = 7700 cal/gmol	ρ_{water} = 1000 kg/m^3