Exam II

(Open Book, 50 min.) Name _____

INSTRUCTIONS: Please read the following before beginning the exam.

- *Please show all work for each problem in the space provided. If there is insufficient space provided, use the back of the page. Be sure to indicate in the space provided that additional work is on the back.*
- *Circle your answers. Be sure to include units!*
- *A teaching assistant or the instructor will be in the room at all times. Feel free to ask questions.*
- *First answer those questions which require no calculation. Trial-and-error should not be necessary.*

Code Number for Posting Grades

After the exam is graded, I will hand out a tabulation of all grades by PIN. If you would like to change your PIN, please enter the new value here.

Numerical Code: ☐☐☐☐

Enter a number only if you want to change your PIN.

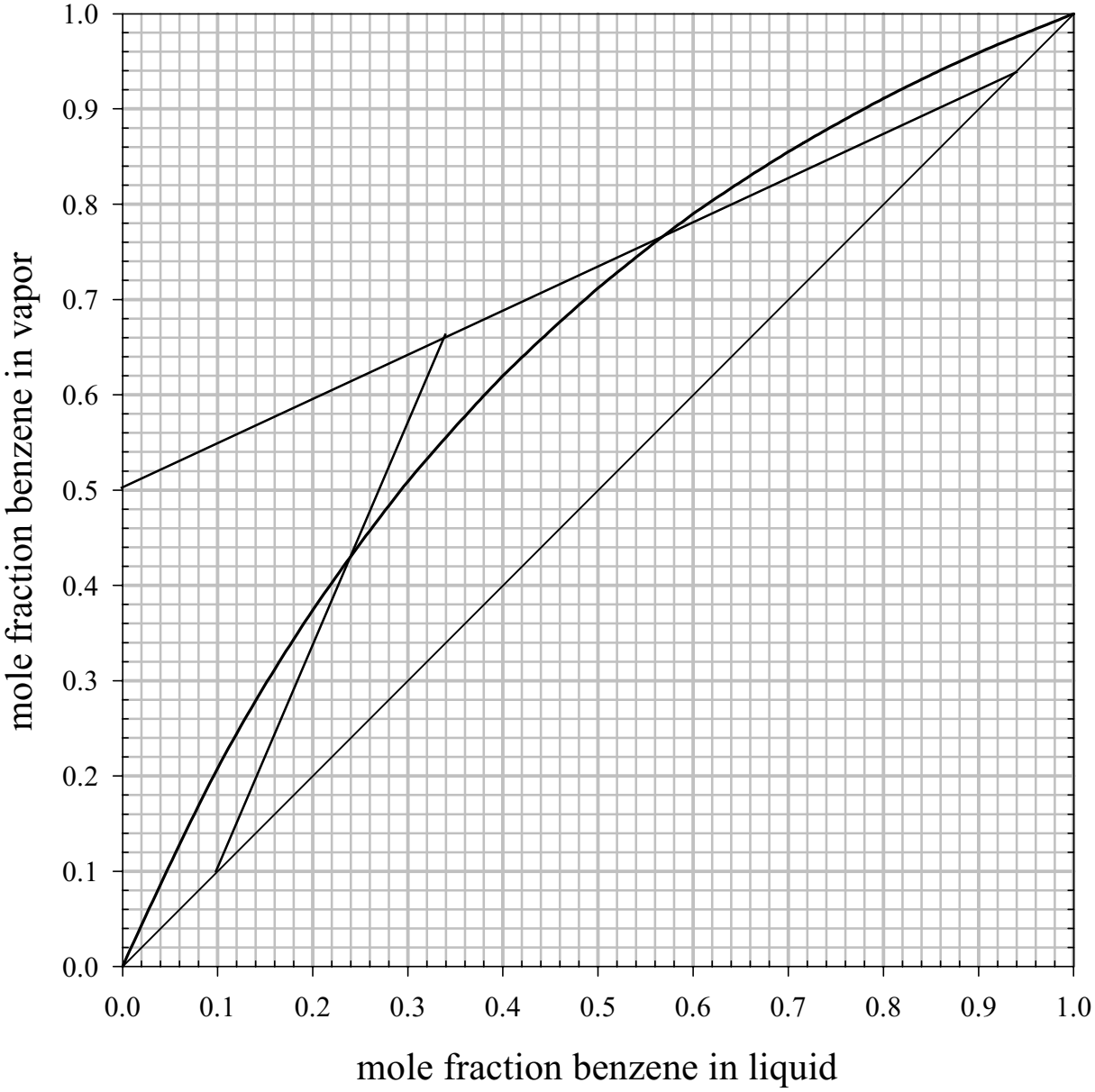
1.) The major assumption in the McCabe-Thiele method is called "equimolar overflow."

5% a. What is the main consequence of this assumption upon the liquid and vapor flowrates within the enriching (rectifying) section of a distillation tower? In other words, what relationships among L_i and V_i (i = 1, 2, … N_E) are implied by equimolar overflow?

5% b. Does this consequence apply to mass flowrates, molar flowrates or volumetric flowrates?

10% c. Sketch the enthalpy-concentration (i.e. Hxy) diagram for saturated vapor and saturated liquid (at constant pressure) which would exactly imply equimolar overflow.

5% d. What is the main consequence of the equimolar overflow assumption upon the shape of the rectifying section operating line (i.e. the ROL)? In other words, just by looking at the ROL (drawn by Chemsep, say), how could you tell if equimolar overflow was assumed or not?



2.) Above is an xy-diagram summarizing the vapor-liquid equilibrium of mixtures of benzene and toluene at 1 atm pressure. A feed containing 30 mol% benzene is to be fractionated to produce a distillate product of 94 mol% benzene and a bottoms product of 10 mol% benzene. As a first step in starting to solve this problem, a fellow student has drawn the operating lines shown on the graph.

10% a. What is wrong with the operating lines as drawn?

5% b. What value of the reflux ratio was used?

10% c. What is the thermal condition of the feed (subcooled liquid, saturated liquid, two-phase mixture, saturated vapor or superheated vapor)?

5% d. Of the feed, distillate product and bottoms product, which stream has the highest temperature?

15% e. What is the highest concentration of benzene which can be obtained in the distillate product (with a very large number of stages) for the reflux ratio used to draw the operating lines shown?

10% 3.) In the previous problem, find the heat duty of the reboiler for a feed flowrate of 100 mol/min of saturated liquid and a reflux ratio of 3. These conditions need not correspond to those of the operating lines drawn. You may assume the column has a total condenser and a partial reboiler. The heat of vaporization is 33 kJ/mol.

10% 4.) Some of the variables which must be input to Chemsep are the number of stages above the feed and the number of stages below the feed. For a given composition and thermal condition specified for the feed, distillate and bottoms streams, we wish to use Chemsep to determine the minimum reflux ratio. In a sentence or two, describe a series of simulations which can be performed on Chemsep which will yield the minimum reflux ratio.

Hint: you might want to start by defining what is generally meant by "minimum reflux ratio."

10% 5.) For a given composition and thermal condition specified for the feed, distillate and bottoms streams, we wish to use Chemsep to determine the minimum number of stages. What happens during a simulation when the number of stages is below the minimum?