

**Chemical Engineering 201
Fall 2003**

Midterm # 3

Name _____

Problem # 1 _____

Problem # 2 _____

Extra Credit _____

Problem One (30 points):

Use Gaussian elimination to solve the following system of equations:

$$7x - y - 2z = 0$$

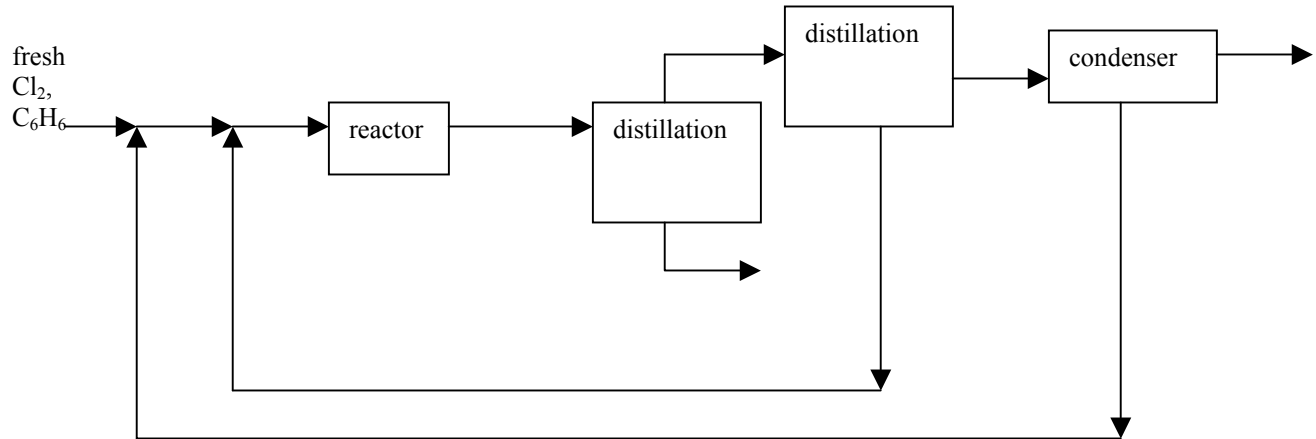
$$-y - 3z + 9x = 0$$

$$-7z + 4y + 2x = 0$$

On this problem, you may check your answer using your calculator to solve the systems of equations, but you must show the steps on how you did the Gauss elimination and then intermediate steps.

Problem Two (70 points):

Liquid benzene is fed to a reactor and reacted with with chlorine gas. The product stream is sent to a distillation column where chlorobenzene is separated from the HCl, benzene, and chlorine so that the bottom stream has 4 mol percent benzene, no chlorine, and no hydrogen chloride, but contains 98% of the chlorobenzene in the reactor product stream. The overhead stream is sent to a secondary distillation column where the HCl and Cl_2 is separated from the benzene/chlorobenzene stream. This benzene/chlorobenzene stream is then recycled to the reactor feed. The HCl and Cl_2 are sent to a condenser where the HCl and 5 % of the Cl_2 is liquefied and sold. This liquid stream has 10 wt% chlorine in it. The gaseous Cl_2 is mixed with fresh chlorine and fed back to the reactor. A flowsheet is shown below:



There is 50 % excess of the non-limiting reactant.

For full credit on this problem: choose a basis and describe why you have selected that flowrate for that stream, convert all given information into mathematical terms, label all info on the flowsheet, make a table and fill in all zeroes, write the extent of reaction equations.

For 10 extra credit points, determine the ratio of fress chlorine feed to benzene fresh feed.