Mini-Assignment (Assignment 2)

Assume a ideal distillation process in which there is a batch feed (the feed isn't continuous) for production of gaseous ethanol-CO2 feedstock. The ethanol is to be recovered from the ethanol-water mixture by distillation followed by contact with CO2 gas. The required mole fraction for ethanol in top product is 95% and for bottom product the required mole fraction for water is 92% or 96% (based on varied uses).
Assumption: The column is operated under isothermal, isobaric conditions and the CMO approximation is valid. Use the relevant information provided below

Part 1

The ethanol-water equilibrium solubility data is given below. Here x and y are mole fractions of ethanol. Use your favourite fitting function in MATLAB to fit the x-y data to the functional form:

$$y = \frac{ax}{1+bx+cx^2}$$

Use this fitted curve for all subsequent calculations. Show both the tabulated and the fitted curve in the same plot along with fitting parameters **a**, **b** and **c** as title of the plot (Name this Figure 1).

x	0	0.02	0.04	0.06	0.08	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.95	1.0
y	0	0.134	0.23	0.304	0.365	0.418	0.579	0.665	0.729	0.779	0.825	0.87	0.915	0.958	0.979	1

Table 1: Values of x and y.

Part 2

Use MATLAB to perform the McCabe-Thiele construction to determine the number of ideal trays required for the given system. Show the construction in Figure 2 (xw = 0.92) and Figure 3 (xw = 0.96).

How to do McCabe-Thiele Construction?

1) start with Y = xd and X = xd (as RS always pass through (xd,xd))
2) Define nt = -1 (number of trays)
3) Start a while loop with condition X>=xb
4) Define Xold = X and Yold = Y
5) For this Yold get X such that (X,Yold) lie on equilibrium curve
6) For the calculated X above, get Y such that (X,Y) lie on operating line
7) nt = nt + 1
8) add the below code for the tray construction:
   line([Xold X],[Yold Yold]); line([X X],[Yold Y]);
9) end the loop
10) calculate nt = round((nt+(Xold-xb)/(Yold-Y)),2);

    Hint: Ideal batch distillation means no rectifying or stripping section and so the 45 degree line is the operating line.