DEPARTMENT OF CHEMICAL & BIOMOLECULAR ENGINEERING
NORTH CAROLINA STATE UNIVERSITY

CHE 596-028/605 **Spring 2020**
Homework Set 4 **Due on February 18, 2020**

An ethylbenzene-styrene stream containing 35 mol % ethylbenzene and 65 mol % styrene at 0.2 atm and 78 ^{o}C is to be processed at the rate of 1.0 kmol/h by means of a low-pressure distillation unit. Analyze the following three cases using Aspen distillation models. In each case, assume an *Ideal* thermodynamic (*Properties*) model.

(a, 20%) Using *DSTWU*. Assume a mole-basis *Reflux Ratio* (*RR*) = 3.5, a *Light key* (Ethylbenzene) recovery in distillate = 0.80, a *Heavy key* (Styrene) recovery in distillate = 0.20, a *Condenser pressure* = 0.1 atm, a *Reboiler pressure* = 0.3 atm. Determine (i) the required number of stages, (ii) the molar flow rates and compositions of the *Distillate* and *Bottom Products* streams, (iii) the condenser heat duty, and (iv) the reboiler heat duty.

(b, 20%) Using *Distl*. Assume a mole-basis *Reflux Ratio* (*RR*) = 3.5, a *Distillate to Feed* (*D:F*) ratio = 0.50, *Number of equilibrium stages* = 20 with the *Feed stage* at 10, a *Total Condenser*, a *Condenser pressure* = 0.1 atm, a *Reboiler pressure* = 0.3 atm. Determine (i) the molar flow rates and compositions of the *Distillate* and *Bottom Products* streams, (ii) the condenser heat duty, (iii) the reboiler heat duty.

(c, 60%) Using *RadFrac*. Assume a *Distillate to Feed* (*D:F*) ratio = 0.50, *Number of equilibrium stages* = 20 with the *optimum Feed stage* to be determined, a *Total Condenser*, *Pressure at the Condenser* (*Top*) *stage* = 0.10 atm, *Pressure drop across each stage* = 2" of water. Determine the optimum feed stage by studying the composition (mole-fraction) profile as a function of the stage number. Determine by trial-and-error using the built-in *Design Spec* and *Vary* feature within *RadFrac* to determine the optimum mole-basis *Reflux Ratio* (*RR*) that will produce a 95 mol % Styrene purity in the *Bottom Products* stream. The range of trial *RR* should be 3−10 with a 0.5 step change. For the optimum *RR*, determine (i) the molar flow rates and compositions of the *Distillate* and *Bottom Products* streams, (ii) the condenser heat duty, (iii) the reboiler heat duty.