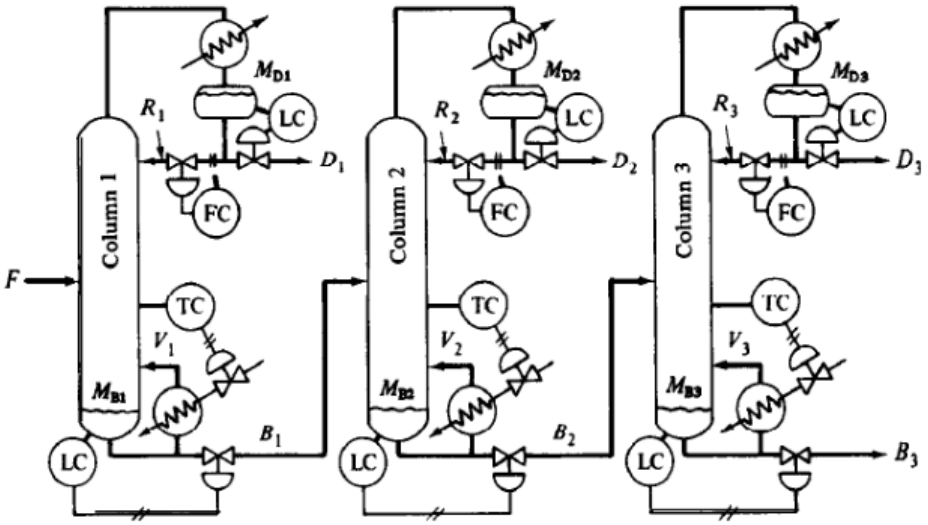
Sardar Beant Singh State University, Gurdaspur
Department of Chemical Engineering & Bio Technology

Assignment No.5
Subject: Chemical Process Simulation

Q1. Develop a mathematical model for the three-column train of distillation columns sketched below. The feed to the first column is 400 kg mol/h and contains four components (1, 2, 3, and 4), each at 25 mol %. Most of the lightest component is removed in the distillate of the first column, most of the next lightest in the second column distillate and the final column separates the final two heavy components. Assume constant relative volatilities throughout the system α_1, α_2, and α_3. The condensers are total condensers and the re-boilers are partial. Trays, column bases, and reflux drums are perfectly mixed. Distillate flow rates are set by reflux drum level controllers. Reflux flows are fixed. Steam flows to the reboilers are set by temperature controllers. Assume equimolal overflow, negligible vapor holdup, and negligible condenser and reboiler's dynamics. Use a linear liquid hydraulic relationship

$$L_n = \overline{L}_n + \frac{M_n - \overline{M}_n}{\beta}$$

$\overline{L}_n$ and $\overline{M}_n$ are the initial steady state liquid rate and holdup and β is a constant with units of seconds.



Q2. Flooded condensers and flooded reboilers are sometimes used on distillation

columns. In the sketch below, a liquid level is held in the condenser, covering some of the tubes. Thus a variable amount of heat transfer area is available to condense the vapor. Column pressure can be controlled by changing the distillate (or reflux) draw-off rate. Write the equations describing the dynamics of the condenser.