Tutorial 2

Q1. A steady-state mass balance for a chemical in a one-dimensional canal is written as:

$$D\frac{d^2c}{dx^2} - U\frac{dc}{dx} - kc = 0$$

where c is the chemical concentration, x is the distance, D is the diffusion coefficient, U is the fluid velocity, and k is the first-order decay rate. Convert this differential equation to an equivalent system of simultaneous algebraic equations. Given $D = 2$, $U = 1$, $k = 0.2$, $c(0) = 80$ and $c(10) = 10$, solve these equations (in MATLAB) from $x = 0$ to 10 and develop a plot of concentration vs distance.

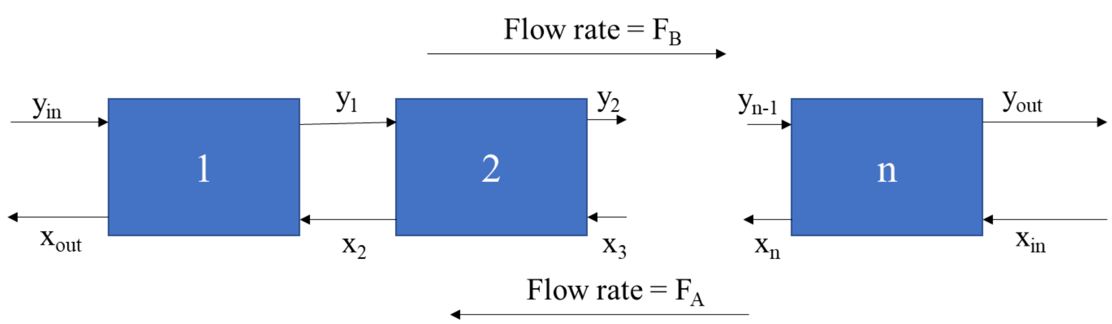
Q2. A stagewise liquid-liquid extraction process is depicted in figure below. A stream containing a weight fraction y_{in} of a chemical enters from the left at a mass flow rate of F_B. Simultaneously, a solvent carrying a weight fraction x_{in} of the same chemical enters from the right at a flow rate of F_A. Thus, for stage i, a mass balance can be represented as

$$F_B y_{i-1} + F_A x_{i+1} = F_B y_i + F_A x_i$$

At each stage, an equilibrium is assumed to be established between y_i and x_i as in

$$K = \frac{x_i}{y_i}$$

where K is called a distribution coefficient. If $F_A = 400$ kg/h, $y_{in} = 0.1$, $F_B = 800$ kg/h, $x_{in} = 0$, and $K = 5$, determine the values of y_{out} and x_{out} if a five-stage process is used (use MATLAB).



Q3. An engineer supervises the production of three types of electrical components. Three kinds of raw materials – metal, plastic, and rubber – are required for production. The amounts needed to produce each component are

Component	Metal (gm/component)	Plastic (gm/component)	Rubber (gm/component)
1	15	0.25	1
2	17	0.33	1.2
3	19	0.42	1.6

A total of 2.12, 0.0434 and 0.164 kg of metal, plastic and rubber, respectively, are available each day. How many components can be produced per day?