1. The transfer function model for a particular system is given as:

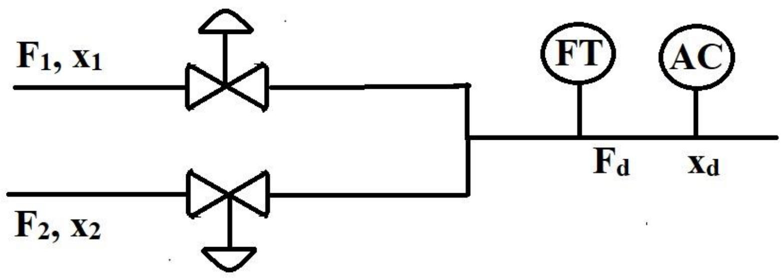
$$\begin{bmatrix} y1 \\ y2 \end{bmatrix} = \begin{bmatrix} \dfrac{4.05e^{-27s}}{50s+1} & \dfrac{1.20e^{-27s}}{45s+1} \\ \dfrac{4.06e^{-8s}}{13s+1} & \dfrac{1.19}{19s+1} \end{bmatrix} \begin{bmatrix} m1 \\ m2 \end{bmatrix}$$

a) Find the RGA for the system and recommend the input-output pairing which is structurally stable.

b) Based on your recommendation, rename the input variables and reorganise the model, if necessary. Using this reorganised model, design a steady state decoupler for this process using i) simplfied decoupling approach ii) generalized matrix approach.

2. Hot water stream at 800C is mixed with cold water stream (300C) in a mixing tank to deliver water at 600C. The level of the mixing tank is to be maintained at 1.2 m The head-flow relationship is linear and the resistance is 1/12 m/m3/min. Hot and cold water streams are the manipulated variable. Should level be controlled by manipulating cold water flow and temperature by hot water flow or vice versa? Also design a steady state decoupler, if necessary, for this system.

3. The process shown in figure is used to blend streams 1 and 2 to get stream d. The respective molal flow rates and composition are denoted by F and x respectively. Find the expression of RGA for the system.



4. A certain multivariable system has two outputs y1 and y2 that can be controlled by any of three available inputs m1, m2, m3. The transfer function matrix is given below.

$$\begin{bmatrix} y1 \\ y2 \end{bmatrix} = \begin{bmatrix} \dfrac{0.5e^{-0.2s}}{3s+1} & \dfrac{0.07e^{-0.3s}}{2.5s+1} & \dfrac{0.04^{-0.03s}}{2.8s+1} \\ \dfrac{0.004e^{-0.5s}}{1.5s+1} & \dfrac{-0.003e^{-0.2s}}{s+1} & \dfrac{-0.001e^{-0.4s}}{1.6s+1} \end{bmatrix} \begin{bmatrix} m1 \\ m2 \end{bmatrix}$$

Which loop pairing is expected to give the best control?

5. The S-domain transfer function model of a distillation column is given as

$$X_D(s) = \frac{12.8e^{-s}}{16.7s+1} R(s) - \frac{18.9e^{-3s}}{21s+1} V(s) + \frac{3.8e^{-8s}}{14.9s+1} F(s)$$

$$X_B(s) = \frac{6.6e^{-7s}}{10.9s+1} R(s) - \frac{19.4e^{-3s}}{14.4s+1} V(s) + \frac{4.9e^{-3s}}{13.2s+1} F(s)$$

The top and bottom compositions (X_D and X_B respectively) are to be controlled by manipulating R and V. The feed flow rate (F) is the load variable.

a) Find the RGA for the system and recommend the input-output pairing which is structurally stable.
b) Based on the pairing found in (a), design any one single loop controller using Z-N method.
c) Detune the controller gain found in (b) to take care of interaction using Mcavoy method

6. Find the RGA for the following process transfer function matrix

$$G(s) = \begin{bmatrix} \dfrac{1.318e^{-2.5s}}{20s+1} & -\dfrac{e^{-4s}}{3s} \\ \dfrac{0.038(182s+1)}{(27s+1)(10s+1)} & \dfrac{0.36}{s} \end{bmatrix}$$

7.. Complete the following RGA

$$\begin{bmatrix} ? & ? & -0.6 \\ ? & 0.8 & ? \\ -0.2 & -0.2 & ? \end{bmatrix}$$

$$\begin{bmatrix} ? & 0.15 & ? & -0.09 \\ -0.01 & ? & 0.29 & 1.15 \\ ? & 3.31 & 0.27 & ? \\ 0.22 & ? & ? & 1.84 \end{bmatrix}$$

8. The transfer function model for a process is given below:

$$y_1(s) = -\frac{0.1e^{-2s}}{s+0.1}u_1(s) - \frac{0.1}{s+0.1}u_2(s) \qquad (1)$$

$$y_2(s) = \frac{e^{-10s}}{60s+1}u_2(s) \quad (2)$$

a) Design a steady state decoupler for the process
b) Design dynamic decoupler using both simplified and generalized approach.
c) Is the decouplers physically realigble? If no, then augment the process with additional delay matrix to make it realizable.