ECEG 5510: Assignment (20%) Submission date: final exam date

Submit only the odd numbered questions (1&3)

1. Assume that you want to design a controller for a practical blending process application based on the steady state model. And you reach at a decision to use feedforward controller. The exit composition of the process is needed to be maintained at a set value of 0.6. The variation in the inlet composition X_1 is the main source of disturbance. The controller adjusts the flow rate W_2, having minimum value of 15LPH (Liters per Hour) and maximum value of 39LPH, to maintain the set value. Assume that the measuring device has an output of 4mA for composition value of 0 and 20mA for composition value of 1. If at some instant the inlet composition X_1 had value of the 0.35, provided that you designed the controller perfectly what is the value of

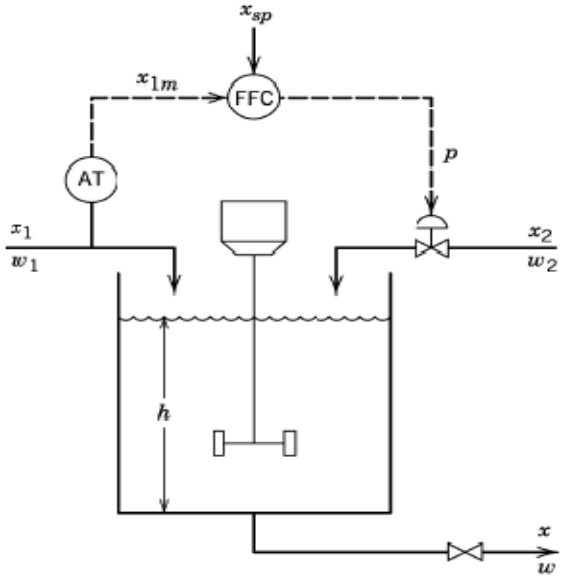
a. The output of the measuring device

b. The output of the controller

c. The manipulated variable, W_2

d. The output of I/P convertor

NB: Assume that the current-to-pressure transducer and the control valve operate as linear devices with negligible dynamics.
$\mathbf{W}_1$ has constant flow rate of 15LPH and stream 2 has mass fraction of X_2= 0.9.



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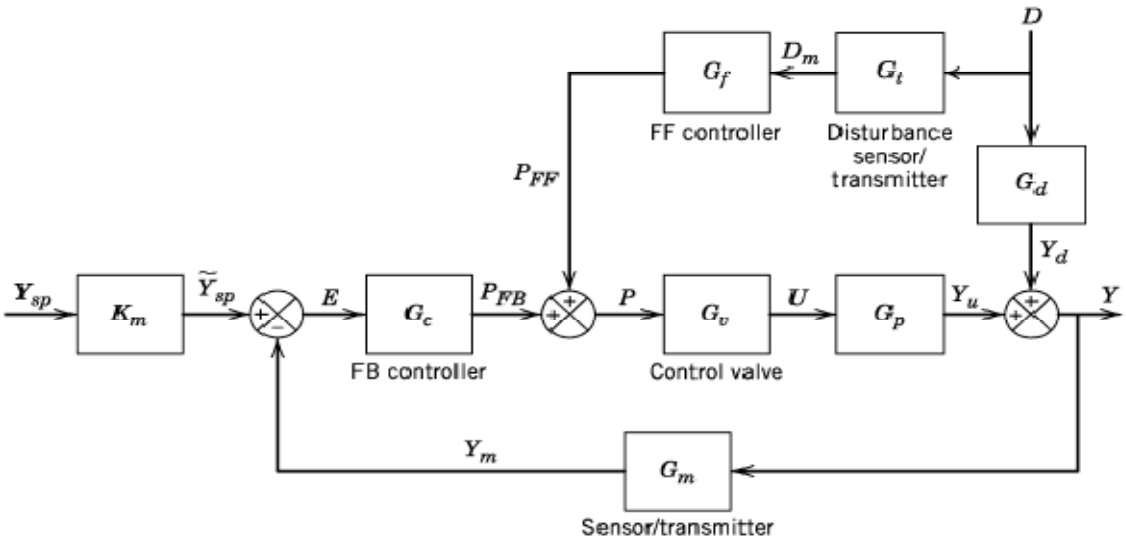
2. Consider the block diagram representation of feedback/feedforward control structure shown below.

If the sensor and the valve are characterized with their linear steady state gains $K_t = 4$ and $K_v = 3$ respectively and if the process dynamics is given as $G_p(s) = \frac{0.5}{(5s+1)(3s+1)}$ and $G_d(s) = \frac{1}{2s+1}$, then determine the **Lead/Lag** unit approximation of the feedforward controller.



3. Consider the stirred-tank heating system shown in the Figure below. It is desired to control temperature T_2 by adjusting the heating rate Q_1 via voltage signal V_1 to the SCR. It has been suggested that measurements of T_1 and T_o, as well as of T_2, could provide improved control of T_2. Assume that the main disturbance is coming from inlet temperature variation. Draw the schematic diagram of the control system if

a. Feedback control scheme is used

b. If feedforward control scheme is used

c. If **cascade control** scheme is used

d. Draw the equivalent block diagram representation of the above three control schemes (structures).

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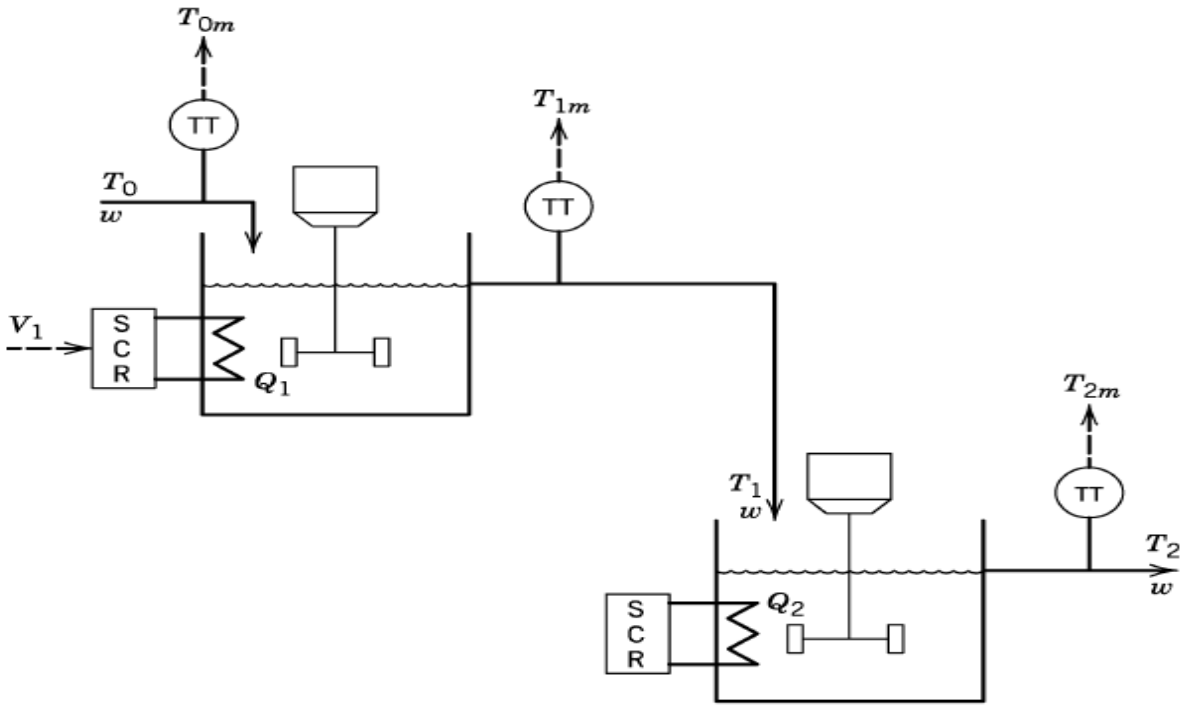
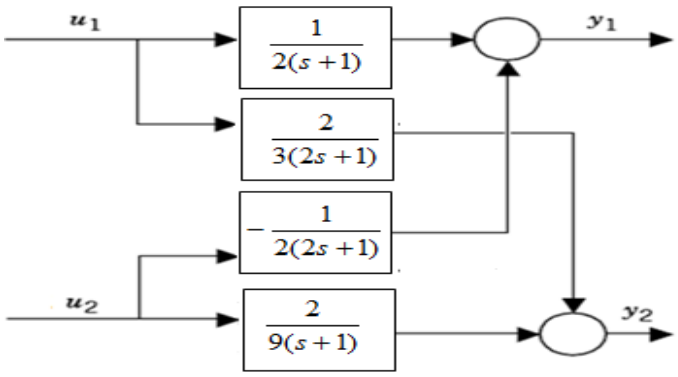


4. Consider 2X2 MIMO process shown by the diagram below



a. Determine the pairing of the manipulated and controlled variables based on steady state relative gain matrix (RGM) approach.

b. Design the appropriate decouplers to break the interaction between control loops.

c. Show the block diagram connection of the multiloop feedback control scheme of the process with decouplers.