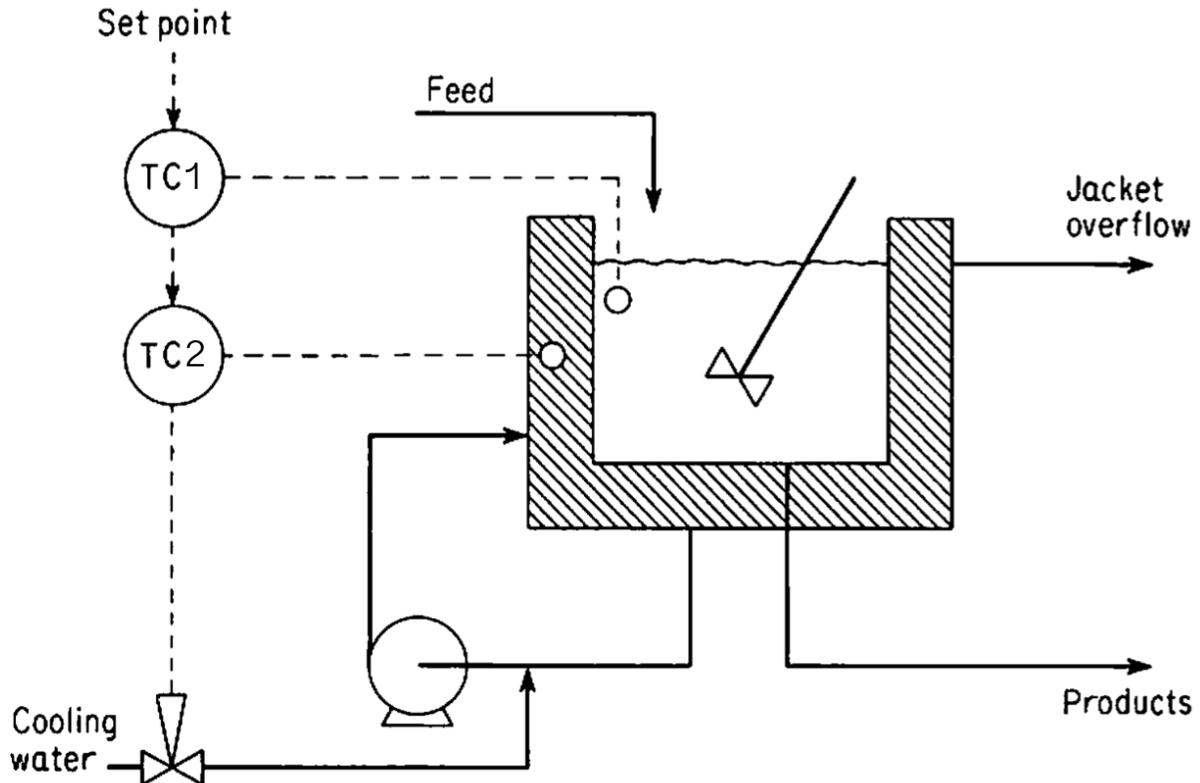


This tutorial provides some practice for cascade control systems.

Question 1

The outlet temperature from the tank is being controlled in a cascade control system, as shown below.



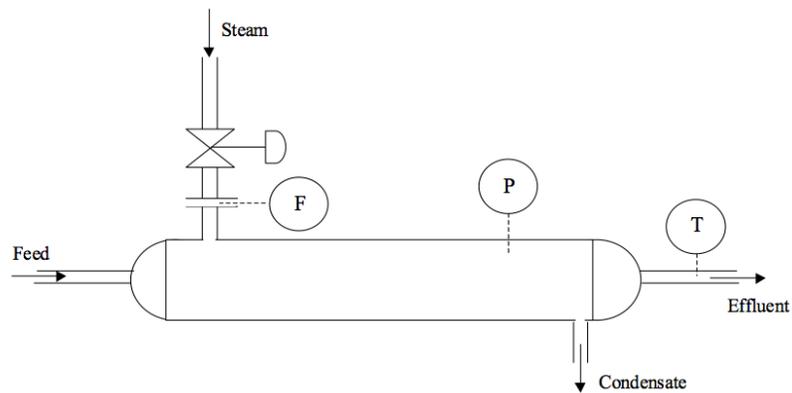
1. What is the primary variable in the cascade loop? _____
2. What is the secondary variable in the cascade loop? _____
3. What is the manipulated variable in the inner loop? _____
4. Explain whether a disturbance in the cooling water feed temperature will be removed rapidly with the cascade loop?

5. Explain whether a disturbance in the cooling water feed pressure will be removed rapidly with the cascade loop?

6. Explain whether a disturbance in the main feed temperature will be removed rapidly with the cascade loop?

Question 2

Update the process drawing below to add cascade control to the primary variable, T.

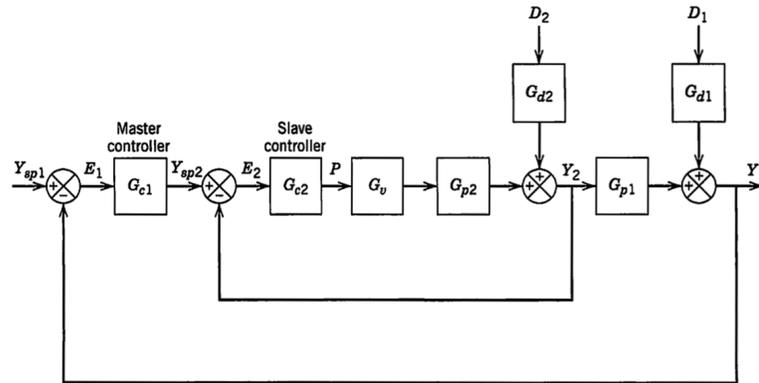


1. Explain how you chose your secondary variable.
2. For which disturbance(s) will your secondary variable be effective?

Over ...

Question 3

A block diagram for a cascade loop is shown below.



1. Derive a single transfer function from input Y_{sp2} to output Y_2 , assuming $D_2 = 0$.

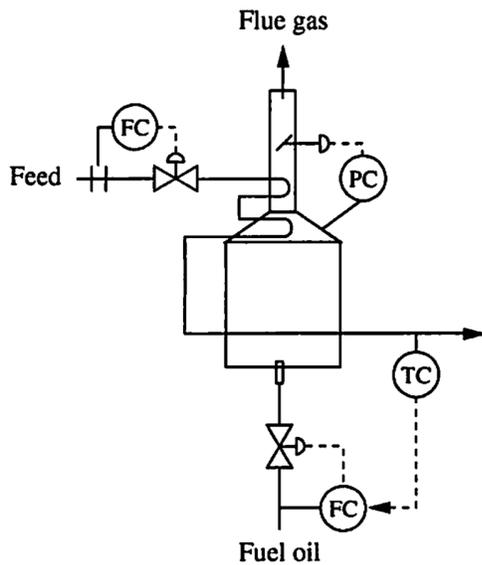
Do the next questions on a separate piece of paper.

2. Redraw the block diagram, replacing it now with your single block transfer function at the suitable place, but still incorporate the disturbance effect from D_2 .
3. What is the characteristic equation for the inner loop?
4. If the inner loop has proportional-only controller for G_{c2} , and $G_v = 3$, and $G_{p2}(s) = \frac{6}{2s + 1}$, derive a constraint (inequality) for the value of K_c so that the inner loop still has stable behaviour.
5. Explain whether this answer matches what we have learned earlier in the course?

Over ...

Question 4 [optional]

Consider the cascade system shown in the figure below:



1. Show that the cascade loop, as drawn, is appropriate. (Don't simply write "Y" or "N" next to the criteria; explain your answers). You may assume the first criterion is met, i.e. the performance without cascade control is not suitable.
2. Determine, use clear, logical reasoning, and all your prior engineering knowledge of heat transfer and fluid flow whether the cascade loop would provide performance that is "better", "worse" or "no different" to direct control of TC using the valve position.
 - (a) the disturbance is change in the composition of the fuel (i.e. the heating value changes)
 - (b) the feed temperature increases
 - (c) the pressure of the fuel decreases