CHL202: PROCESS SYSTEMS ANALYSIS & CONTROL
MAJOR – Thursday 6 May 2010 from 8:00 – 10:00 AM in Room WS 209

1. A process is described by the following transfer function

$$G_P(s) = \frac{4-16s}{(10s+1)(3s+1)}$$

a) What type of process is depicted by this kind of transfer function? Make a rough sketch of the response of the system to a unit step change.

b) When this system is placed in a closed loop with a proportional controller, and it is known that $G_V(s) = \frac{2}{s+1}$, $G_M = 1$, determine the stability limits of K_C.

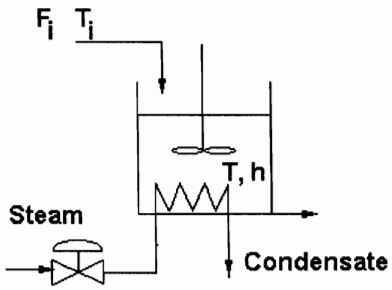
(2+3+5 marks)

2. a) Substrate concentration is being controlled in a fed-batch bioreactor using a PI controller. The process transfer function is $G_p = \frac{0.5}{2s+1}$, substrate measurement transfer function $G_m = \frac{3}{0.2s+1}$ and the PI controller transfer function is $G_C = 25\left(1+\frac{1}{20s}\right)$. Assume that the other components do not influence the closed-loop dynamics. Prepare a Table of the frequencies ranges and transfer functions, and draw the Bode Diagram.

b) With the help of a simple sketch, describe (i) Gain Margin (ii) Phase Margin

(6+2+2 marks)

3. Derive the dynamic mass and energy balance of a stirred tank heater (No Reaction) shown below. Next assume that F_i does not change and that the inlet temperature T_i is the disturbance. The amount of heat Q supplied by steam is the manipulated variable. The control objective is to keep the liquid temperature, T, at the desired set point value, T_{SP}. Develop the *static* and *dynamic* feed forward control laws for temperature for this process and *compare* the results.



(2+3+3+2 marks)

4. a) Derive the elements of the Relative Gain Array (RGA) for a general 2X2 system.

b) A distillation process is described by the following transfer function

$$x_D = \frac{0.6e^{-1.1s}}{(5s+1)(2s+1)}R(s) - \frac{0.5e^{-1.0s}}{(6s+1)(3s+1)}V(s)$$

$$x_B = \frac{0.3e^{-1.3s}}{(5s+1)(s+1)}R(s) - \frac{0.5e^{-1.0s}}{(5s+1)(s+1)}V(s)$$

Where compositions of the distillate x_D and bottoms x_B product are regulated by the reflux flow R and the vapour flow V.

Determine the elements of the RGA and recommend the pairing for the control loops.

(5+5 marks)