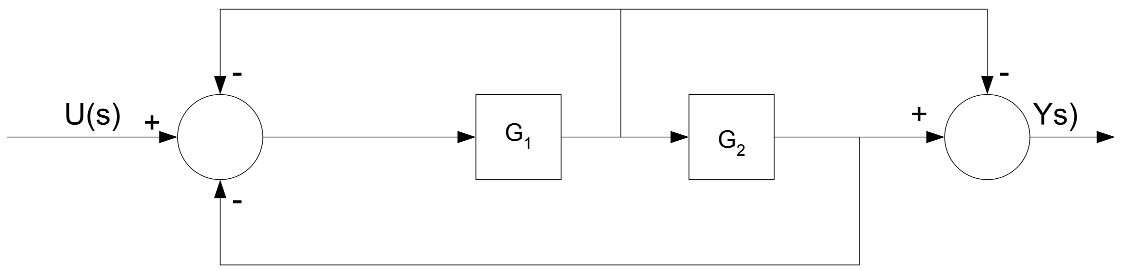
ECE 386
HOMEWORK-1
DUE DATE: 29-APRIL-2015

Q1) Obtain the transfer function $T(s)=\dfrac{Y(s)}{U(s)}$ for the system whose state-flow diagram is given below. **(20 POINTS)**



Q2) The input- disturbance-output relation of a system in Laplace Domain is given by the formula

$$Y(s)=G_1(s)G_2(s)U(s)+G_2(s)D(s)$$

where $G_1(s)=\dfrac{7}{s+7}$ and $G_2(s)=\dfrac{1}{s+1}$. Assume D(s) = 0 (no disturbance) and $U(s)=\sigma(s)=\dfrac{1}{s}$ (input is unit step input). Find y(t) (output signal in time domain). **(20 POINTS)**

Q3) A polynomial x(s) is given by the formula

$$x(s)=s^4-4s^3-7s^2+22s+24$$

Using Routh-Hurwitz method find the number of roots of x(s) on the Open Right Half Plane (ORHP). **(20 POINTS)**

Q4) A system is given by the matrix differential equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix}=\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}+\begin{bmatrix} 1 \\ 0 \end{bmatrix}u$$

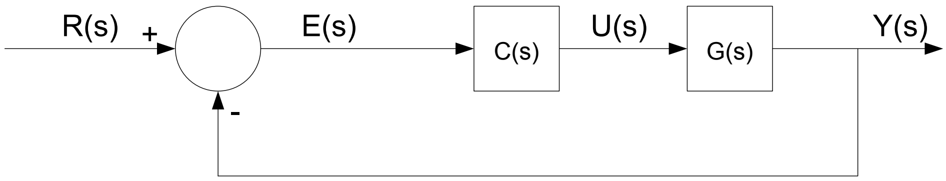
$$y=\begin{bmatrix} 1 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

a) Find the transfer function $T(s)=\dfrac{Y(s)}{U(s)}$. **(10 POINTS)**

b) Obtain the state flow diagram for this system in Laplace domain. **(10 POINTS)**

Hint: In the state flow diagram U(s) will be the input Y(s) will be the output and $X_1(s)$ and $X_2(s)$ will be the states. In the state flow diagram only use integrators whose transfer function is '$\dfrac{1}{s}$' (in rectangles) and summation points (in circles) while drawing the mathematical relation between the signals (U(s), Y(s), $X_1(s)$ and $X_2(s)$).

Q5) A **negative unity feedback** system is given as below where R(s) is the reference signal, E(s) is the error signal, U(s) is the input signal, Y(s) is the output signal, C(s) is the controller transfer function and G(s) is the plant transfer function. **(20 POINTS)**



a) Write the error signal E(s) in terms of R(s) C(s) and G(s). **(3 POINTS)**

b) Assume $C(s)G(s)=\dfrac{5}{s(s+1)(s+5)}$. Find the steady state error value 'e_{ss}' if the reference signal R(s) is a unit step signal ($R(s)=\sigma(s)=\dfrac{1}{s}$). **(3 POINTS)**

c) Assume $C(s)G(s)=\dfrac{5}{(s+1)(s+5)}$. Find the steady state error value 'e_{ss}' if the reference signal R(s) is a unit step signal ($R(s)=\sigma(s)=\dfrac{1}{s}$). **(3 POINTS)**

d) Assume $C(s)G(s)=\dfrac{5}{(s+1)(s+5)}$. Find the steady state error value 'e_{ss}' if the reference signal R(s) is a unit ramp signal ($R(s)=\sigma(s)=\dfrac{1}{s^2}$). **(3 POINTS)**

e) Assume $C(s)G(s)=\dfrac{1}{(s)(s+5)}$. Find the transfer function of the closed loop system $T(s)=\dfrac{Y(s)}{R(s)}$. Also find the damping ratio, resonant angular frequency, rise time, settling time and maximum overshoot (%). **(8 POINTS)**