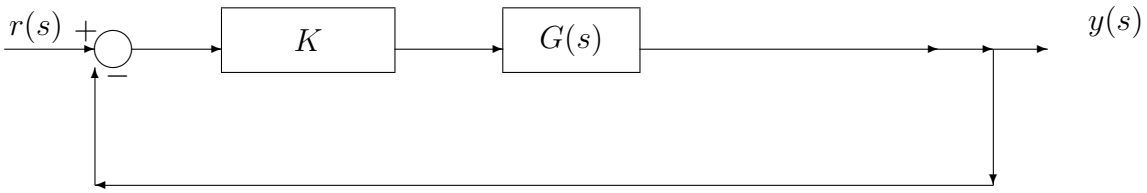
CHE 576 Assignment 6
due: March 30, 2012

Note: Show all your work. The use of MATLAB is allowed.

Q.1:

(10 marks)

A proportional controller ($G_c(s) = K$) is used to stabilize the following system:



$$G(s) = \frac{s+2}{s(s+5)(s^2+s+1)}$$

Find a range for K over which the closed-loop system is stable.

Q2

(10 marks) Given the plant:

$$\dot{\mathbf{x}} = \begin{bmatrix} 1 & -2 \\ 1 & 1 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u \tag{1}$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \mathbf{x} \tag{2}$$

find the controller $C(s) = \frac{\alpha_1 s+\alpha_0}{s+\beta_0}$ such that closed loop polynomial has stable $\sigma_{cl} = \{-1, -2, -3\}$ eigenvalues.

Q3

(15 marks) For the system given by:

$$\dot{\mathbf{x}} = \begin{bmatrix} 2 & 1 \\ -1 & 1 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u \tag{3}$$

$$y = \begin{bmatrix} 1 & 1 \end{bmatrix} \mathbf{x} \tag{4}$$

Part 1

Is the system stable? Is the system controllable? Is the system observable?

Part 2

Design a full state feedback controller that assigns the closed-loop eigenvalues to $\sigma_{cl} = \{-1, -2\}$

Part 3

Design a full order observer that assigns the observer closed-loop eigenvalues to $\sigma_{cl} = \{-\frac{3}{2}, -\frac{5}{2}\}$

Part 3

Given the state-feedback control law: $\mathbf{u} = \mathbf{K}\hat{x} + \mathbf{r}$, where $\mathbf{r}$ is input vector, K is the state-feedback matrix, determine the closed loop control transfer function $G_{cl}(s) = \frac{Y(s)}{R(s)}$.

Part 4

Design an output regulator which combines observer and state feedback and obtain state and estimated trajectories with initial condition $x_1(0) = 2$ and $x_2(0) = -2$. Plot the state and estimated state trajectories for the time interval so that you can demonstrate convergence of the state observer. (This part you can do with MATLAB)