O K L A H O M A   S T A T E   U N I V E R S I T Y

S C H O O L   O F   E L E C T R I C A L   A N D   C O M P U T E R   E N G I N E E R I N G

ECEN 4413
Automatic Control Systems
Spring 2005
Final Exam

Choose any four out of five problems.

Please specify which four listed below to be graded:

1)_____; 2)_____; 3)_____; 4)_____;

Name : _______________________________

Student ID: _________________________________

E-Mail Address:____

Problem 1:

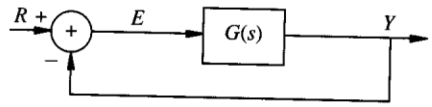
Let

$$H(s)=\begin{bmatrix}\dfrac{Y_1(s)}{U(s)}\\ \dfrac{Y_2(s)}{U(s)}\end{bmatrix}=\begin{bmatrix}\dfrac{2s^2+s-1}{s^2-1}\\ \dfrac{s+2}{s^2-1}\end{bmatrix}$$

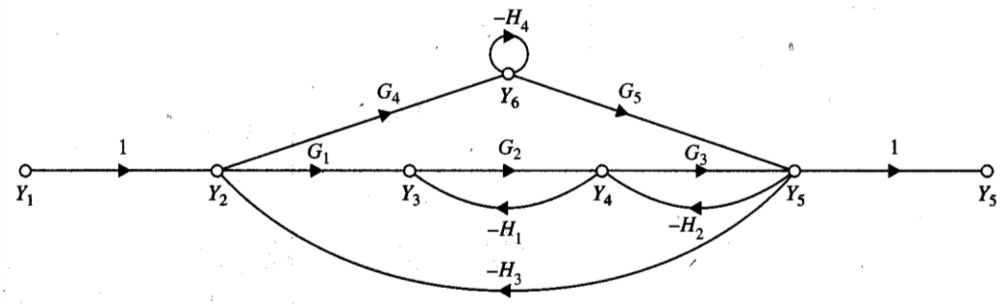
be a transfer function matrix for a single-input, two-output system. Find a *controllable* minimal realization using only two integrators. Show the resulted state diagram and its corresponding state space representation.

Problem 2:

Find the range of K in $G(s) = \dfrac{K}{s^4 + 6s^3 + 13s^2 + 12s + 4}$ for which the G-configuration equivalent system shown below is stable.



Problem 3:
Apply the gain formula to the SFG shown below to find the transfer functions of $\frac{Y_5}{Y_1}$ and $\frac{Y_5}{Y_2}$.



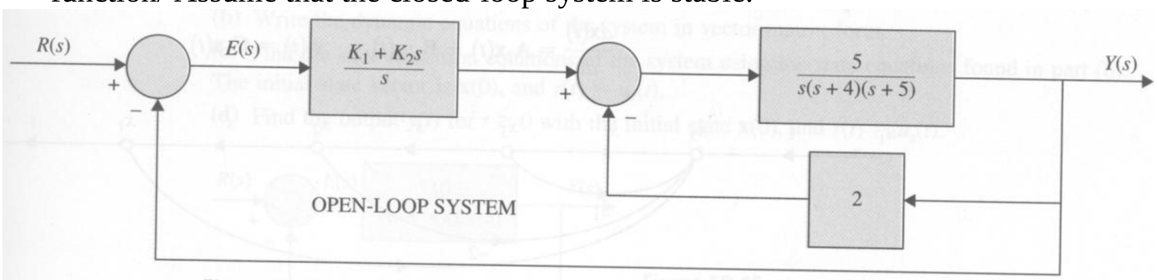
Problem 4:

The block diagram of a feedback control system is shown below.

a) Find the forward path transfer function $Y(s)/E(s)$ and the closed-loop transfer function $Y(s)/R(s)$.

b) Express the dynamic system in the form of state space representation, $\dot{x}(t) = Ax(t) + Br(t), \quad y(t) = Cx(t) + Dr(t)$.

c) Find the steady-state value of the output $y(t)$ when the input $r(t)$ is a unit-step function/ Assume that the closed-loop system is stable.



Problem 5:

Figure below shows the block diagram of a control system with conditional feedback. The transfer function $G_p(s)$ denotes the controlled process, and $G_c(s)$ and $H(s)$ are the controller transfer functions.

a) Derive the transfer function $Y(s)/R(s)\big|_{N=0}$ and $Y(s)/N(s)\big|_{R=0}$. Find $Y(s)/R(s)\big|_{N=0}$ when $G_p(s) = G_c(s)$.

b) Let

$$G_p(s) = G_c(s) = \frac{100}{(s+1)(s+5)},$$

find the output response $y(t)$ when $N(s) = 0$ and $r(t) = u_s(t)$ (i.e., unit step function).

c) With $G_p(s)$ and $G_c(s)$ as given in part b), select $H(s)$ among the following four choices such that when $n(t) = u_s(t)$ and $r(t) = 0$, the steady state value of $y(t)$ is equal to zero.

$$H(s) = \frac{10}{s(s+1)} \qquad H(s) = \frac{10}{(s+1)(s+2)}$$

$$H(s) = \frac{10(s+1)}{s+2} \qquad H(s) = \frac{K}{s}.$$

Keep in mind that the pole of the closed-loop transfer function must all be in the left-half *s*-plane in order for the final-value theorem, to be valid.