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 2009

Midterm Exam #1

Choose any four out of five problems.
Please specify which four listed below to be graded:
1)_____; 2)_____; 3)_____; 4)_____;

Name : _____

E-Mail Address:_____

Problem 1:

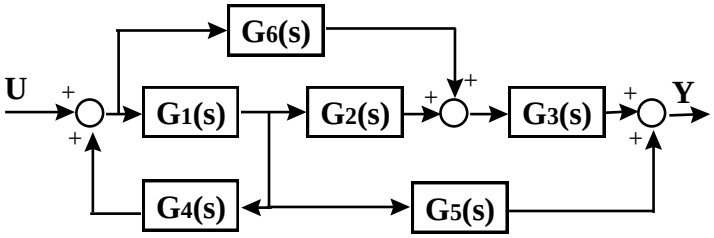
Given a system described by the transfer function

$$H(s) = \frac{Y(s)}{X(s)} = \frac{2s+3}{s^2+4s+13}$$

with initial conditions and input: $y(0) = 3$, $\left.\frac{dy(t)}{dt}\right|_{t=0} = -2$, $x(t) = e^{-4t}u(t)$, where $y(t)$ is the output response and $x(t)$ is the input signal. Find $y(t)$ and steady-state output.

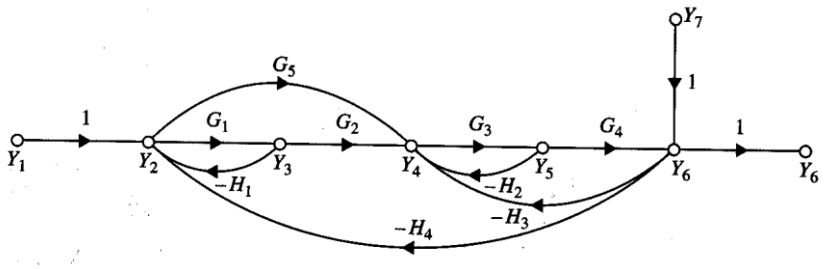
Problem 2:

Using the block diagram reduction technique, find the closed-loop transfer function, $H(s) = \frac{Y(s)}{U(s)}$.



Problem 3:

Apply the gain formula to the SFG shown below to find the transfer functions of $\left.\frac{Y_6}{Y_1}\right|_{Y_7=0}$ and $\left.\frac{Y_6}{Y_7}\right|_{Y_1=0}$.

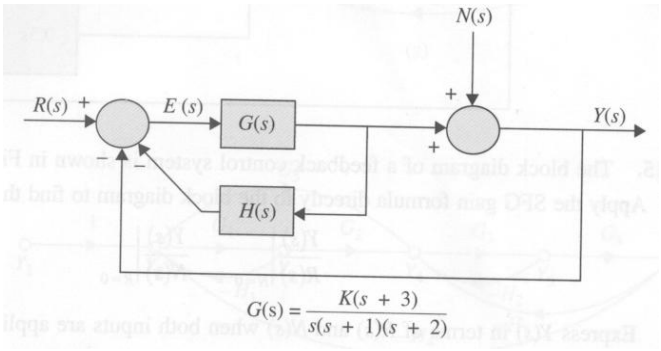


Problem 4:

Figure below shows the block diagram of a dc-motor control system (note the dc-motor is represented by $G(s)=\dfrac{K(s+3)}{s(s+1)(s+2)}$). The signal $N(s)$ denotes the frictional torque at the motor shaft.

a) Find the transfer function $H(s)$ so that the output $Y(s)$ is not affected by the disturbance torque $N(s)$.

b) With $H(s)$ as determined in part a), find the value of *K* so that the steady-state value of $e(t)$ is equal to 0.1 when the input is a unit-ramp function, $r(t)=tu(t)$ and $N(s)=0$.



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 functions $\left.\frac{Y(s)}{R(s)}\right|_{N=0}$ and $\left.\frac{Y(s)}{N(s)}\right|_{R=0}$. Find $\left.\frac{Y(s)}{R(s)}\right|_{N=0}$ when $G_c(s) = G_p(s)$.

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 choices such that when $n(t) = u_s(t)$ and $r(t) = 0$, the steady-state value of $y(t)$ is equal to zero. (There may be more than one answer.)

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

$H(s) = \frac{10(s+1)}{s+2}$ $\quad$ $H(s) = \frac{K}{s^n}$ (n = positive integer) Select n.

Keep in mind that the poles 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.