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

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

ECEN 4413/MAE 4053
Automatic Control Systems
Spring 2006

Midterm Exam #1

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

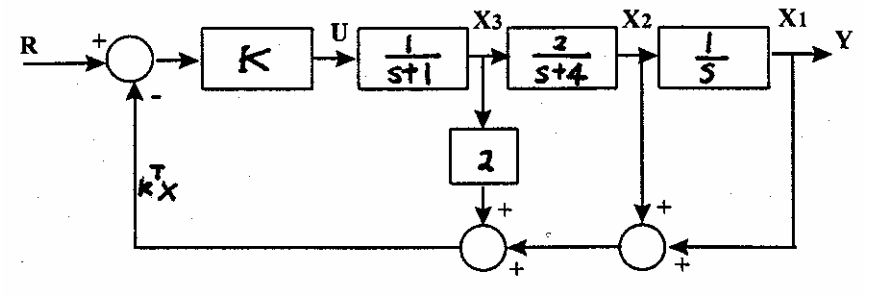
Name : _____

Student ID: _____

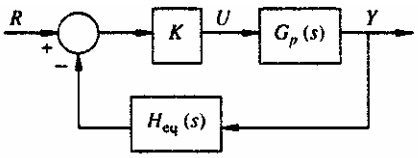
E-Mail Address:_____

Problem 1:

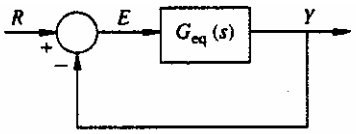
Using *block diagram reduction technique* to rearrange the following block diagram into the equivalent *H* and *G* configurations of the feedback control system shown below. Clearly identify the transfer functions for $G_p(s)$, $H_{eq}(s)$ and $G_{eq}(s)$.



H Configuration

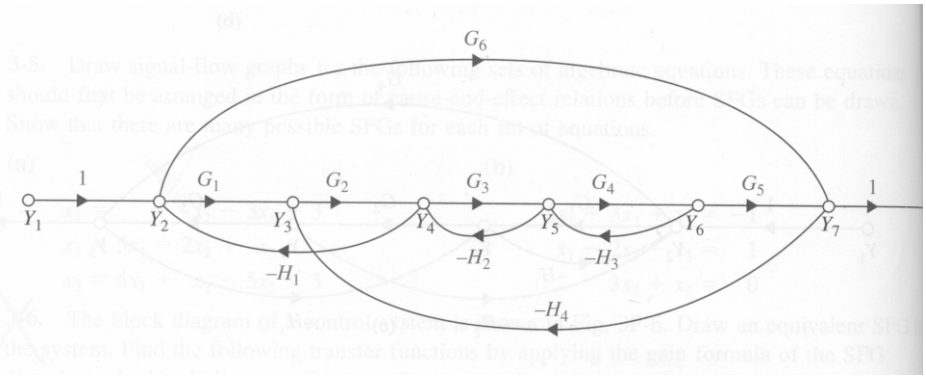


G Configuration



Problem 2:

Find the transfer functions $Y_7(s)/Y_1(s)$ and $Y_2(s)/Y_1(s)$ of the SFG shown below.



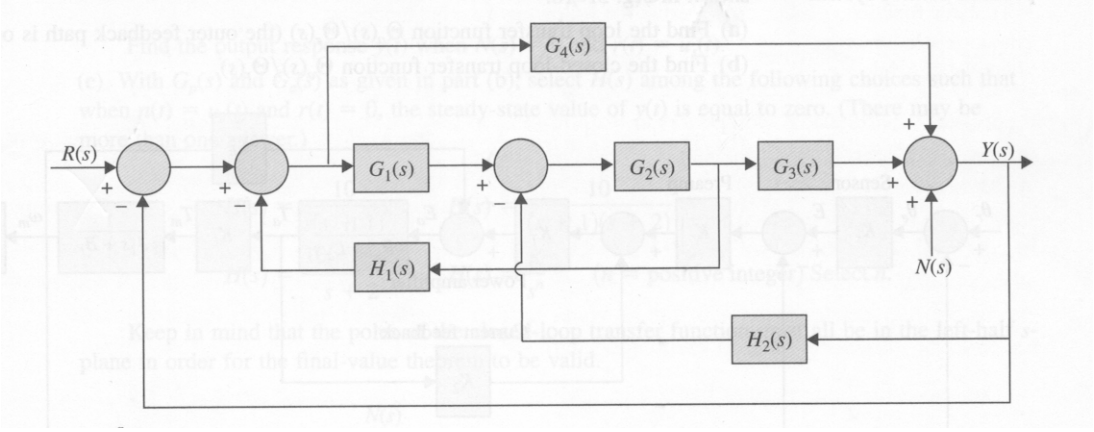
Problem 3:

The block diagram of a feedback control system is shown below

a) Apply the SFG gain formula directly to the block diagram to find the transfer functions $\left.\frac{Y(s)}{R(s)}\right|_{N=0}$ and $\left.\frac{Y(s)}{N(s)}\right|_{R=0}$.

Express $Y(s)$ in terms of $R(s)$ and $N(s)$ when both inputs are applied simultaneously.

b) Find the desired relation among the transfer functions $G_1(s)$, $G_2(s)$, $G_3(s)$, $G_4(s)$, $H_1(s)$ and $H_2(s)$ so that the output $Y(s)$ is not affected by the disturbance signal $N(s)$ at all.



Problem 4:

The differential equation of a linear system is

$$\frac{d^4y(t)}{dt^4} + 4\frac{d^3y(t)}{dt^3} + 3\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + y(t) = r(t)$$

where $y(t)$ is the output and $r(t)$ is the input.

a) Draw a state diagram for the system.

b) Write the state equation from the state diagram. Define the state variables from right to left in ascending order.

c) Find the transfer function $Y(s)/R(s)$.

d) Perform a partial fraction expansion of $Y(s)/R(s)$ and find the output $y(t)$ for $t \geq 0$ when $r(t)$ is fed with unit-step function. Find the final value of $y(t)$.

Problem 5:

Write the equation of motion for the linear translational system shown below. Draw the state diagram using a minimum number of integrators. Write the state equation from the state diagram. Find the transfer functions $Y_1(s)/F(s)$ and $Y_2(s)/F(s)$. Set $Mg = 0$ for the transfer function.