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

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:_______________________________________

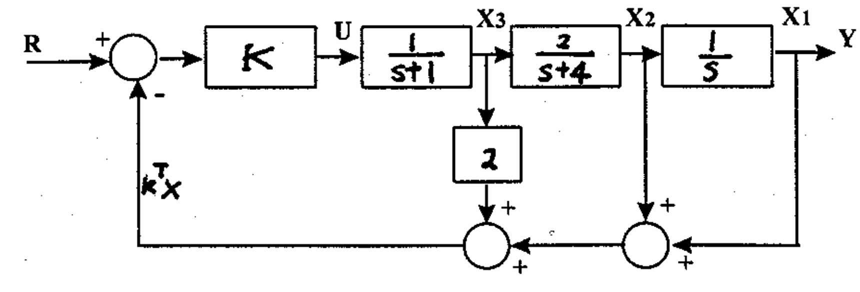
Problem 1:

The differential equation given below represents a linear time-invariant system, where $r(t)$ denotes the input and $y(t)$ the output. Find the transfer function, $Y(s)/R(s)$.

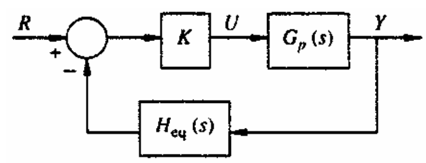
$$\frac{d^3y(t)}{dt^3}+10\frac{d^2y(t)}{dt^2}+2\frac{dy(t)}{dt}+y(t)+2\int_0^t y(\tau)d\tau=\frac{dr(t)}{dt}+2r(t)$$

Problem 2:

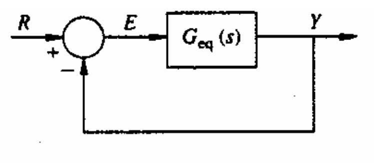
Using *block diagram reduction technique* to rearrange the following block diagram into the equivalent *H* and *G* configurations of the feedback control system shown below.



H Configuration

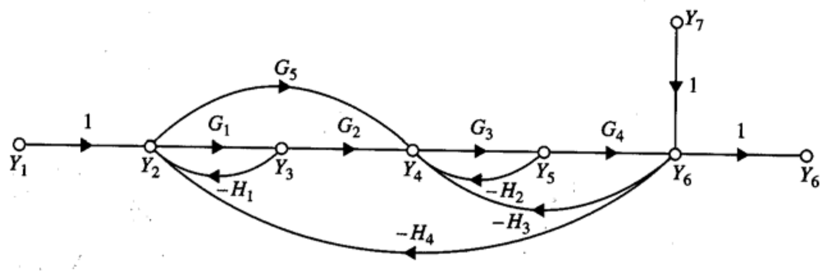


G Configuration



Problem 3:

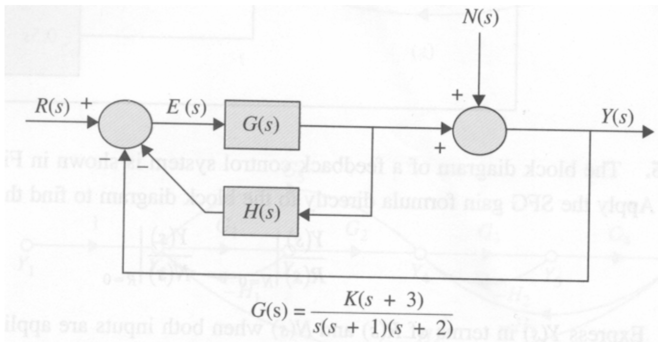
Apply the gain formula to the SFG shown below to find the transfer functions of $\left.\frac{Y_6}{Y_1}\right|_{Y_7=0}$ and $\left.\frac{Y_6}{Y_7}\right|_{Y_1=0}$.



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 $N(s) = 0$. Apply the final-value theorem.



Problem 5:

For the system described by input-output differential equation given below,

$$c\dddot{y} = (a+1)y + \dot{y} - b\ddot{y} + 2u + \dot{u} + \ddot{u},$$

find the state space representation in the form of

$$\begin{aligned} \dot{x}(t) &= Ax(t) + bu(t) \\ y(t) &= cx(t) + du(t) \end{aligned},$$

where input is $u(t)$ and output is $y(t)$.