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

ECEN 4413/MAE 4053
Automatic Control Systems
Spring 2007

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:_____

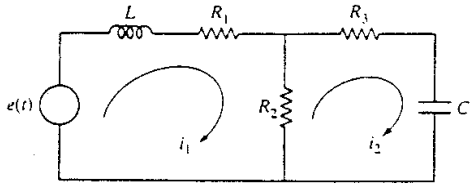
Problem 1:

For the RLC circuit shown below, consider voltage source $e(t)$ is the input (u) and voltage across capacitor C is the output (y) and then find various system representations:

a) input-output representation (described by ordinary differential equations)

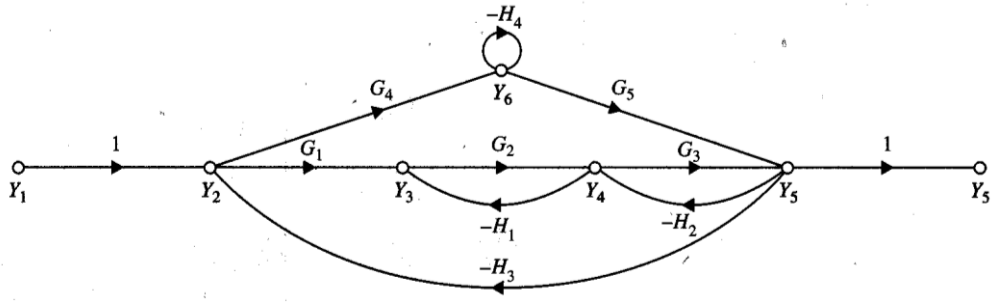
b) transfer function, $H(s) = Y(s)/U(s)$

c) state space representation, $\dot{x} = Ax + Bu, \quad y = Cx + Du$ and its state diagram



Problem 2:

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

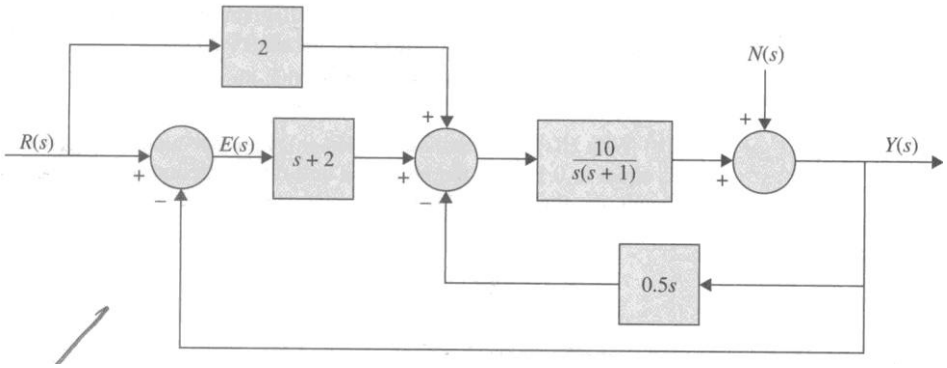


Problem 3:

The block diagram of a feedback control system is shown below. Find the following transfer functions:

a) $\left.\frac{Y(s)}{R(s)}\right|_{N=0}$, $\left.\frac{Y(s)}{E(s)}\right|_{N=0}$, $\left.\frac{Y(s)}{N(s)}\right|_{R=0}$

b) Find the output $Y(s)$ when $R(s)$ and $N(s)$ are applied simultaneously.

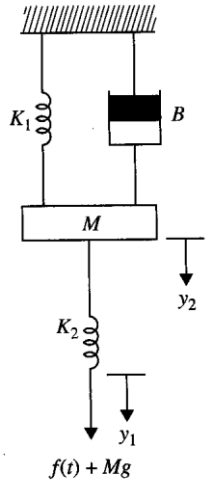


Problem 4:
Find a minimal state space representation for the MIMO system (using only three state variables) described by

$$\begin{aligned}\ddot{y}_1(t) - 5\dot{y}_1(t) + 10y_1(t) + 5y_2(t) &= u_1(t) + 2\dot{u}_1(t) - \ddot{u}_1(t)\\ \dot{y}_2(t) + 4\left[y_2(t) - y_1(t)\right] &= 2\dot{u}_2(t) - u_1(t)\end{aligned}.$$

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 $Y_2(s)/F(s)$.



(a)