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 2010

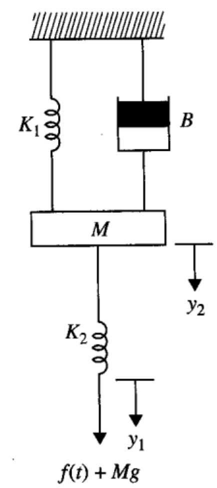
Midterm Exam #2

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

Name : ______________________________

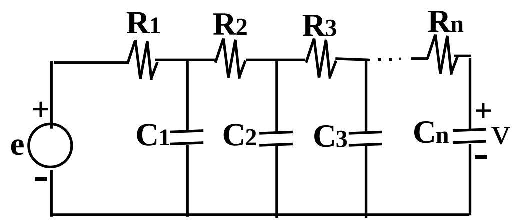
E-Mail Address:_______________________________________

Problem 1:
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 reaching asymptotic equilibrium.



Problem 2:

Choose state variables appropriately and then derive the transfer function $V(s)/E(s)$ for the given RC ladder circuit given below where e is the input source and V is the output response (note $R_1 \neq R_2 \neq \cdots \neq R_n$ and $C_1 \neq C_2 \neq \cdots \neq C_n$)..



Problem 3:

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

$$\begin{cases} \ddot{y}_1 + 3\dot{y}_1 + 2(y_1 - y_2) = u_1 + \dot{u}_2 \\ \dot{y}_2 + 3(y_2 - y_1) = u_2 + 2\dot{u}_1 \end{cases},$$

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 $u(t) = \begin{bmatrix} u_1(t) & u_2(t) \end{bmatrix}^T$ and output is $y(t) = \begin{bmatrix} y_1(t) & y_2(t) \end{bmatrix}^T$.

HINT: Choose state variables in such a way including u_2 and u_1 appropriately, so when dot equations are taken, the $\dot{u}_2$ and $\dot{u}_1$ will be absorbed.

Problem 4:

For the state variable description,

$$\dot{x}(t) = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u(t),$$

$$y(t) = \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} x(t)$$

if $u(t) = e^{-3t} u_s(t)$, where $u_s(t)$ is the unit step function and initial conditions are all zeros, find $y(t)$.

Problem 5:

Find the region of K in $G(s)$ for which the G-Configuration (with unity feedback) will be stable, specifically $G(s) = \dfrac{K(s^2 + 15s + 55)}{s(s^2 + s + 10)}$.