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 #2

For all students, choose any four out of five problems.
Please specify which four listed below to be graded :
1)_____; 2)_____; 3)_____; 4)_____;

Name : _____

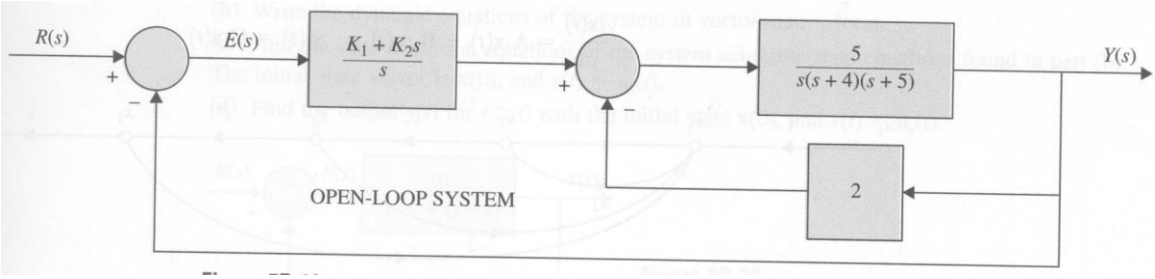
E-Mail Address:_____

Problem 1:

The block diagram of a feedback control system is shown below.

a) Find the forward path transfer function $Y(s)/E(s)$ and the closed-loop transfer function $Y(s)/R(s)$.

b) Express the dynamic system in the form of state space representation, $\dot{x}(t) = Ax(t) + Br(t), \quad y(t) = Cx(t) + Dr(t)$.



Problem 2:

Given a nonlinear system described by

$$\ddot{y} - \dot{y} - e^{a+1} y = \ddot{u} + \dot{u} + 2u ,$$

linearize the system about the equilibrium point and show the linearized state space representation in $\dot{x} = Ax + Bu,\ y = Cx + Du$.

Problem 3:

For the matrix

$$A = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix},$$

determine the e^{At}.

Problem 4:
Prove that a square matrix with distinct eigenvalues is nonsingular if and only if there is no zero eigenvalue.

Problem 5:

Find the solution of $\dot{x}(t) = Ax(t) + Bu(t)$, where

$$A = \begin{bmatrix} 1 & 0 & 1 \\ -1 & 2 & -1 \\ 0 & 0 & 3 \end{bmatrix} \text{ and } B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$$

with

$$x(0) = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \text{ and } u(t) = 1 \text{ for all } t \geq 0.$$