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 5713 Linear Systems
Fall 2003
Final Exam

Ph.D. Students- DO ALL FIVE PROBLEMS

MS Students- Choose FOUR out of five problems: Indicate below which four are chosen

1).____ 2).____ 3).____ 4).____

Name: ______________________________

Student ID: ________________________________

E-Mail Address:_______________________________________

Problem 1:
Find an canonical form realization (in minimal order) from SISO continuous-time system given below:

$$5\ {}^{2}\,\ddot{}(\ )+(\ -1)\,\dot{}(\ )+\ {}^{-2}\ (\ )=2\,\ddot{}(\ )+2\ \dot{}(\ )-\ {}^{2}\ (\ )\ .$$

Notice that gain blocks may be dependent. Show the state space representation and its corresponding simulation diagram.

Problem 2:

a) Prove that a square matrix is nonsingular if and only if there is no zero eigenvalue.

b) Show that functions of the same matrix commute, i.e., $(\ )\ (\ ) = (\ )\ (\ )$.

<u>Problem 3</u>:

Show that if λ is an eigenvalue of the matrix

$$= \begin{bmatrix} 0 & 1 & 0 & \cdots & 0 \\ 0 & 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & 1 \\ -\alpha_0 & -\alpha_1 & -\alpha_2 & \cdots & -\alpha_{\ -1} \end{bmatrix},$$

then a corresponding eigenvector is $= \begin{bmatrix} 1 & \lambda & \cdots & \lambda^{\ -1} \end{bmatrix}$.

Problem 4:

Find an "equivalent" continuous-time dynamical equation of

$$\begin{bmatrix} {}_1(\ \ +1) \\ {}_2(\ \ +1) \\ {}_3(\ \ +1) \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix} \begin{bmatrix} {}_1(\ ) \\ {}_2(\ ) \\ {}_3(\ ) \end{bmatrix} + \begin{bmatrix} 0 & 1 \\ 1 & 2 \\ -1 & 1 \end{bmatrix} (\ ),$$

$$(\ ) = \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} {}_1(\ ) \\ {}_2(\ ) \\ {}_3(\ ) \end{bmatrix}.$$

Problem 5:

Show the continuous, time-invariant system $\dot{}\ =\ \ +$ is controllable, if and only if $\rho[\lambda\ \ -\ \ ,\ \ ] =$ for every eigenvalue λ , $= 1, \cdots,$ of .