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
Spring 2008
Final Exam

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:

Find an *observable* canonical form realization (in minimal order) from SISO discrete-time system given below:

$$y(k+3)+3ky(k+2)+e^{-k}y(k+1)+y(k)=k^2u(k+3)-(k+1)u(k+1).$$

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

Problem 2:

Find a minimal *observable* canonical form realization (i.e., its simulation diagram and state space representation) for the following MISO system described by

$$H(s) = \begin{bmatrix} \dfrac{2s}{s^3 + 6s^2 + 11s + 6} \\ \dfrac{s^2 + 2s + 2}{s^4 + 6s^3 + 9s^2 + 4s} \end{bmatrix}$$

Please note matrix *A* should be a 6×6 matrix.

Problem 3:
Prove that a square matrix is nonsingular if and only if there is no zero eigenvalue.

Problem 4:

For the matrices

$$A_1 = \begin{bmatrix} 2 & 2 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \quad A_2 = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix},$$

Determine the function of matrices $e^{A_1 t}$, A_2^{99}, and $\cos A_2 t$.

Problem 5:

Verify that $B(t) = \Phi(t, t_0) B_0 \Phi^*(t, t_0)$ is the solution of

$$\frac{d}{dt} B(t) = A(t)B(t) + B(t)A^*(t), \quad B(t_0) = B_0,$$

where $\Phi(t, t_0)$ is the state-transition matrix of $\dot{x}(t) = A(t)x(t)$ and $\Phi^*(t, t_0)$ is the complex conjugate of $\Phi(t, t_0)$.