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 2000
Final Exam

Name : ______________________________

Student ID: ________________________________

E-Mail Address:_______________________________________

Problem 1: (25%)

Find an "equivalent" continuous-time *Jordan-canonical-form* dynamical equation of

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \\ \dot{x}_3(t) \end{bmatrix} = \begin{bmatrix} 0 & 4 & 3 \\ 0 & 20 & 16 \\ 0 & -25 & -20 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -1 & 1 \end{bmatrix} u(t),$$

$$y(t) = \begin{bmatrix} 0 & 1 & -1 \\ 1 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix}.$$

<u>Problem 2</u>: (25%)

For the matrix

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

determine the functions of matrix A, 1) A^{101}, and 2) $e^{\sin At}$.

Problem 3: (25%)

Determine the state transition matrix $\Phi(t, t_0)$ for the system of equation

$$\dot{x} = e^{-At} B e^{At} x,$$

where $A \in \Re^{n \times n}$ and $B \in \Re^{n \times n}$. Investigate the case when in particular $AB = BA$.

<u>Problem 4</u>: (25%)

Consider the system

$$\dot{x} = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 2 \end{bmatrix} x,$$

$$y = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} x,$$

if possible, select initial state in such a manner so that $y(t) = te^{-t}, t \geq 0$.

<u>Problem 5</u>: (10% bonus)

Is it possible to transform a time-invariant system, $\{A, B, C\}$, into $\{0, \overline{B}, \overline{C}\}$ by equivalence transformation?