ECEN 5713 Linear Systems
Fall 2002
Midterm Exam #1

Choose any four out of five problems,
*Please specify*
1)_____ ; 2)_____ ; 3)_____ ; 4)_____ ;

Name : ______________________________

Student ID: ______________________________

E-Mail Address: ______________________________
Problem 1:
Suppose it is known that a linear, continuous-time system has impulse response given by
\[ h(t, \tau) = \exp(-|t - \tau|)l(t - \tau), \]
where \( l(\cdot) \) denotes a unit step function. Is this system causal? Is it time-invariant? Justify your answer.
**Problem 2:**
Find the *observable* canonical form realization (in minimal order) from SISO continuous-time system given below:

\[ 5t^2 \ddot{y}(t) + (t - 1) \dot{y}(t) + e^{-2t} y(t) = 2\ddot{u}(t) + 3t\dot{u}(t) + t^2 u(t). \]

Notice that gain blocks may be *time* dependent. Show the state space representation and its simulation diagram.
Problem 3:
Find the 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 time dependent. Show the state space representation and its simulation diagram.
**Problem 4:**
Find an minimal controllable canonical form realization for the following system

\[
H(s) = \begin{bmatrix}
\frac{2s}{s^3 + 6s^2 + 11s + 6} \\
\frac{s^2 + 2s + 2}{s^3 + 6s^3 + 9s^2 + 4s}
\end{bmatrix}.
\]

Note $A$ is a $6 \times 6$ matrix
Problem 5:
Let
\[ H(z) = \begin{bmatrix} \frac{z + 2}{z^2 + z} & \frac{z}{z^3 + z} \\ \frac{1}{z^3 + z} & \frac{z + 1}{z^2 + 2z} \end{bmatrix} \]
be a transfer function matrix. Find a minimal realization (i.e., simulation diagram and state space representation) for the discrete-time system represented by \( H(z) \).