ECEN 5713 Linear System
Fall 1998
Midterm Exam #1

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**Problem 1:**
Suppose it is known that a discrete-time system has impulse response described by
\( h(n, k) = \sin k u(n - k) \). Is this system causal? Is it time-invariant? Please justify your answer.
Problem 2:
Linearize the (bilinear control) system described by
\[ \dot{y} + (3 + y^2)\dot{y} + (1 + y + y^2)u = 0 \]
about the equilibrium point. Show the linearized state space representation (i.e., including state equation and output equation).
Problem 3:
Consider the linear system described by
\[
y(t) = \int_{-\infty}^{t} \left( t + e^{-\tau} \sin(t - \tau)e^\tau + 2 - \tau \right)u(\tau)d\tau
\]
find the transfer function \( H(s) \) and state space representation \( \{ A, B, C, D \} \) with corresponding simulation diagram.
Problem 4:
Realize the following SIMO discrete-time, time-varying system and show the state space representation \( \{A(k), B(k), C(k), D(k)\} \) with corresponding simulation diagram

\[
y_1(k) + k^2 y_2(k - 1) + ky_1(k - 2) = u(k) + k^2 u(k - 1) + ku(k - 2)
\]

\[
\frac{1}{k + 1} y_2(k + 2) + k^2 y_1(k) = u(k + 2) + ku(k + 1) + 2u(k)
\]