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 2000
Midterm Exam #1

Name : _____

Student ID: _____

E-Mail Address:_____

Problem 1:

Consider the *truncation* and *shift* operators defined by,

$$T_\tau(u(t)) = \begin{cases} u(t) & t \le \tau \\ 0, & t > \tau \end{cases},$$

and

$$Q_\tau(u(t)) = u(t-\tau),$$

respectively. If a given system is described by

$$y(t) = Q_t\left(T_t(u(t))\right),$$

Is it causal ? Is it linear ? And is it time-invariant (fixed) ? Justify your answers.

Problem 2:

Linearize the following bilinear control system and show the linearized state space representation (i.e., $\{A, B, C, D\}$),

$$\ddot{y}(t) + (3 + \dot{y}^2(t))\dot{y}(t) + (1 + y(t) + y^2(t))u(t) = 0.$$

Problem 3:

Realize the following SIMO discrete-time, time-varying system and show one feasible state space representation, i.e., $\{A(t), B(t), C(t), D(t)\}$,

$$ky_1(k+2) + 2y_2(k+2) + k^3 y_2(k) = u(k+2) + (k+1)^2 u(k+1) - e^k u(k)$$

$$\frac{1}{1+k} y_2(k+1) + ky_1(k) = \sin ku(k+1) - 2u(k)$$

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Problem 4:

Consider the discrete-time, LTI system described by

$$y(n) = \sum_{k=-\infty}^{n} \left(2 - n + n\frac{2^n}{2^k} + k - 2^n k 2^{-k} \right) u(k),$$

find the transfer function $H(z)$ and the state space representation $\{A, B, C, D\}$ with corresponding simulation diagram.

Problem 5:

Let

$$H(z)=\begin{bmatrix} \dfrac{2z^2+z-1}{z^2-1} & \dfrac{1}{z^2+2z-3} \\ \dfrac{z+2}{z^2-1} & \dfrac{3z^2+1}{z^2+z+2} \end{bmatrix}$$

be a transfer function matrix. Find a minimal realization (i.e., simulation diagram and state space representation) for discrete-time system, $H(z)$.