UNIVERSITY OF TEXAS AT AUSTIN
Dept. of Electrical and Computer Engineering

Quiz #1

Date: October 4, 1999 Course: EE 313

Name: _____
Last, First

- The exam is scheduled to last 50 minutes.
- Open books and open notes. You may refer to your homework and solution sets.
- Calculators are allowed.
- You may use any standalone computer system, i.e. one that is not connected to a network.
- All work should be performed on the quiz itself. If more space is needed, then use the backs of the pages.
- Fully justify your answers unless instructed otherwise.

Problem	Point Value	Your Score	Topic
1	30		Differential Equation
2	20		Continuous-Time Convolution
3	30		Tapped Delay Line
4	20		Discrete-Time Stability
Total	100		

Problem 1.1 Differential Equation. 30 points.

Given the following differential equation

$$\frac{d^2}{dt^2}y(t) + 2\frac{d}{dt}y(t) + y(t) = f(t)$$

(a) What are the characteristic roots? 5 points.

(b) Find the zero-input response assuming non-zero initial conditions for $y'(0)$ and $y''(0)$. You may leave your answer in terms of C_1 and C_2. 15 points.

(c) Find the zero-input response for the initial conditions $y'(0) = 1$ and $y''(0) = -2$. 10 points.

Problem 1.2 Continous-Time Convolution. 20 points.

Sketch the following convolutions. On the sketches, clearly label significant points on the t and $y(t)$ axis. You do not have to show intermediate work, but showing intermediate work may qualify for partial credit.

(a) $y(t) = p(t) * p(t)$, where $p(t) = \begin{cases} 1 & \text{for } 0 \leq t \leq 1 \\ 0 & \text{otherwise} \end{cases}$. 10 points.

(b) $y(t) = u(-t) * u(-t)$, where $u(t)$ is the unit step function. 10 points.

Problem 1.3 Tapped Delay Line. 30 points.

A tapped delay line is a continuous-time linear time-invariant system. A block diagram for a tapped delay line is shown below. For input $x(t)$, the output $y(t)$ is

$$y(t) = \sum_{n=0}^{N-1} a_n x(t - nT)$$

(a) How would you characterize the tapped delay line? 2 points.

1. Infinite impulse response
2. Finite impulse response

(b) Compute the impulse response $h(t)$. 7 points.

(c) Compute the step response, i.e. the response when unit step $u(t)$ is input. 7 points.

(d) Sketch the step response for $N = 3$. The sketch should be in terms of T, a_0, a_1, a_2, and a_3. 7 points.

(e) What is the system time constant as a function of N, T, a_0, a_1, ..., a_{N-1}? You can answer this based on either the impulse response or step response. 7 points.

Problem 1.4 Discrete-Time Stability. 20 points.

Given a linear time-invariant discrete-time system with input $f[k]$ and output $y[k]$ described by the following difference equation

$$y[k] - \frac{3}{2}y[k-1] + Ky[k-2] = f[k]$$

where K is a real-valued parameter,

(a) What are the characteristic roots? 5 points.

(b) For what range of K makes the system stable? 15 points.