University of Texas at Austin
Dept. of Electrical and Computer Engineering
Quiz #1

Date: October 11, 2001 Course: EE313

Name: ____
Last, First

- The exam is scheduled to last 75 minutes.
- Open books and open notes. You may refer to your homework and solution sets.
- Calculators are allowed.
- You may use any stand alone 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	25		Differential Equation
2	20		Convolution
3	20		Linear System Theory
4	20		Discrete-Time Stability
5	15		Continuous-Time Stability
Total	100		

Problem 1.1 Differential Equation. 25 points.
Given the following differential equation

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

(a) What are the characteristics 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. 10 points.

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

Problem 1.2 Convolution. 20 points.
Perform the following convolutions

(a) Continuous-time convolution. 10 points.
A first-order all-pass filter impulse response is given by

$$h(t) = -\delta(t) + 2e^{-t}u(t)$$

Find the zero-state response of this filter for the input $f(t) = e^{t}u(-t)$

(b) Discrete-time convolution. 10 points.
The system impulse response of a linear time-invariant system is given by

$$h[k] = \left[(2)^k + 3(-5)^k\right]u[k]$$

Find the zero-state response of this system for the input $f[k] = (3)^{k+2}u[k]$

Problem 1.3 Linear System Theory. 20 points.

For an AM radio transmitter, the input $m(t)$ is a message signal (speech/audio) and the output $y(t)$ is a radio frequency signal:

$$y(t) = A(1 + k_a m(t))\cos(2\pi f_c t)$$

where f_c is the frequency of the AM radio station.

(a) Draw a block diagram of the system. 5 points.

(b) Is the system linear? Either prove that it is linear, or give a counter-example. 5 points.

(c) Is the system time-invariant? Either prove that it is time-invariant, or give a counter-example. 5 points.

(d) Does the system have memory? Please give some justification to your answer. 2.5 points.

(e) Is the system causal? Please give some justification to your answer. 2.5 points.

Problem 1.4 Discrete-Time Stability. 20 points.

For a discrete-time linear time-invariant system with an impulse response $h[k]$, the condition on $h[k]$ for the system to have bounded-input bounded-output (BIBO) stability is

$$\sum_{k=-\infty}^{\infty} |\, h[k]| < \infty$$

(a) Give an example of a marginally stable system and show that it is BIBO unstable. 15 points.

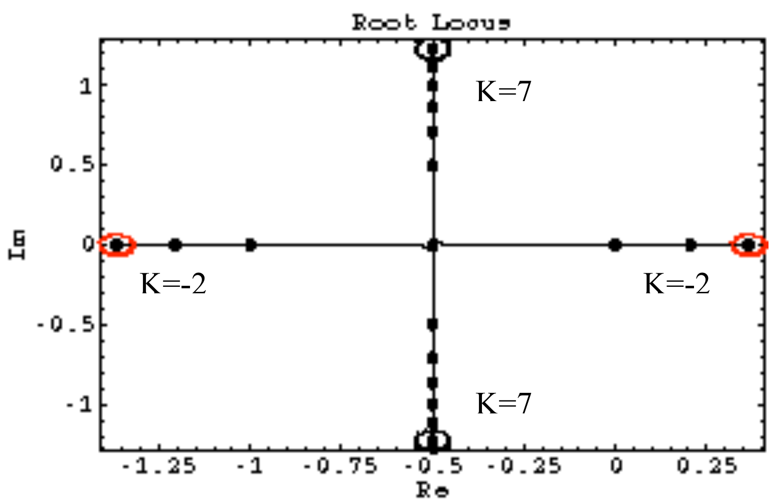
(b) What are the characteristic roots? 5 points.

Problem 1.5 Continuous-Time Stability. 15 points.

A linear time-invariant continuous-time system with input $f(t)$ and output $y(t)$ is described in the following differential equation

$$4\frac{d^2}{dt^2}y(t)+4\frac{d}{dt}y(t)+Ky(t)=f(t)$$

where K is a real-valued parameter. Below is the plot of the roots for $K\in[-2,7]$. The horizontal axis is the real part of the root, and the vertical axis is the imaginary part of the root.



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

(b) What range of K makes the system stable? 10 points.