

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

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

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

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

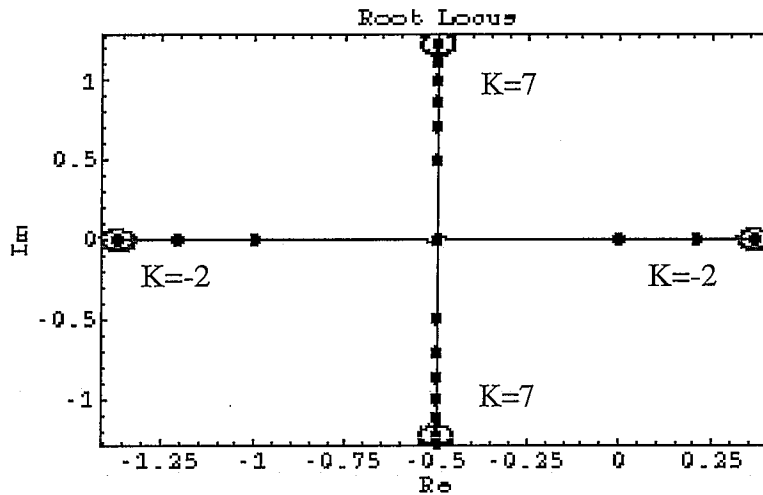
- (a) Give an example of a marginally stable system and show that it is BIBO unstable. 15 points.
- (b) What are the characteristic roots? 5 points.

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.