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

Date: October 2, 2003 Course: EE 313 Evans/Arifler

Name: _____
Last, First

- The exam is scheduled to last 75 minutes.
- Open books and open notes. You may refer to your homework assignments and the homework 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	20		Differential Equation
2	20		Discrete-Time System Response
3	20		Tapped Delay Line
4	24		Continuous-Time System Responses
5	16		Potpourri
Total	100		

Problem 1.1 Differential Equation. 20 points.

For a continuous-time system with input $f(t)$ and output $y(t)$ governed by the differential equation

$$\frac{d^2}{dt^2}y(t) + 7\frac{d}{dt}y(t) + 6y(t) = f(t)$$

(a) What are the characteristics roots of the differential equation? 4 points.

(b) Find the zero-input response assuming non-zero initial conditions. Please leave your answer in terms of C_1 and C_2. 8 points.

(c) Find the zero-input response for the initial conditions $y(0^+) = 5$and $y'(0^+) = 0$. 8 points.

Problem 1.2 Discrete-Time System Response. 20 points.

A discrete-time linear time-invariant system has the impulse response

$$h[k] = \left(\frac{1}{2}\right)^k u[k]$$

By any means necessary, find the output $y[k]$ for

(a) an input of

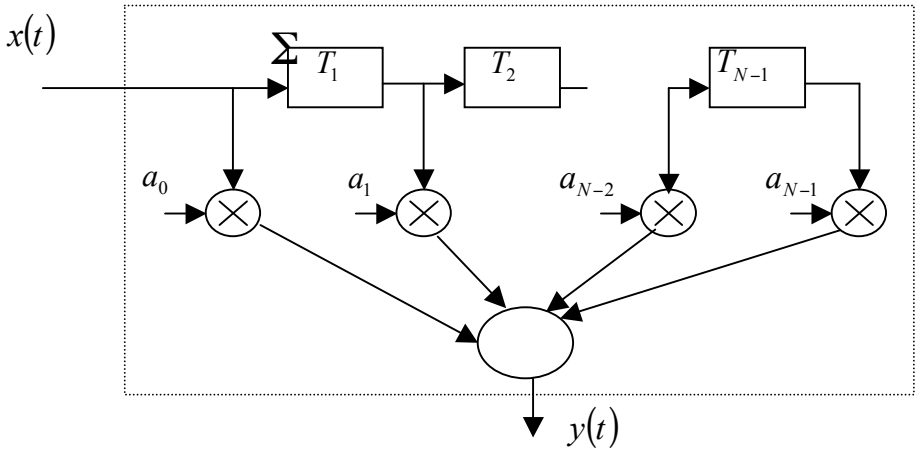
$$f[k] = \left(\frac{1}{2}\right)^k u[k]$$

(b) an input of a rectangular pulse

$$f[k] = \begin{cases} 1 & \text{for } 0 \le k \le N-1 \\ 0 & \text{otherwise} \end{cases}$$

Problem 1.3 Tapped Delay Line. 20 points.

A continuous-time tapped delay line, in which each of the N-1 delay blocks has a possibly different delay value, is shown below as a block diagram:



(a) Give a formula for the impulse response $h(t)$. 5 points.

(b) Sketch the impulse response $h(t)$. 5 points.

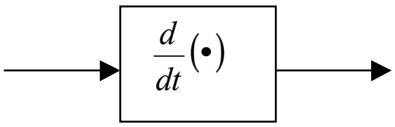
(c) Give a formula for the step response, i.e. the response when the unit step $u(t)$ is input. 5 points.

(d) What is the system time constant? 5 points.

$f(t)$ $y(t)$

Problem 1.4 Continuous-Time System Responses. 24 points.

Consider the continuous-time linear time-invariant system with input $f(t)$ and output $y(t)$ that is an ideal differentiator shown on the right:



(a) What is the impulse response? 8 points.

(b) What is the (unit) pulse response? 8 points.

(c) What is the (unit) step response? 8 points.

Problem 1.5 Potpourri. 16 points.

(a) Derive the shifting property of the impulse signal using the convolution definition

i. In continuous time. $f(t) * \delta(t - t_0) = f(t-t_0)$. 4 points.

ii. In discrete time: $f[k] * \delta[k - k_0] = f[k - k_0]$. 4 points.

(b) Give one signal processing or communication system that uses each of the following subsystems and describe the role that the subsystem plays in the function of the overall system:

i. Resonators. 4 points.

ii. Oscillators. 4 points.