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

Quiz #2

Date: November 3, 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		Step-To-Pulse Response
3	30		Tapped Delay Line
4	20		Sigma-Delta Modulation
Total	100		

Problem 2.1 Differential Equation. 30 points.

Solve the following differential equation

$$\frac{d^2}{dt^2}y(t) + 3\frac{d}{dt}y(t) + 2y(t) = u(t)$$

with the initial conditions $y(0) = 1$ and $y'(0) = 1$ by using the Laplace transform.

Problem 2.2 Step-To-Pulse Response. 20 points.

The step response of a linear time-invariant system is $4\left(1 - e^{-5t}\right)u(t)$. Suppose that an input

$$x(t) = \left\{ \begin{array}{cc} 5 & \text{if } 0 \le t \le 2 \\ 0 & \text{otherwise} \end{array} \right\}$$

is applied to the system. Find the corresponding output $y(t)$ for $-\infty < t < \infty$.

Problem 2.3 Tapped Delay Line. 30 points.

The **discrete-time** tapped delay line is also known as a digital finite impulse response filter. For input $x[k]$, the output $y[k]$ is given by

$$y[k] = \sum_{m=0}^{N-1} a_m \, x[k-m]$$

(a) Compute the transfer function $H(z)$. 7 points.

(b) Compute the frequency response $H(\omega)$. 7 points.

(c) For each of the following sets of coefficients, state whether the filter is lowpass, highpass, bandpass, or bandstop.

i. $N = 2$, $a_0 = 1$, and $a_1 = 1$. 4 points.

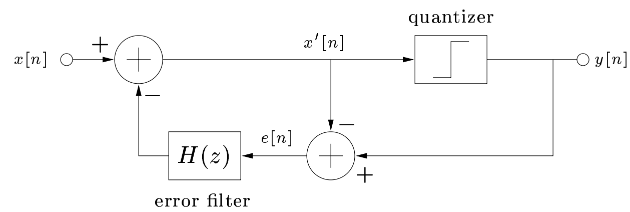
ii. $N = 2$, $a_0 = 1$, and $a_1 = j$. 4 points.

iii. $N = 2$, $a_0 = 1$, and $a_1 = -1$. 4 points.

iv. $N = 2$, $a_0 = 1$, and $a_1 = -j$. 4 points.

Problem 2.4 Sigma-Delta Modulation. 20 points.

Shown below is a type of sigma-delta modulator called a noise-shaping feedback coder.



We can approximate the effect of the quantizer as a gain K, which would make the overall system linear and time-invariant. Replace the quantizer with a gain of K and derive the transfer function from input $x[n]$ to output $y[n]$.