EEL 3135 Signals and Systems
Fall 2001
Professor Jian Li
50-MINUTE EXAMINATION # 2
November 7, 2001

There are four problems on the exam. Each problem counts 25 points. Do your work on the exam. You may use two “crib sheets” of notes written by you (your handwriting, no xeroxing). Hand your crib sheets in with the exam.

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Please read and sign the following statement:

I have neither given nor received aid on this examination.

Signed:
1. (25 points) A finite impulse response (FIR) digital filter has input $x[n]$ and output $y[n]$ related by the difference equation:


(a) Find the unit impulse response for the system and either give a formula, sequence, or a plot of your result.

(b) If the input $x[n]$ is given by

$$x[n] = \{0, 1, 0, -1, 1\}, \quad n = 0, 1, \cdots, 4$$

Find the output.
2. (25 points) A discrete time linear time invariant system has unit impulse response function

\[ h[n] = \{2, 4, 2\}, \quad n = 0, 1, 2 \]

(a) What difference equation would describe this system? What is the order of the FIR filter?

(b) Find the frequency response function \( H(\hat{\omega}) \) for this system.

(c) Plot the magnitude and phase of \( H(\hat{\omega}) \). Is this system a linear phase system?

(d) The input to the system is sampled from

\[ x(t) = 2 \sin(3\pi t + \frac{\pi}{3}) \]

with a sampling interval of \( T_s = 1/9 \). Find the output \( y[n] \).
3. (25 points) A discrete time linear time invariant system has frequency response function

\[ \mathcal{H}(\hat{\omega}) = e^{-j\hat{\omega}} (2 \cos(\hat{\omega}) - 3) \]

(a) What difference equation would describe this system? What is the order of the FIR filter?

(b) Determine and plot the output \( y_1[n] \) when the input is

\[ x_1[n] = 2u[n] \]

Specify the transient and steady-state responses.

(c) Determine the output \( y_2[n] \) when the input is

\[ x_2[n] = 2 - \delta[n - 2] \]
4. (25 points) A Gator fan has measured the response of a digital filter to the following input $x[n]$ and found the listed output $y[n]$:

$$x[n] = 2u[n - 2]$$
$$y[n] = \delta[n - 4] - \delta[n - 5]$$

(a) Find the z-transform of $y[n]$.

(b) Determine and plot the output $y_1[n]$ when the input is

$$x_1[n] = u[n - 2]$$

(c) Determine and plot the output $y_2[n]$ when the input is

$$x_2[n] = u[n]$$

(d) Find and plot the unit impulse response for the system.