February 13, 1997 **Name:**_____

EE 438 **Exam No. 1** **Spring 1997**

- You have 75 minutes to work the following five problems.
- Be sure to show all your work to obtain full credit.
- The exam is closed book and closed notes. However, you bring with you a sheet of formulas handwritten on both sides of one 8.5x11 in. sheet of paper
- Calculators are permitted.

1. (20 pts.) For the signal $x[n] = 2^n u[-n + 2]$, do the following:
   a. Sketch $x[n]$.
   b. State whether or not the signal has finite or infinite duration.
   c. State whether or not the signal is right-sided, left-sided, or two-sided.
   d. State whether or not the signal is causal or anticausal.
   e. Calculate the DTFT $X(e^{j\omega})$ of the signal $x[n]$.

1. (continued)

2. (20 pts.) Consider the system defined by the equation $y[n] = \frac{1}{3}(x[n] - x[n-3])$.

   a. State whether or not the system is linear, ime-invariant, causal, and BIBO stable. (Note: no proofs are needed.)

   b. Find the impulse response $h[n]$ for the system.

   c. Find the frequency response $H(e^{j\omega})$ for the system, and determine simple expressions for the magnitude and phase of the frequency response.

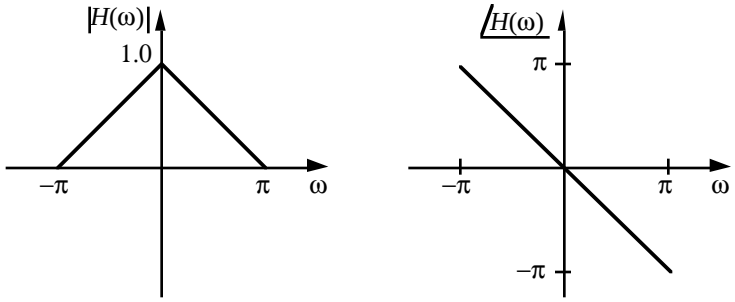
2. (continued)

3. (20 pts.) Find the convolution of the following two signals:

$$x_1[n] = \mathrm{u}[n+20] - u[n], \;\; x_2[n] = 2^{-n}\,\mathrm{u}[n].$$

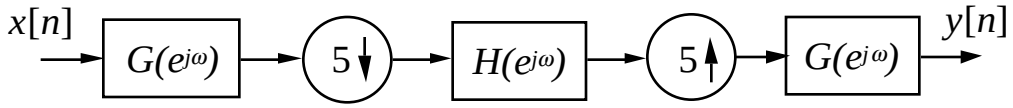
3. (continued)

4. (20 pts.) The CT signal $x_a(t) = \cos[2\pi(2000)t]$ is sampled with an ideal sampler at a rate $f_s = 8$ kHz. to yield the DT signal $x_d[n]$. The signal $x_d[n]$ is filtered with a digital filter with frequency response $H(e^{j\omega})$ given below to yield the DT signal $y_d[n]$ .This signal is then converted to the CT signal $y_a(t)$ using an ideal D/A convertor with a cutoff filter at 4 kHz. Find $y_a(t)$.



4. (continued)

5. (20 pts.) Consider the system shown below.



where the filter frequency responses of the two filters are given by

$$G(e^{j\omega}) = \begin{cases} 1, & |\omega| < \pi / 5 \\ 0, & \text{else} \end{cases} \qquad H(e^{j\omega}) = e^{-j\omega/2}\cos(\omega / 2)$$

Find a simple expression for the frequency response of the overall system.

5. (continued)

1. _____

2. _____

3. _____

4. _____

5. _____

Total _____