EE 120 SIGNALS AND SYSTEMS, Spring 2013

Midterm # 2, April 8, Monday, 2:10-3:50 pm

Name ___________________

Closed book. Two letter-size cheatsheets are allowed. Show all your work. Credit will be given for partial answers.

Problem	Points	Score
1	20	
2	20	
3	20	
4	20	
5	20	
Total	100	

1. (20 points) Consider the discrete-time LTI system with impulse response:

$$h[n] = \begin{cases} 1/3 & n = 0, 1, 2, \\ 0 & \text{otherwise.} \end{cases}$$

a) (10 points) Calculate and sketch the phase of $H(e^{j\omega})$ as a function of ω.

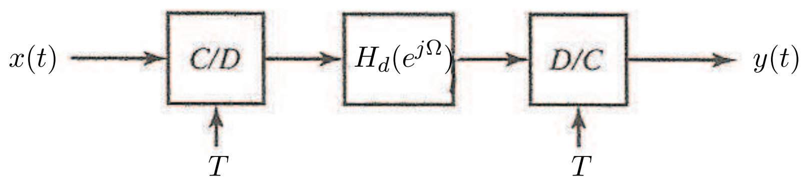
b) (10 points) Determine if this system is generalized linear phase. If so, indicate whether it also meets the more stringent condition of being linear phase.

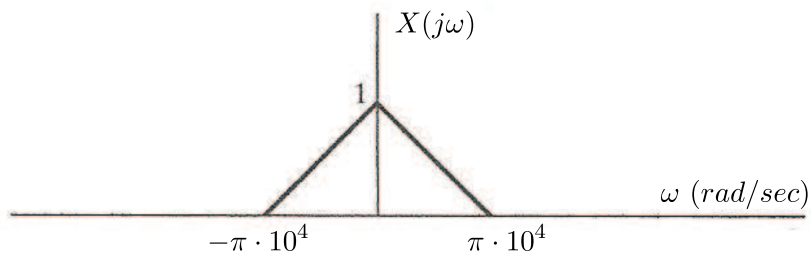
Additional workspace for Problem 1

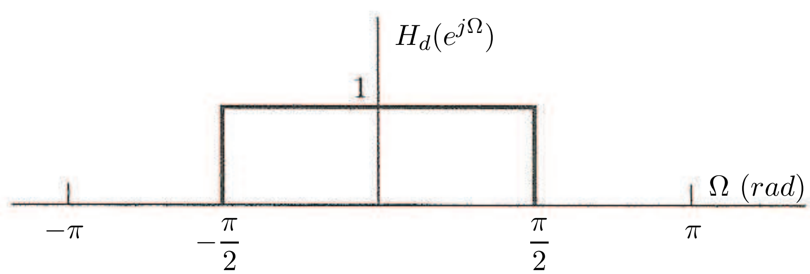
2. (20 points) An analog signal $x(t)$ is processed with a digital filter using ideal C/D and D/C converters operating at sampling period $T = 10^{-4}$ s.

a) (10 points) Suppose the spectrum of $x(t)$ is as shown below. Using the frequency response $H_d(e^{j\Omega})$ below, sketch the spectrum, $Y(j\omega)$.

b) (10 points) Repeat part (b) when the input signal is replaced with $x(t) = \cos(2 \cdot 10^4 \pi t)$. What is $y(t)$ in this case?







Additional workspace for Problem 2

3. (20 points) For each discrete-time signal below, determine whether down-sampling by a factor of 2 followed by upsampling by a factor of 2 recovers the original signal. If not, determine the output signal. (Assume that an *ideal* low pass filter is used in the interpolation step of upsampling.)

a) (10 points) $x[n] = \delta[n]$.

b) (10 points) $x[n] = \cos(\pi n/4)$.

Additional workspace for Problem 3.

4. a) (15 points) Find the absolutely integrable function $x(t)$ whose Laplace transform is given by:

$$X(s) = \frac{2s+3}{(s-1)(s^2+2s+2)}.$$

b) (5 points) Find the *unilateral* Laplace transform of the signal $x(t)$ in part (a).

Additional workspace for Problem 4.

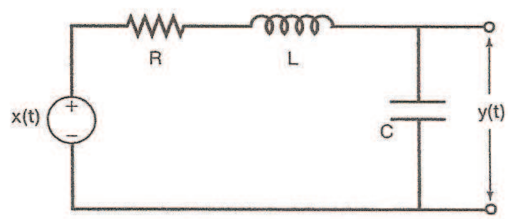
5. (20 points) Consider the RLC circuit below governed by the differential equation:

$$LC\frac{d^2y(t)}{dt^2} + RC\frac{dy(t)}{dt} + y(t) = x(t).$$

a) (6 points) Determine the transfer function of the LTI system implemented with this circuit.

b) (7 points) How should R, L and C be related so that there is no oscillation in the step response?

c) (7 points) How should R, L and C be related so that there is no resonance peak in the magnitude of the frequency response, $|H(j\omega)|$?



Additional workspace for Problem 5.