EE 120 SIGNALS AND SYSTEMS, Spring 2011

Midterm # 1, March 2, Wednesday, 10:10-11:50 am

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. Consider the LTI system described by the difference equation:

$$y[n] - 0.25y[n-2] = x[n] + x[n-1].$$

a) (15 points) Find the impulse response.

b) (5 points) Determine if the system is stable.

Additional workspace for Problem 1

2. (20 points) Consider a discrete-time LTI system with impulse response:

$$h[n] = \begin{cases} 1 & -2 \leq n \leq 2 \\ 0 & \text{otherwise.} \end{cases}$$

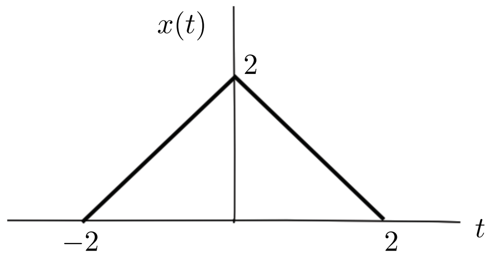
Given that the input to this system is:

$$x[n] = \sum_{k=-\infty}^{\infty} \delta[n - 5k],$$

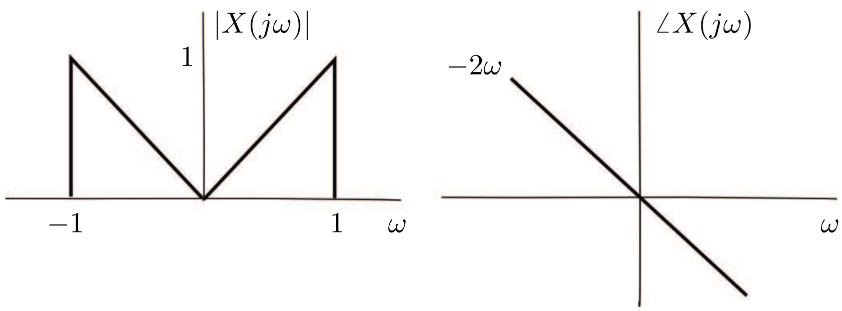
determine the Fourier series coefficients of the output $y[n]$.

Additional workspace for Problem 2

3. a) (10 points) Determine the Fourier transform of the continuous-time signal depicted below:



b) (10 points) Determine the continuous-time signal whose Fourier transform is depicted below:



Additional workspace for Problem 3.

4. (20 points) Consider a discrete-time LTI system described by the difference equation:

$$y[n] - 0.5y[n-1] = bx[n] + x[n-1].$$

Determine the frequency response $H(e^{j\omega})$, and find a value of b such that the frequency response satisfies:

$$|H(e^{j\omega})| = 1 \text{ for all } \omega.$$

Additional workspace for Problem 4.

5. a) (15 points) Find the impulse response coefficients $h[0]$, $h[1]$, $h[2]$ of a length-3, causal FIR filter that satisfies the following constraints:

i) The group delay is constant, and equal to 1.

ii) $\frac{1}{2\pi}\int_{-\pi}^{\pi} H(e^{j\omega})d\omega = 1.$

iii) $\frac{1}{2\pi}\int_{-\pi}^{\pi} |H(e^{j\omega})|^2 d\omega = 2.$

Is the answer to this problem unique?

b) (5 points) Sketch the magnitude and the phase for the frequency response of the filter you found in part (a).

Additional workspace for Problem 5.