EECS 861 Signals Systems Review Problems

(As needed for plotting you can use Matlab or another software tool for your choice)

1.

a) Plot $x(t) = 10(rect(\frac{t+2}{0.25}) - rect(\frac{t-2}{0.25}))$

b) Find the energy and power in x(t).

E_x=________ P_x=__________

c) Find X(f)

d) Plot $|X(f)|^2$

2. Plot $x_1(t) = 2\cos(2\pi 50t)$, $x_2(t) = 2\cos(2\pi 50(t-0.0025))$, and $x_3(t) = 2\cos(2\pi 50t - \frac{\pi}{4})$

Compare these three signals and explain their similarities and differences.

3. Let z(t) be a complex signal

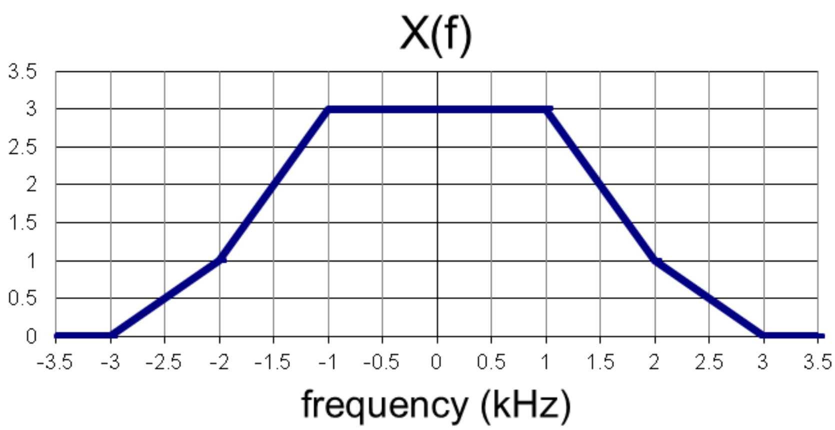
$z(t) = Ae^{j(2\pi f_c t + \phi)}$ find f(t)=Re($z(t)$), g(t)= Im($z(t)$), and r(t), and $\theta(t)$ *if* z(t)=r(t)$e^{j\theta(t)}$

4. Let

$z_1 = 1 + j,\ z_2 = 1 - j,\ z_3 = -1 + j,\ z_4 = -1 - j$

Find $\text{Re}(z_i e^{j2\pi f_c t})$ for $i = 1...4$

5. The spectrum of x(t) is given below:

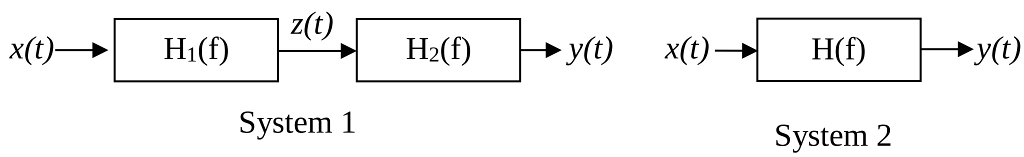


a) The signal x(t) is sampled at 7000 samples/sec to form $x_s(t)$. Plot the spectrum of $x_s(t)$.

b) For x(t) given above, what is the minimum sample rate required to prevent aliasing?

c) If no aliasing is present, describe how x(t) is recovered from $x_s(t)$.

6. Two linear time invariant systems have transfer functions of H_1 and H_2 are configured as:



H_1 and H_2 have the following transfer functions

$$H_1(f) = e^{-j2\pi(0.2)f} \qquad H_2(f) = \frac{1}{\frac{1}{4} + j2\pi f}$$

a) For x(t) = cos(2πt) find z(t). Describe in words what $H_1(f)$ does to x(t). Is $H_1(f)$ a distortionless system.

b) Find H(f) such that the two systems above (System 1 and System 2) are the same, i.e., for the same input x(t) find H(f) such that System 1 and System 2 produce the same output.

c) Plot $|H_2(1)|^2$

d) Find $h_2(t)$.

e) Find the output signal, y(t), when the input signal is $x(t) = \cos(2\pi t)$.

7. An ideal bandpass filter H(f) has center frequency of 200 kHz and bandwidth B_h=50 kHz. The input to H(f) is x(t), where

$$x(t) = \sum_{k=-\infty}^{\infty} rect\left(\frac{t - kT_0}{\tau}\right) \quad \text{where } \tau = 1\mu s \text{ and } T_0 = 5\mu s$$

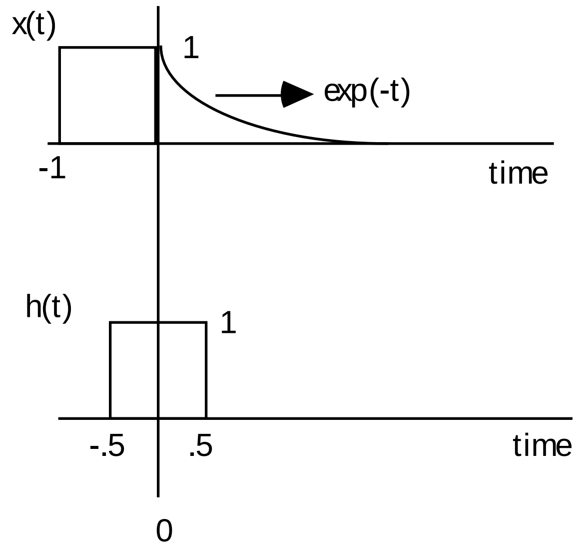
a) Sketch $|H(f)|^2$.

b) Sketch $|X(f)|^2$.

c) Find the power at the fundamental frequency f_0.

d) For the x(t) and H(f) given above find the system output y(t).

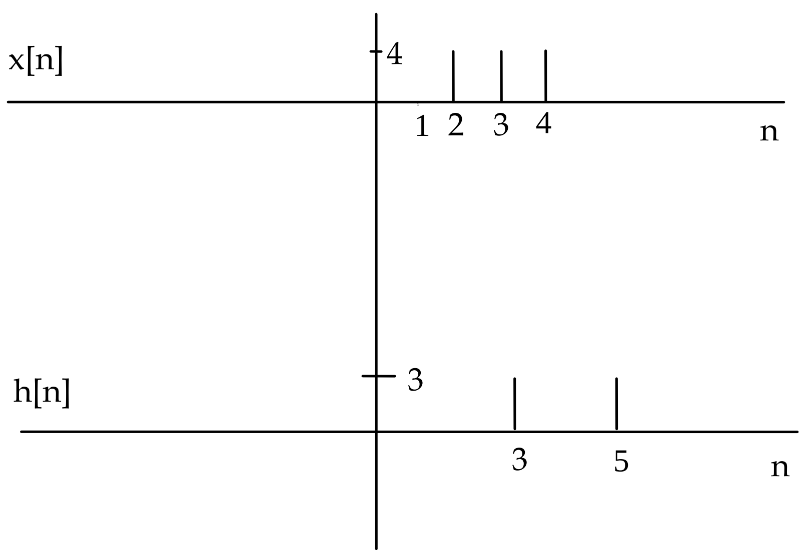
8. Consider a linear time invariant system with an impulse response of h(t), and input signal x(t) given below. The input signal x(t) given below produces and output of y(t).



a) What is y(-5)?

b) What is y(+.5)?

9. The signal x[n] is input to a LTI system with impulse response h[n].



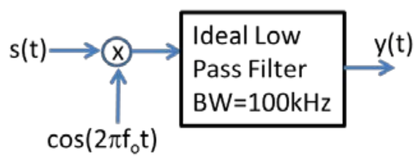
Find the discrete time convolution of x[n]*h[n]=y[n].

10. Let of $s_I(t) = x(t)\cos(2\pi f_o t)$ and $s_q(t) = z(t)\sin(2\pi f_o t)$, and $s(t) = s_I(t) + s_q(t) = x(t)\cos(2\pi f_o t) + z(t)\sin(2\pi f_o t)$, assume that both x(t) and z(t) have a 100KHz bandwidth and that f_o=10 MHz. Assume $X(f) = rect(\frac{f}{200000})$ and $Z(f) = tri(\frac{f}{100000})$.

a) Sketch the amplitude spectrum of $s_I(t) = x(t)\cos(2\pi f_o t)$ and $s_q(t) = z(t)\sin(2\pi f_o t)$.

b) Sketch the amplitude spectrum of $s(t) = s_I(t) + s_q(t) = x(t)\cos(2\pi f_o t) + z(t)\sin(2\pi f_o t)$.

c) Find the output y(t) of the following system in terms of x(t) and z(t):



d) Discuss the spectral occupancy of s(t), $s_I(t)$, and $s_q(t)$? What property of signals can be used to explain the result of part c) assuming that an ideal low pass filter is an approximation for an integrator?

11. For this problem use the data in the file
http://www.ittc.ku.edu/~frost/EECS_861/EECS_861_HW_Fall_2017/HW_1_Fall_2017.csv

a) Plot the data in the first row in the file.
b) Plot the data in the first column in the file.
c) Calculate the average of all the values in each row, plot the row averages.
d) Calculate the average of all the values in each column, plot the column averages.
e) What you think each row represents?