BME 350: Signals & Systems for Bioengineers

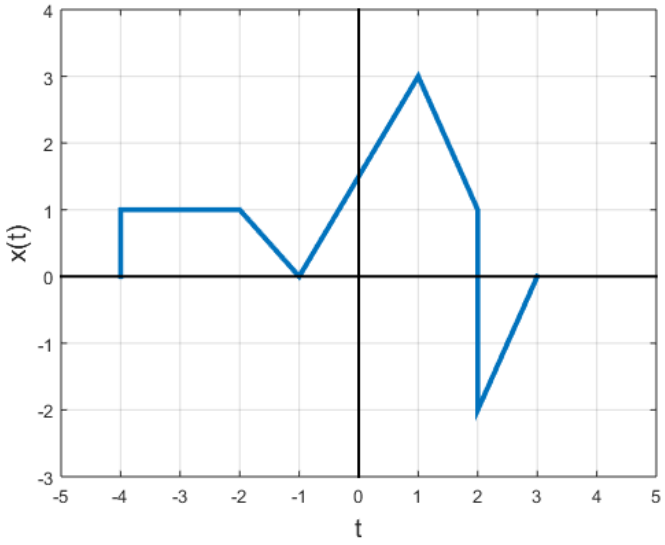
Homework #1 (50 Points)

Deadline: 9am on Tuesday, September 6th.
Late Assignments: 5 points deducted per hour (delay rounded up to the next hour).
Note: For questions 3-5, show all your work to receive full credit

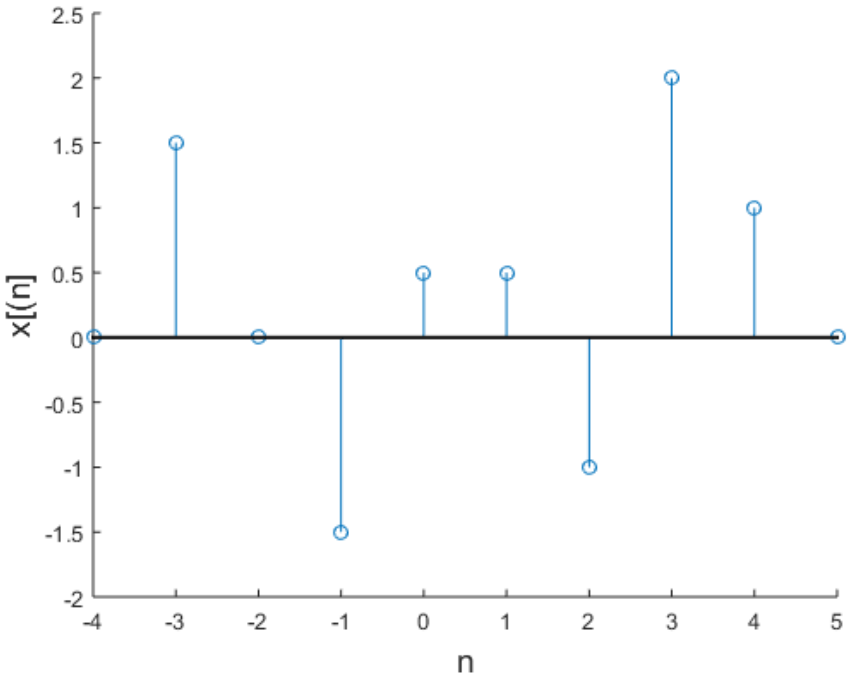
1) **Signals & Systems (7 points).** Select if the following statements are true or false.
   a. Signals are always one dimensional. T F
   b. A system can have both continuous and discrete outputs. T F
   c. Real life signals are always continuous. T F
   d. Signal to Noise Ratio (SNR) is given as Signal/RMS(Noise). T F
   e. A system can be described as a set of mathematically representable components which can take an output signal y and give an input signal x. T F
   f. Magnetoneurography involves acquisition of biomagnetic signals from the brain. T F
   g. Different biosignals are acquired using different data acquisition methods. T F

2) **Biosignals (8 points)**. Complete the following statements.
   a. A biosignals is the spatial and/or temporal recording of a biological event.
   b. ECG and EEG are examples of bioelectric signals from the body.
   c. Biosignals are used for detection and treatment of pathology.
   d. A picture is an example of a 2-dimensional signal.
   eElectrochemicalsensors are often used for real time monitoring of biochemical signals.
   f. Pulse Oximetry is an example of measurement of a bio-optical signal.
   g. Biomechanical signals contain information about displacement in body parts.

3) **Continuous signals (14 points).** Given the continuous signal $x(t)$ in the figure below, sketch each of the following signals. Show all the procedure down for each transformation. *(Note: remember to properly label all your axes)*
   a. $x(t-3)$ **(3 points)**
   b. $x(2t+4)$ **(4 points)**
   c. $x(2t)-x(2-t)$ **(7 points)**



4) **Discrete Signals (8 points).** Given the discrete signal $x[n]$ below, sketch each of the following signals. Show all your procedure for each transformation. *(Note: remember to properly label all your axes)*
   a. $x[2n-2]$
   b. $x[n/2+3]$



5) **Complex Numbers and Polar Plots (4 points).**
Express the following complex number in the polar form and plot in the complex plane indicating the magnitude and angle. Show all your procedure. *(Note: remember to properly label all your axes)*
   a. $12-5j$

Express the following complex number in Cartesian form and plot in the complex plane. Show all your procedure. *(Note: remember to properly label all your axes)*
   b. $2e^{j3\pi/2}/e^{j\pi/4}$

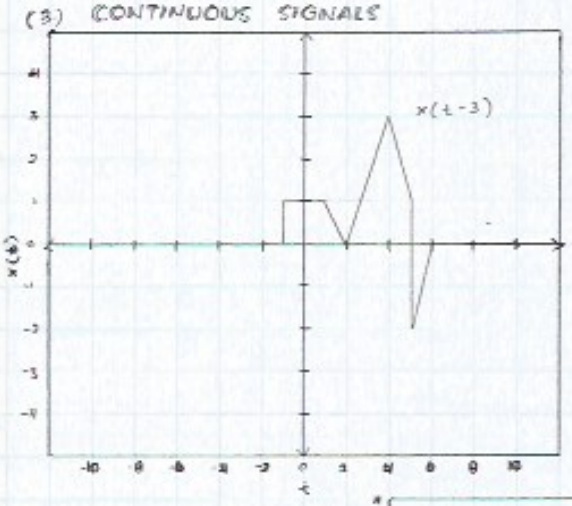
6) **Quantization (4 points).**
Consider an incoming analog signal ranging from -3V to +2V into an A/D converter. Calculate the minimum resolution (or number of bits) for the A/D converter to be sensitive to atleast +/- 100 µV. *Hint: Number of bits can only be whole numbers*

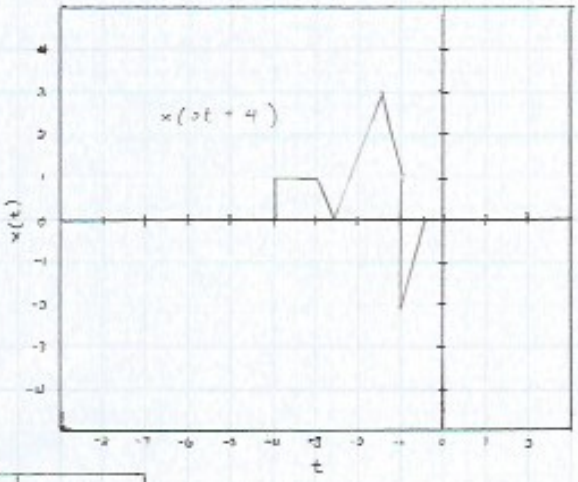
7) MATLAB plotting (5 points). ***Include matlab code with ASU ID number***
   a. Plot the following discrete time signal x[n] with proper axes labels in MATLAB.

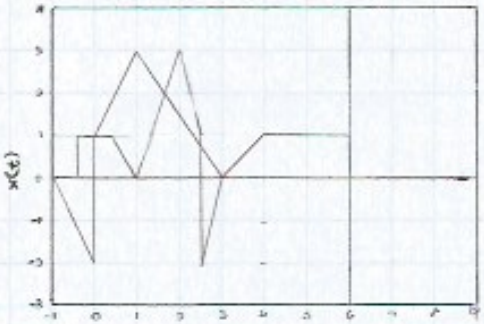
$$x[n] = \begin{cases} 0.5, n = 0 \\ 2, n = 1 \\ -3, n = -2 \\ -4, n = 3 \\ 0, otherwise \end{cases}$$

b. Plot the continuous time signal, $x(t) = e^{-2t}\sin(0.5t)$ for 0 ≤ t ≤ 20s in MATLAB with proper axes labels.

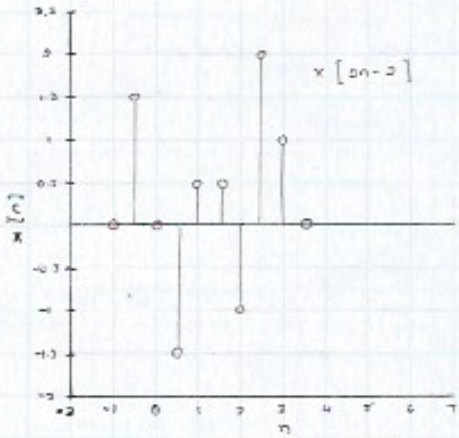
(3) CONTINUOUS SIGNALS

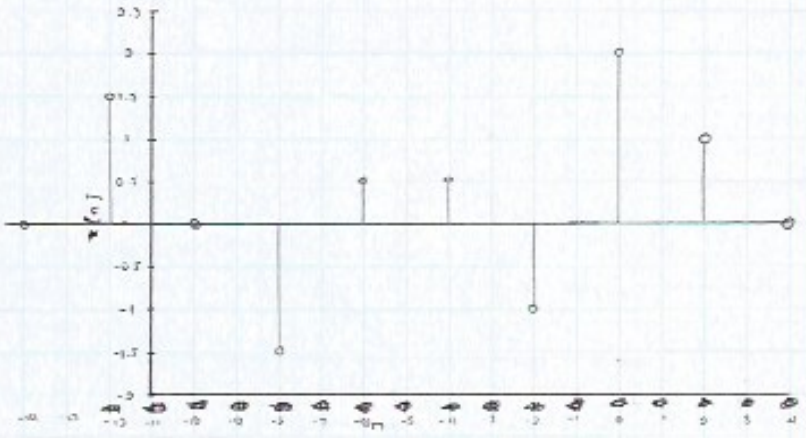






(4) DISCRETE SIGNALS





(5) COMPLEX NUMBERS & POLAR PLOTS

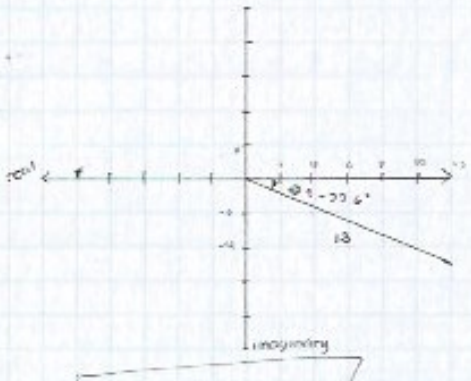
(a) $12 - 5j$

$r = \sqrt{12^2 + (-5)^2}$

$r = 13$

$\tan^{-1}\left(\frac{-5}{12}\right) = \theta$

$\theta = -22.6°$

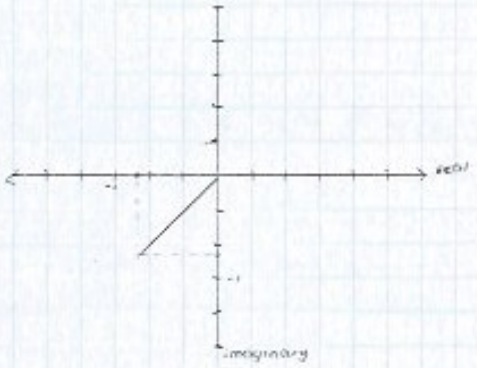


$z = 13\,e^{-22.6j}$

(b) $\frac{2e^{3\pi/2}}{e^{\pi/4}} = 2e^{5\pi/4}$

$2e^{5\pi/4} = 2\left[\cos\left(\frac{5\pi}{4}\right) + j\sin\left(\frac{5\pi}{4}\right)\right]$

$z = -\sqrt{2} - j\sqrt{2}$



(6) QUANTIZATION

10 μV ≈ 0.0001 V

$2^n \approx 0.02 / 0.0001$

$2^n \approx 200$ LEVELS

$n = \log_2(200)$

$n \approx 7.64$ BITS $\approx$ 8 BITS

$2^8 = 256$ LEVELS

$0.02\,V / 256$ LEVELS $= 8\,\mu V$/LEVEL (RESOLUTION)

∴ 8 BITS / 8 μV/LEVEL (RESOLUTION)

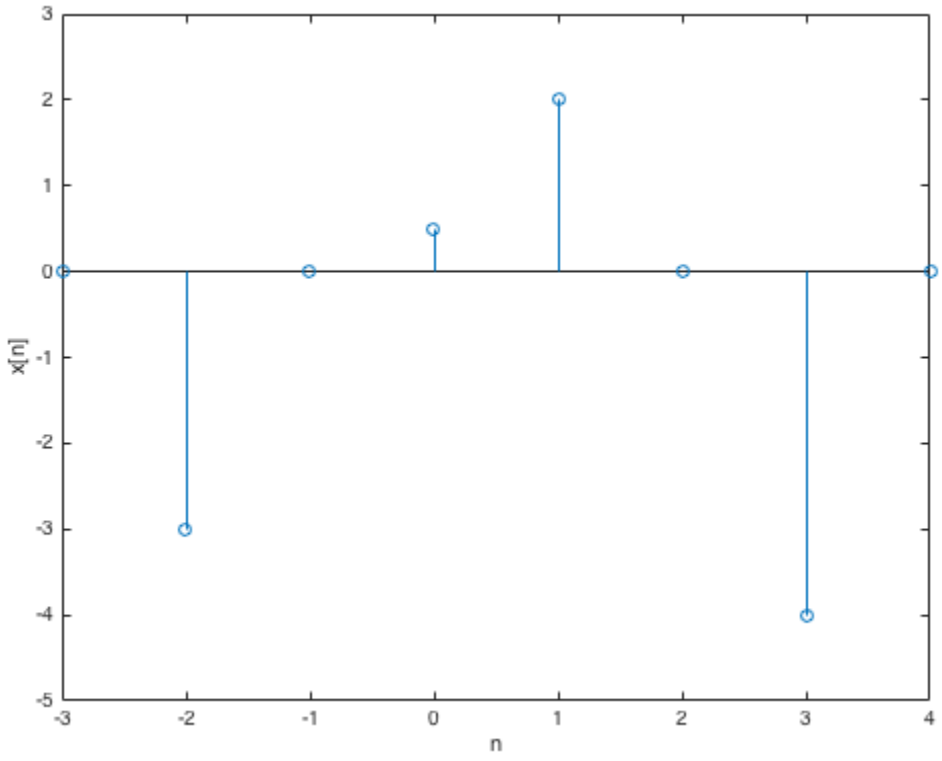
```
% Mary Christine Oh
% 1208315416
% BME 250 HW 1

% Plotting the discrete time signal x[n] with proper axes labels

clc
clear all
close all

n = [-3:4];
x = [0 -3 0 0.5 2 0 -4 0];

figure
stem(n, x)
xlabel('n')
ylabel('x[n]')
ylim([-5 3])
```




```
% Plotting the continuous time signal x(t) wuth proper axes labels

clc
clear all
close all
```

```
syms x(n)
n = 0:1:20;
x = sin(0.5*n) * exp(-2*n);
plot(n,x)
xlabel('n')
ylabel('x(n)')
```

```
Error using *
Inner matrix dimensions must agree.

Error in bme350hw1 (line 29)
x = sin(0.5*n) * exp(-2*n);
```

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