EENG/INFE 226 SIGNALS AND SYSTEMS
LAB 2
SOME FUNDAMENTAL PROPERTIES OF SIGNALS

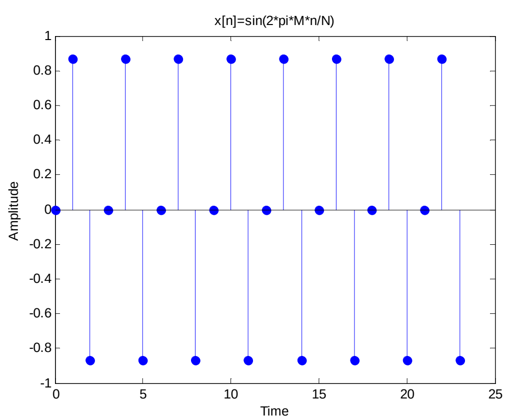
1) Consider the discrete-time signal

$$x_M[n] = \sin\left(\frac{2\pi Mn}{N}\right)$$

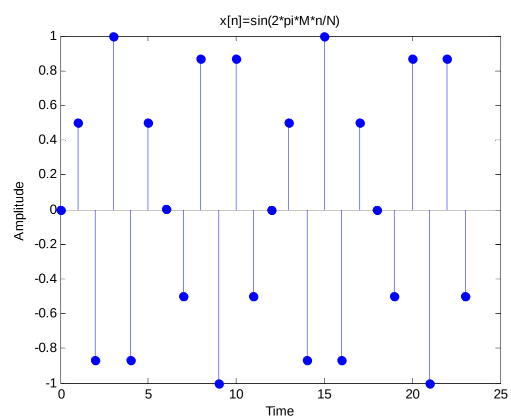
and assume N=12. For M=4, 5, 7 and 10, plot $x_M[n]$ on the interval $0 \le n \le 2N-1$. Use `stem` to create your plots, and be sure to appropriately label your axes. What is the fundamental period of each signal?

Answer:

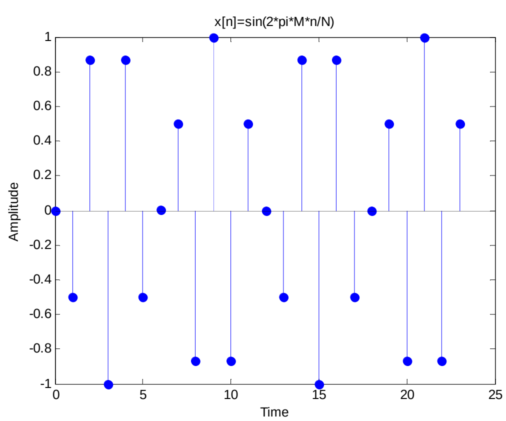
```
N=12;
n=[0:2*N-1];                   % Discrete time interval
M=4                                % M=5,7,10
x_M=sin((2*pi*M*n)/N);         % Discrete time signal
figure(1)                      % open new figure
stem(n,x_M,'filled')           % draw the signal
title('x[n]=sin(2*pi*M*n/N)') % title of Discrete time signal
xlabel('Time')                 % Name of x direction
ylabel('Amplitude')            % Name of y direction
```



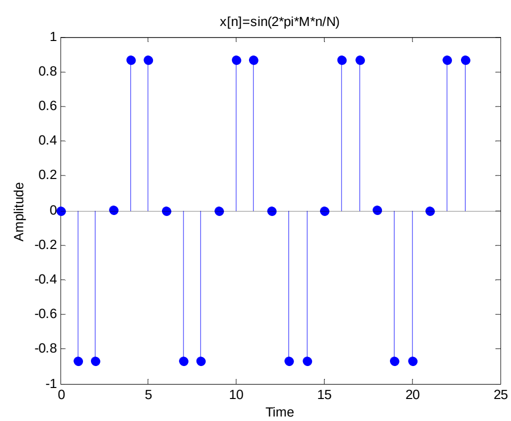
M=4



M=5



M=7



M=10

2) Now consider the following signals:

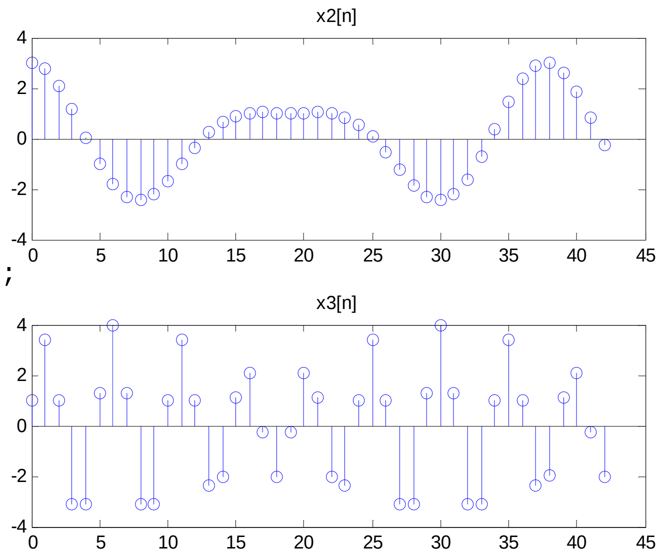
$$x_2[n] = 2\cos\left(\frac{2n}{N}\right) + \cos\left(\frac{3n}{N}\right)$$

$$x_3[n] = \cos\left(\frac{2\pi n}{N}\right) + 3\sin\left(\frac{5\pi n}{2N}\right)$$

Assume N=6 for each signal. Determine whether or not each signal periodic. If a signal is periodic, plot the signal for two periods, starting at n=0. Plot the signal for $0 \le n \le 7N$ and explain why it is periodic or not. Remember to use `stem` and to appropriately label your axes.

Answer:

```
N=6;
n=[0:7*N];
x2=2*cos(2*n/N)+cos(3*n/N);
x3=cos(2*pi*n/N)+3*sin(5*(pi/2)*n/N);
subplot(2,1,1),stem(n,x2)
title('x2[n]')
subplot(2,1,2),stem(n,x3)
title('x3[n]')
```



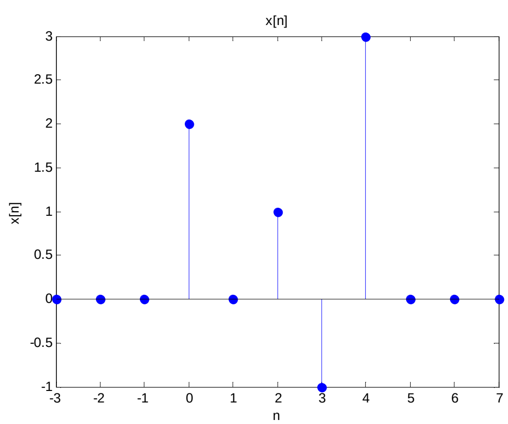
3) a) Define a MATLAB vector nx to be the time indices $-3 \le n \le 7$ and the MATLAB vector x to be the values of the signal x[n] is given by

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

If you have defined these vectors correctly, you should be able to plot this discrete time sequence by typing `stem(nx,x)`.

Answer:

```
nx=[-3:7];
x=[0 0 0 2 0 1 -1 3 0 0 0];
stem(nx,x,'filled')
title('x[n]')
xlabel('n')
ylabel('x[n]')
```



b) For this part, you will define MATLAB vectors y1 through y4 to represent the following discrete-time signals:

$$y_1[n] = x[n-2],$$
$$y_2[n] = x[n-1],$$
$$y_3[n] = x[-n],$$
$$y_4[n] = x[-n+1]$$

to do this, you should define y1 through y4 to be equal to x. The key is to define correctly the corresponding index vectors ny1 through ny4. First, you should figure out how the index of a given sample of x[n] changes when transforming to $y_i[n]$. The index vectors need not span the same of indices as nx, but they should all be at least 11 samples long and include the indices of all nonzero samples of associated signal.

Answer:

```
n=[-3:7];
x=[2  0 1 -1 3 0];
nx=[0 0 0 x 0 0];
ny1=n+2;
ny2=n-1;
ny3=-n;
ny4=-n+1;

figure(1)

subplot(2,1,1),stem(ny1,nx,'filled')
xlabel('time')
ylabel('x[n-2]')
title('x[n-2]')

subplot(2,1,2),stem(ny2,nx,'filled')
xlabel('time')
ylabel('x[n+1]')
title('x[n+1]')

figure(2)

subplot(2,1,1),stem(ny3,nx,'filled')
xlabel('time')
ylabel('x[-n]')
title('x[-n]')

subplot(2,1,2),stem(ny4,nx,'filled')
xlabel('time')
ylabel('x[-n+1]')
title('x[-n+1]')
```