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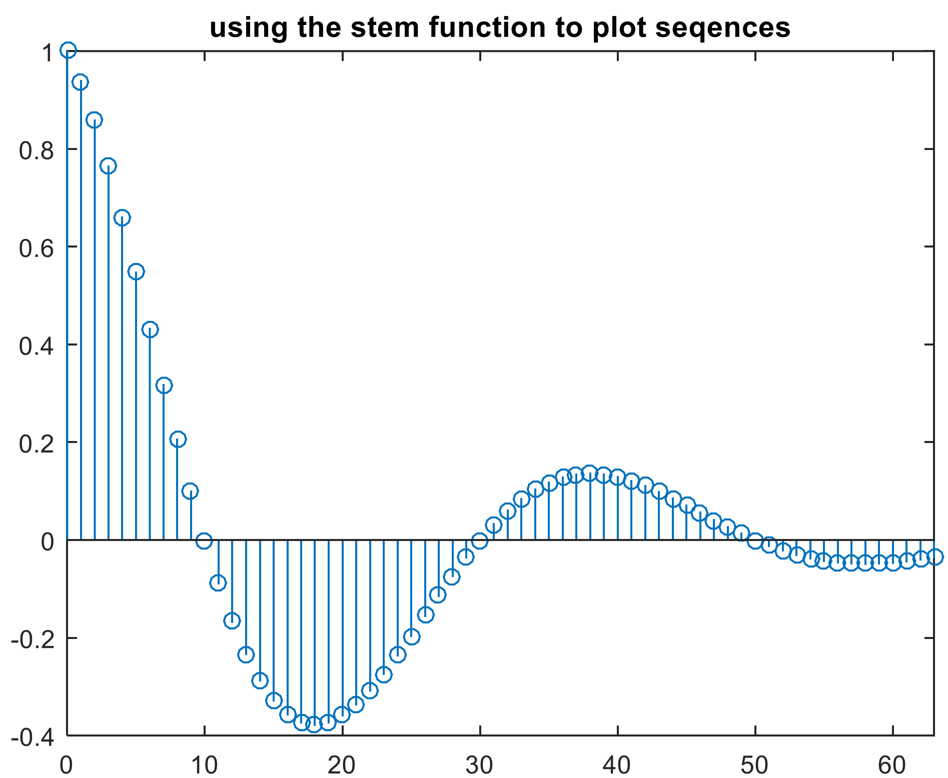
EECE 491 – Digital Signal Processing

Problem Set 1 MATLAB - Solution

Problem 1: MATLAB stem command

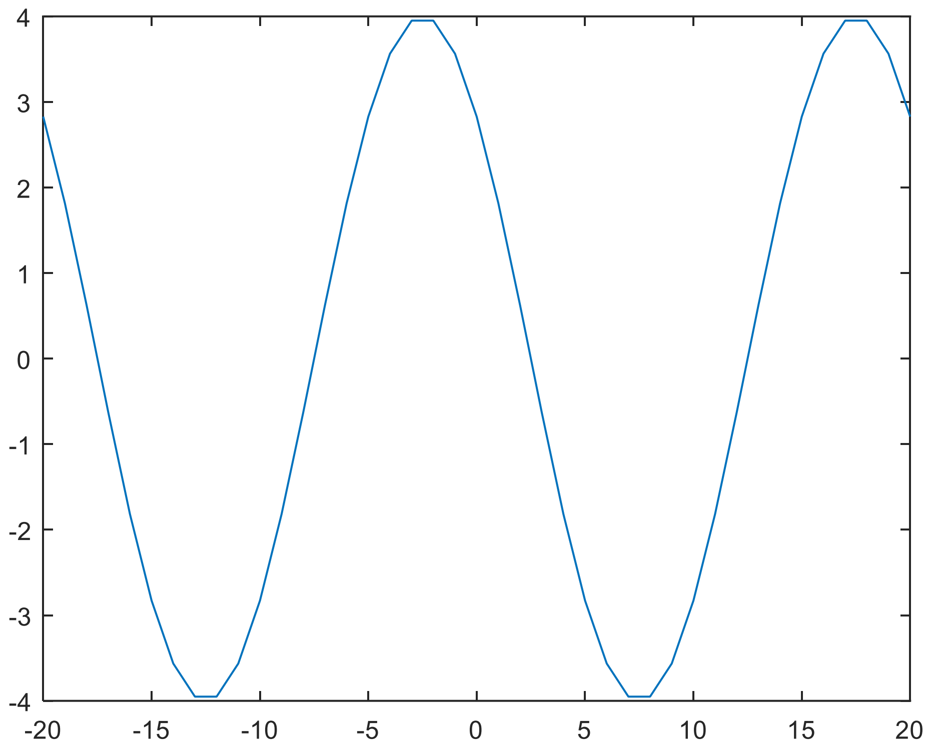
Part A:

```
n=0:1:63;
x= realpow((0.95),n).*cos((pi./20).*n);
figure;
stem(n,x);
xlim([0 63]);
title('using the stem function to plot seqences');
```



Part B:

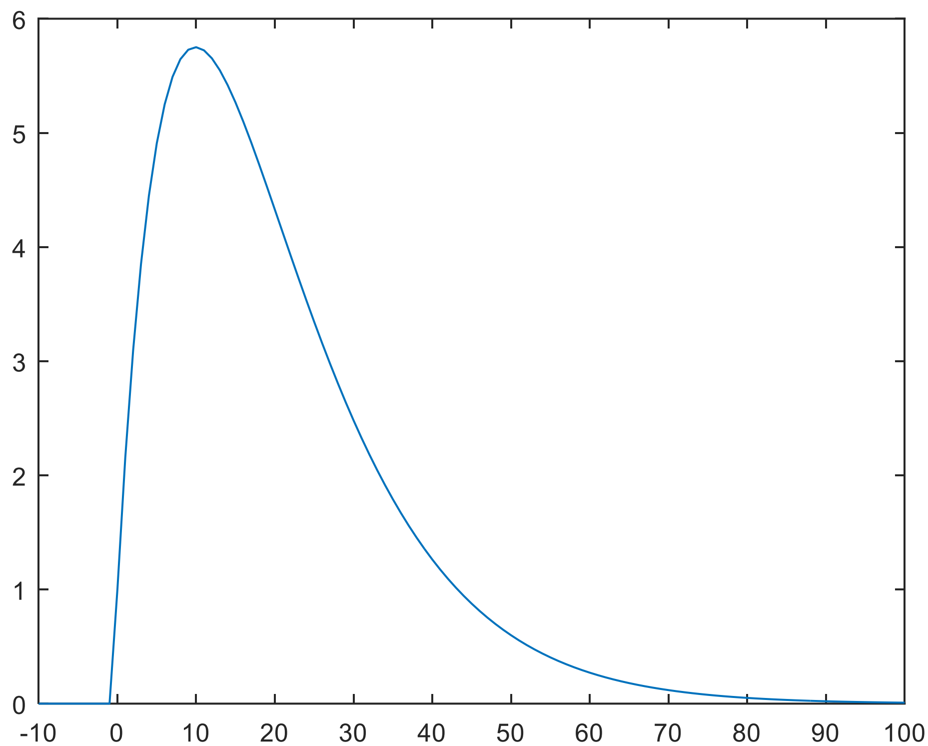
```
A =4; w0= pi/10; theta= pi/4; n1= -20; nf= 20;
x = fcosine(A,w0,theta,n1,nf);
plot(-20:20, x);
```



Problem 2: Impulse response and Step Response

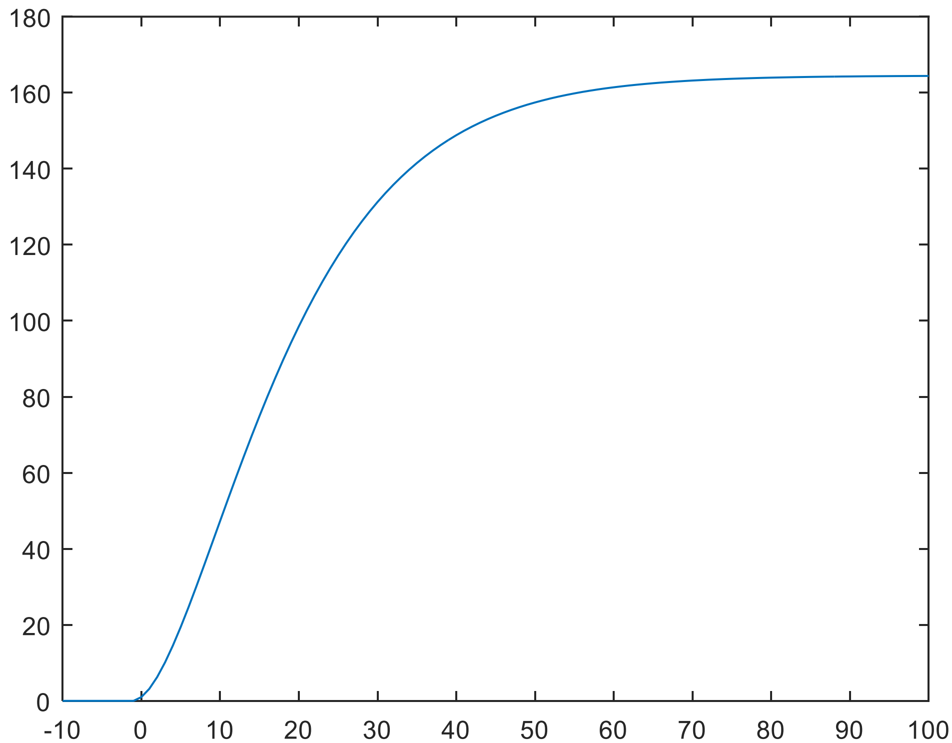
Part A:

```
n= zeros(1,111);
n(11)=1;
A = [1 -1.85*cos(pi/18) 0.83];
B = [1 1/3];
x = filter(B,A, n);
plot(-10:100,x)
xlim([-10 100]);
```



Part B:

```
n = [zeros(1,10) ones(1,101)];
A = [1 -1.85*cos(pi/18) 0.83];
B = [1 1/3];
x = filter(B,A, n);
plot(-10:100,x);
xlim([-10 100]);
```



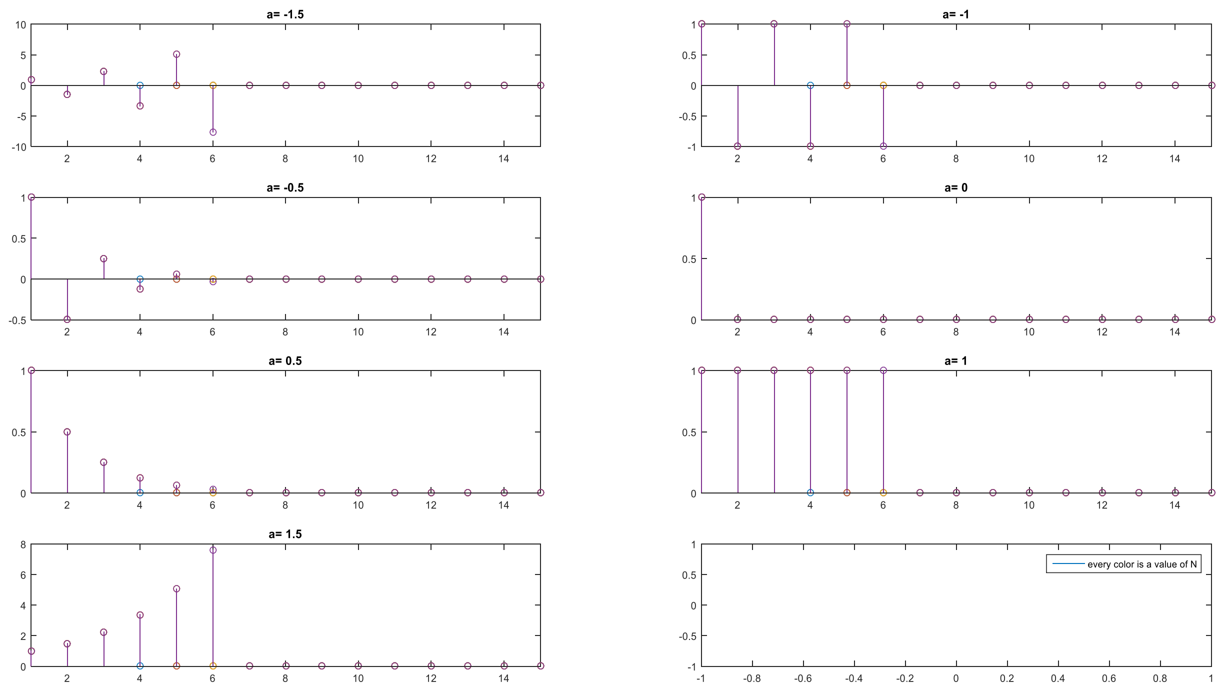
Problem 3:

a. For the system to be stable, |h[n]| -> 0 as n -> infinity
   Thus we can see that |a|<1
b. The code is given below:

```
y[n] = a*y[n-1]+x[n]-(a^N)*x[n-N]
% sketching the impulse reponse:
% Y = a*D*Y + X - ((a*D)^N) * X
%         1 - (a*D)^N       1           a^N
% Y/X =  -------------- = -------- - ----------------------
%           1 - a*D       1 - a*D     D^(-N) - a*D^(-N+1)

    n =[1 zeros(1,14)];
    figure
    i=1;
    for a = -1.5:0.5:1.5
        subplot(4,2,i);
        for N=3:6
        A = [1 -a ];
        B = [1 zeros(1,N-1) -power(a,N)];
        x = filter(B, A, n);
        stem(1:15,x);
        xlim([1 15]);
        hold on;
        end
        title(['a= ' num2str(a)]);
        i=i+1;
    end
    subplot(4,2,8); %% this is useless just to add a note
    plot(0,0);      %% through the legend on the plot
    legend('every color is a value of N');
```

Check the plots below.

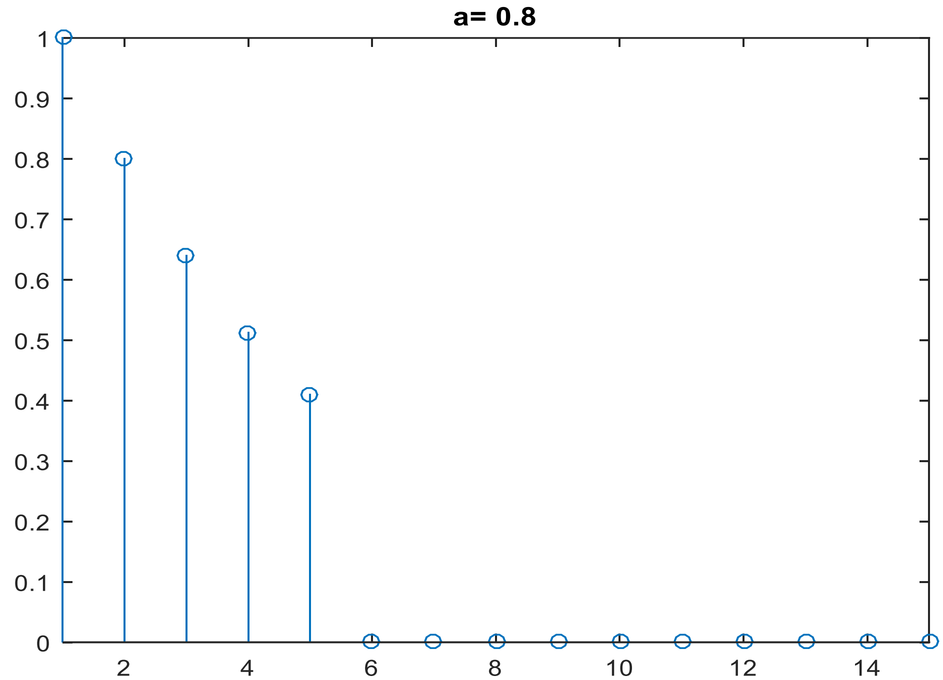
For a better clarity, try running the code in MATLAB and observe the outcome.



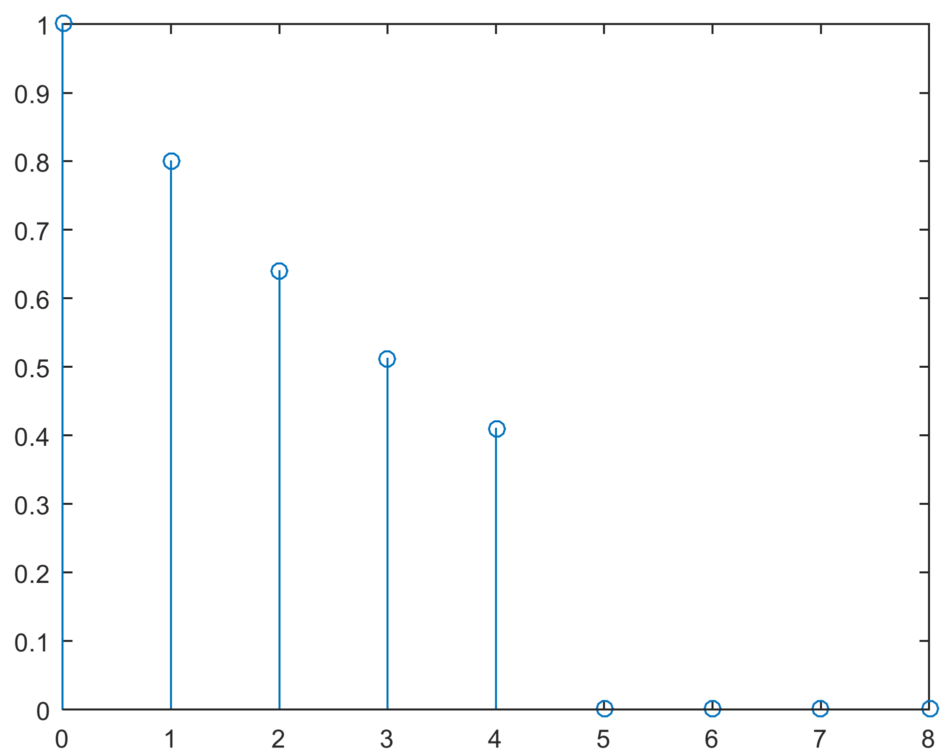
c. It is an FIR filter.
d. h[n] is finite so it converges for all values of a.
e. The code for both the conv() and the filter is given below

```
- using filter

    n =[1 zeros(1,14)];
    figure
    a=0.8;N=5;
        A = [1 -a ];
        B = [1 zeros(1,N-1) -power(a,N)];
        x = filter(B, A, n);
        stem(1:15,x);
        xlim([1 15]);
        title(['a= ' num2str(a)]);

- using conv()
    a=0.8;N=5;
    H=[1];
    X=[1];
    for i=N:-1:2
    H = [H power(a,N-i+1)];
    X= [X 0];
    end
    Y=conv(H,X);
    stem(0:length(Y)-1,Y);
```

Using filter:



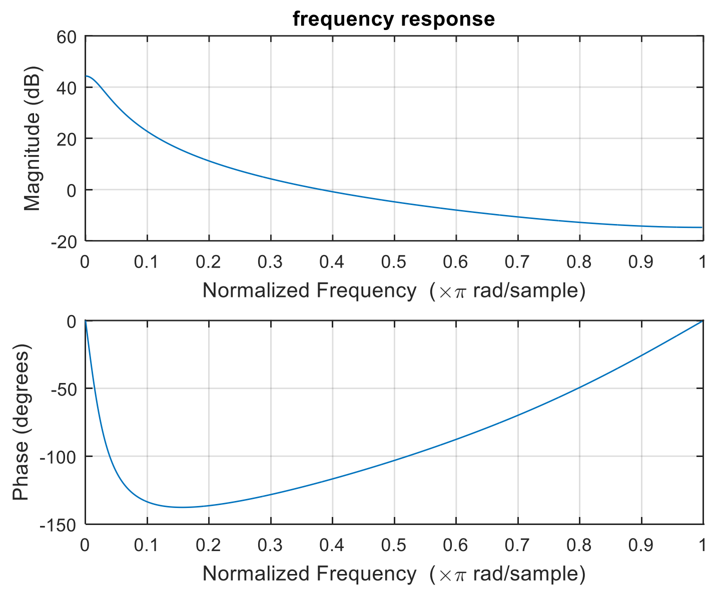
Using conv:



Problem 4: System functions, Frequency response, and Pole/Zero plots

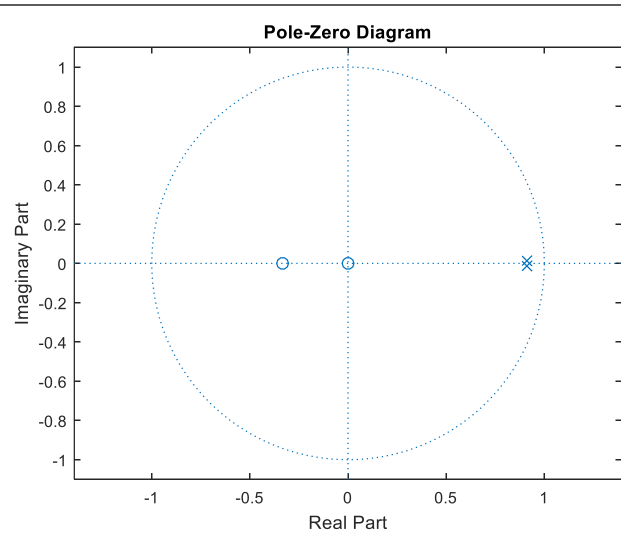
1. Since the ratio of the power at low frequencies to that at higher frequencies is >>>1, we can say that the filter is attenuating high frequencies and preserving low frequencies, which implies that it a low pass filter.

```
N=512;
A = [1 -1.85*cos(pi/18) 0.83];
B = [1 1/3];
freqz(B,A,N);
title('frequency response');
```



2.

```
zplane(B,A,N);
title('Pole-Zero Diagram');
```



Problem 5:

```
A = [1 -1.556 1.272 -0.398];
B = [0.0798 1 1 1];
n = [1 zeros(1,50)];
Y = filter(B,A,n);

figure
stem(0:length(Y)-1,Y);
title('Impulse Responsse');

figure
freqz(B,A);
title('Frequency Response');
```