1

TO FIND THE IMPULSE RESPONSE FOR A GIVEN SYSTEM

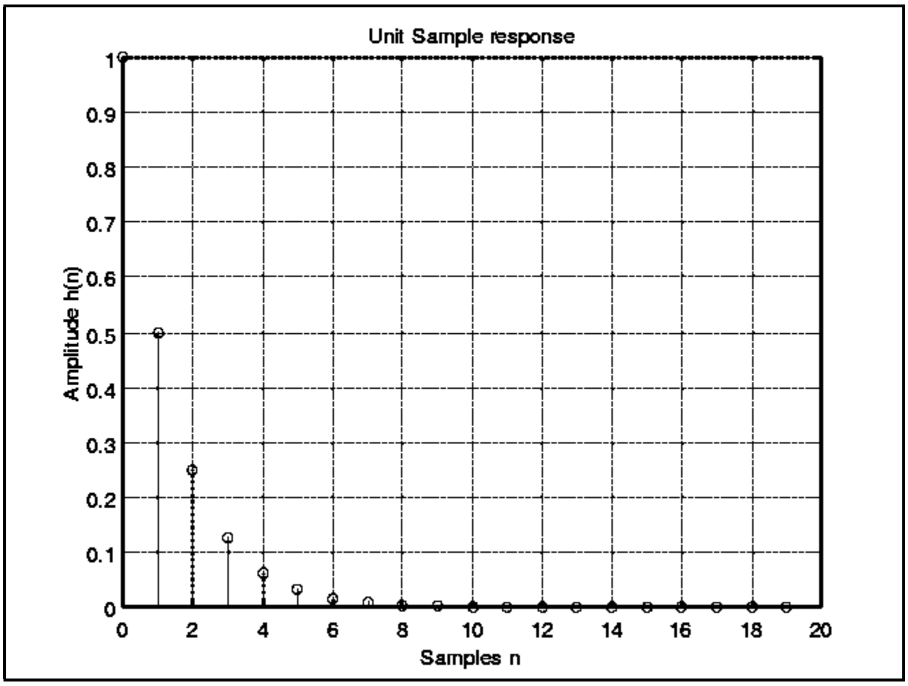
```
% To find the impulse response for a given system
clc
clear all
b=input('Enter Numerator Coefficients b=');
a=input('Enter Denominator Coefficients a=');
n=input('Enter the length of the unit sample response n=');
[h,t]=impz(b,a,n);
disp(h);
stem(t,h);
grid on;
xlabel('Samples n');
ylabel('Amplitude h(n)');
title('Unit impulse response');
```

Example: To find the impulse response of a system with system function

$$H(Z) = \frac{1}{1-0.5Z^{-1}}$$

Result:

```
» Enter Numerator Coefficients b=1
Enter Denominator Coefficients a=[1 -0.5]
Enter the length of the unit sample response n=20
   1.0000
   0.5000
   0.2500
   0.1250
   0.0625
   0.0312
   0.0156
   0.0078
   0.0039
   0.0020
   0.0010
   0.0005
   0.0002
   0.0001
   0.0001
   0.0000
   0.0000
   0.0000
   0.0000
   0.0000
```



2<u>TO SOLVE THE DIFFERENCE EQUATION</u>

```
% Solve the given Difference equation
clc
clear all
b=input('Enter the Numerator Coefficients b=');
a=input('Enter the denominator Coefficients a=');
n=input('Enter the length of the sequence =');

[h,t]=impz(b,a,n);

x=ones(1,n);

y=conv(x,h);
disp('h=');
disp(h);
disp('y=');
disp(y);
stem(y);
grid on;
xlabel('n');
ylabel('y(n)');
title('The response y(n)');
```

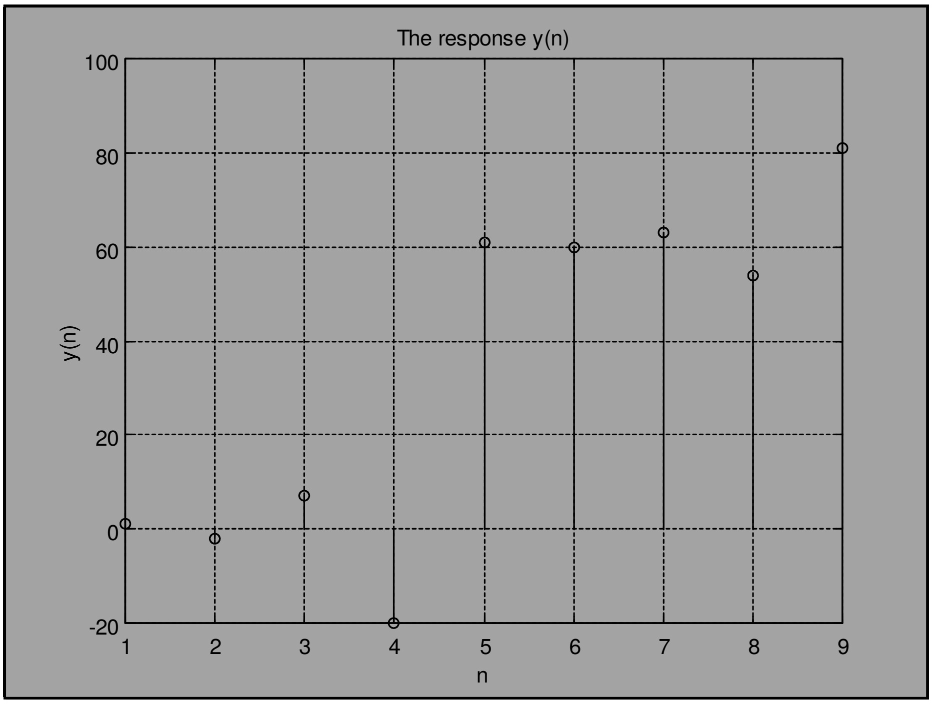
<u>Example:</u> To solve the following difference equation y(n)+3 y(n-1)=x(n) with input x(n)=u(n).

<u>Result</u>

Enter the Numerator Coefficients b=[1]
Enter the denominator Coefficients a=[1 3]
Enter the length of the sequence =5

```
h=
     1
    -3
     9
   -27
    81

y=
     1
    -2
     7
   -20
    61
    60
    63
    54
    81
```



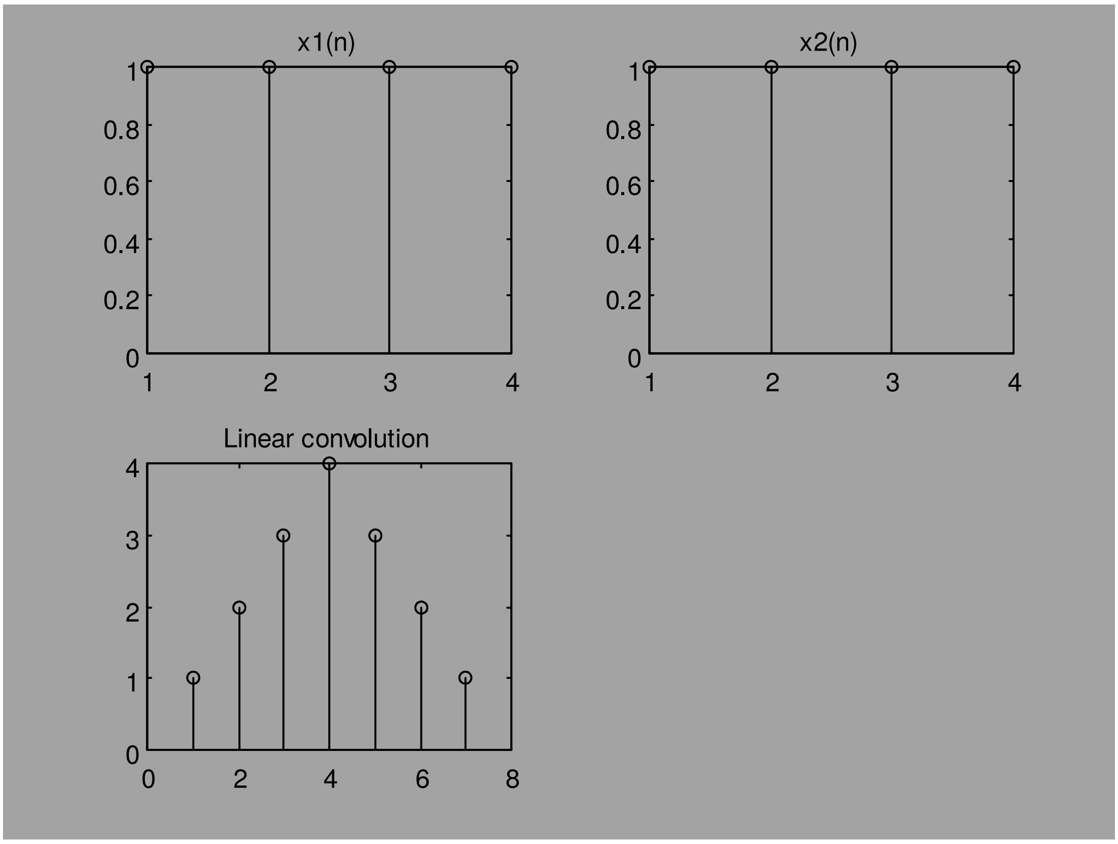
3TO FIND THE LINEAR CONVOLUTION OF TWO GIVEN SEQUENCES

```
% Linear convolution of two given sequences
clc
clear all
x1=input('Enter the first sequence x1(n)=');
subplot(2,2,1);
stem(x1);
title('x1(n)');
x2=input('Enter the second sequence x2(n)=');
subplot(2,2,2);
stem(x2);
title('x2(n)');
y=conv(x1,x2);
subplot(2,2,3);
stem(y);
title('Linear convolution');
disp('Linear convolution coefficients are y(n)=');
disp(y);
```

Example: To find the linear convolution for the given sequences $x_1(n)=\{1\ 1\ 1\ 1\}$ $x_2(n)=\{1\ 1\ 1\ 1\}$

Result

```
Enter the first sequence x1(n)=[ 1 1 1 1]
Enter the second sequence x2(n)=[1 1 1 1]
Linear convolution coefficients are y(n)=
    1    2    3    4    3    2    1
```



4TO FIND THE LINEAR CONVOLUTION OF TWO GIVEN SEQUENCES USING DFT AND IDFT

```
% Linear convolution using DFT and IDFT
clc
clear all
x=input('Enter the first sequence x(n)=');
subplot(2,2,1);
stem(x);
title('x(n)');
h=input('Enter the first sequence x(n)=');
subplot(2,2,2);
stem(h);
title('h(n)');
L=length(x)+length(h)-1;
X=fft(x,L);
H=fft(h,L);
Y=X.*H;
y=real(ifft(Y));
subplot(2,2,3);
stem(y);
title('Linear convolution');
disp('Linear convolution coefficients are y(n)=');
disp(y);
```

Example: To find the linear convolution for the given sequences x(n)={1 1 1 1}& h(n)={1 2 3 4}

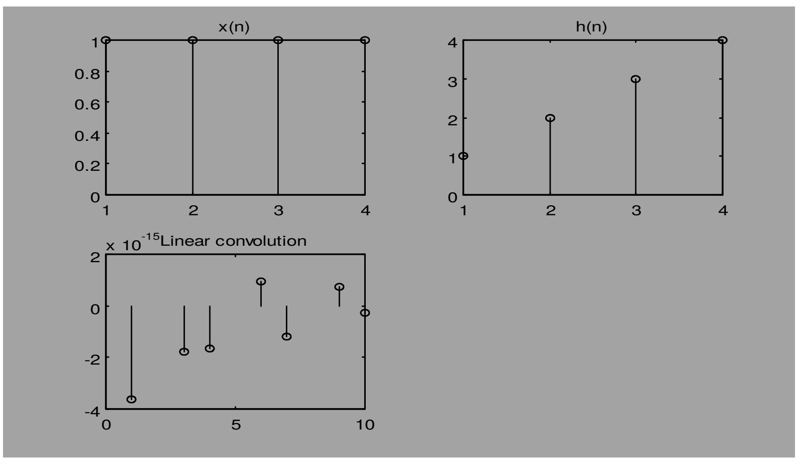
Result:

```
Enter the first sequence x(n)=[1 1 1 1]
Enter the first sequence x(n)=[1 2 3 4]
Linear convolution coefficients are y(n)=
  Columns 1 through 4

   1.0000 - 0.0000i   3.0000 - 0.0000i   6.0000 + 0.0000i  10.0000 - 0.0000i

  Columns 5 through 7

   9.0000 + 0.0000i   7.0000 - 0.0000i   4.0000 - 0.0000i
```

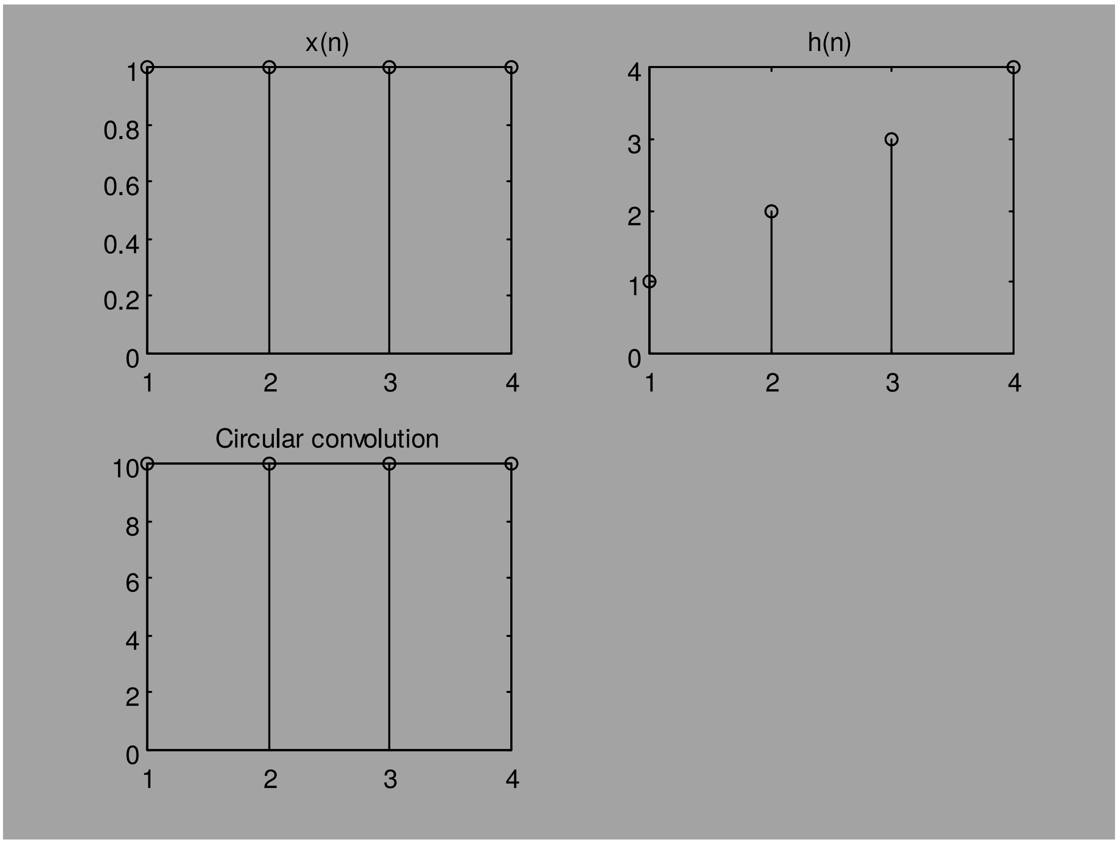


5CIRCULAR CONVOLUTION

```
% To find the circular convolution of two given sequences using dft and idft
Clc
Clear all
x=input('Enter the first sequence x(n)=');
subplot(2,2,1);
stem(x);
title('x(n)');
h=input('Enter the first sequence x(n)=');
subplot(2,2,2);
stem(h);
title('h(n)');
n=max(length(x),length(h));
a=fft(x,n);
b=fft(h,n);
c=a.*b;
y=ifft(c,n);
subplot(2,2,3);
stem(y);
title('Circular convolution');
disp('Circular convolution coefficients are y=');
disp(y);
```

Example:To find the circular convolution for the signals x(n)={1 1 1 1} and h(n)={1 2 3 4}

Result:

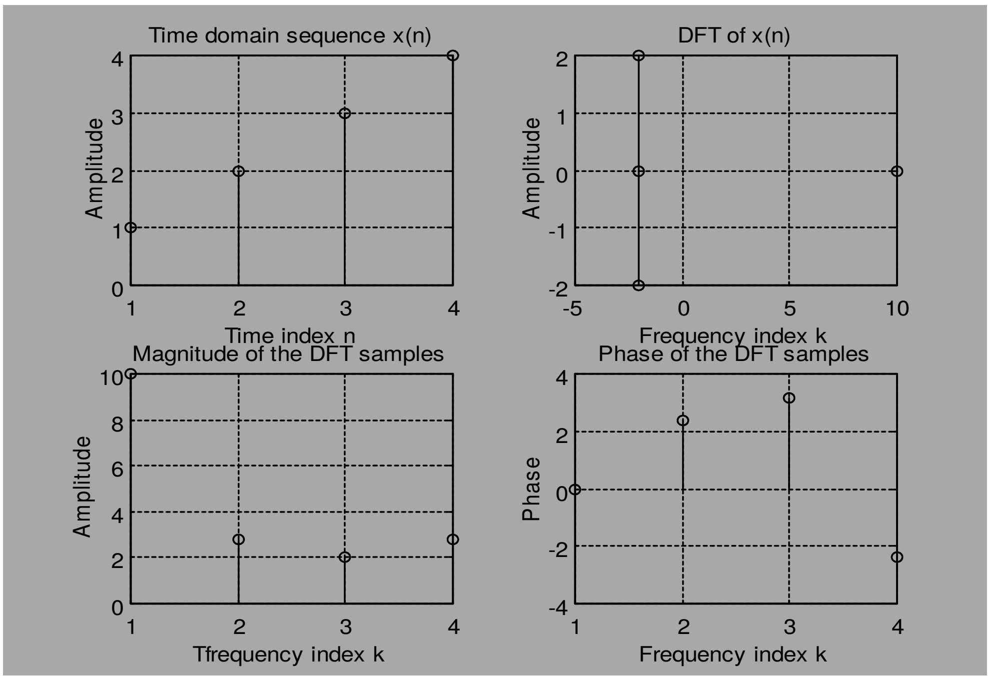


6 TO COMPUTE N POINT DFT

```
% To compute n point dft of a given sequence and to plot magnitude and phase spectrum.
Clc
Clear all
x=input('Enter the sequence x(n)=');
subplot(2,2,1);
stem(x);
grid on;
title('Time domain sequence x(n)');
xlabel('Time index n');
ylabel('Amplitude');
X=fft(x);
subplot(2,2,2);
stem(X);
grid on;
title('DFT of x(n)');
xlabel('Frequency index k');
ylabel('Amplitude');
a=abs(X);
subplot(2,2,3);
stem(a);
grid on;
title('Magnitude of the DFT samples');
xlabel('Tfrequency index k');
ylabel('Amplitude');
b=angle(X);
subplot(2,2,4);
stem(b);
grid on;
title('Phase of the DFT samples');
xlabel('Frequency index k');
ylabel('Phase');
```

Example: To find DFT for the sequence x(n)={1 2 3 4}

Result:



7To design a low pass FIR filter using Kaiser window

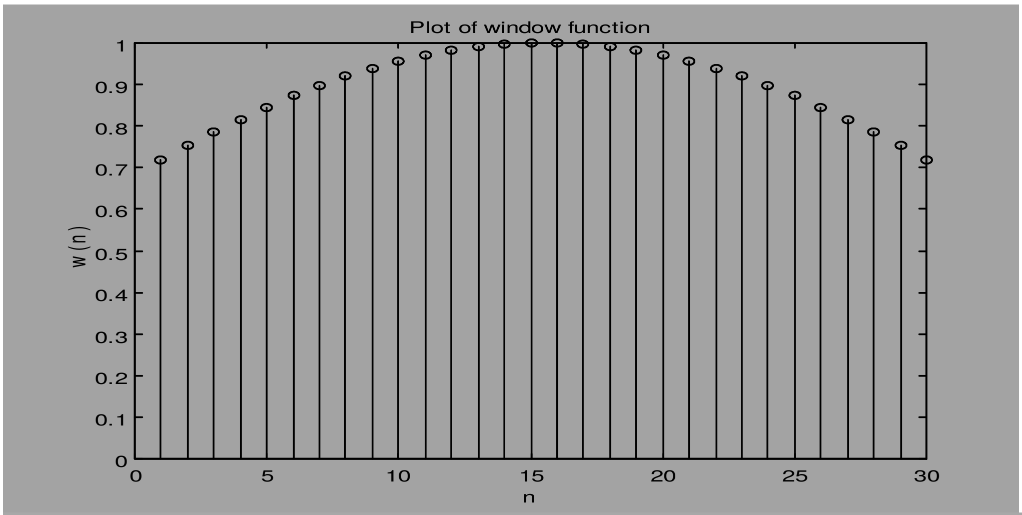
```
% To design a low pass FIR filter using Kaiser window
clc
clear all
M=input('Enter the length of the filter=');
beta=input('Enter the value of beta=');
wc=input('Enter the digital cut off frequency=');
wn=kaiser(M,beta);
figure(1);
stem(wn);
title('Plot of window function');
xlabel('n');
ylabel('w(n)');
disp(wn);
hn=fir1(M-1,wc,wn);
figure(2);
freqz(hn,1,512);
grid on;
xlabel('Normalized frequency');
ylabel('Gain in dBs');
title('Frequency response of the FIR filter');
disp('The unit sample response of FIR filter is h(n)=');
disp(hn);
```

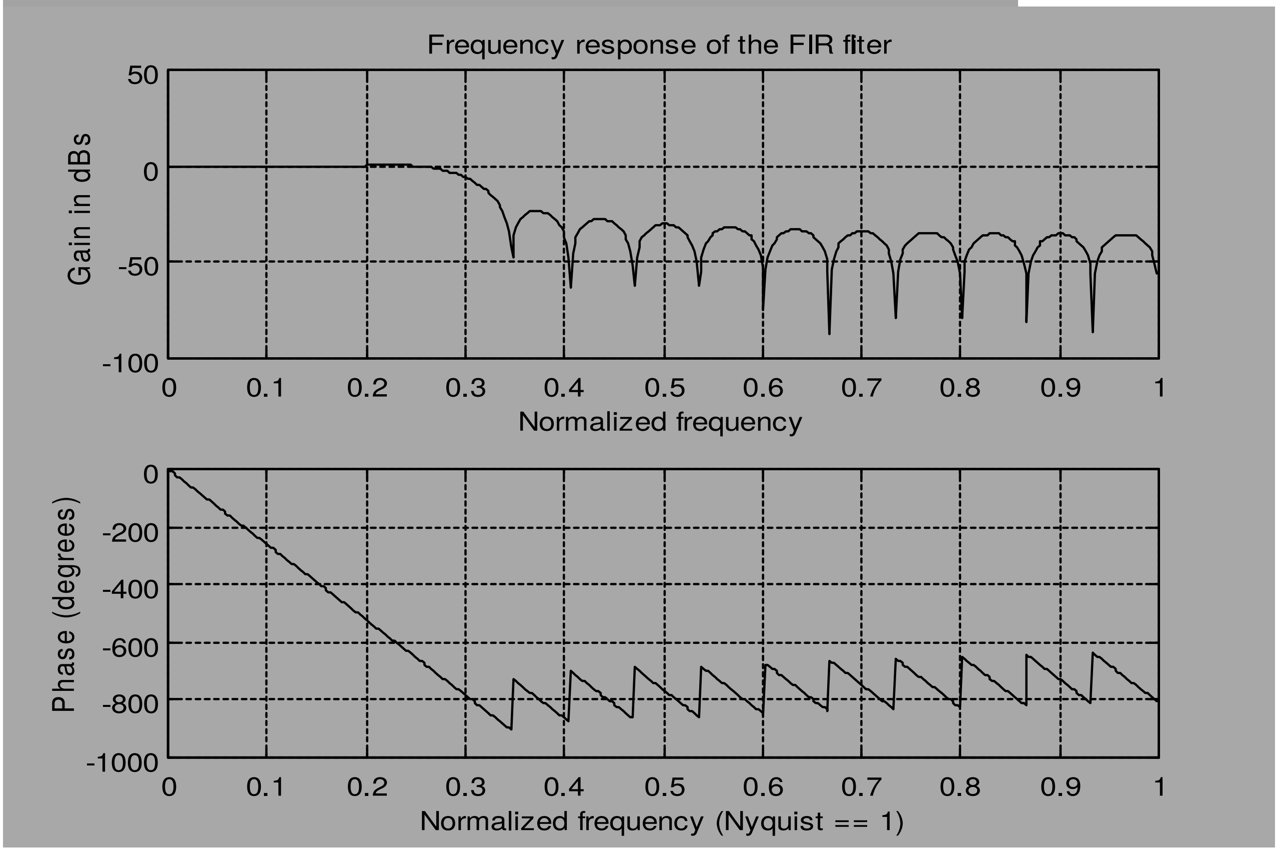
Example:

To design a low pass FIR filter using Kaiser window of length 30, β=1.2 and cut off frequency=0.3 rads.

Result:

```
Enter the length of the filter=30
Enter the value of beta=1.2
Enter the digital cut off frequency=0.3
The Kaiser window coefficients are as follows
    0.7175
    0.7523
    0.7854
    0.8166
    0.8457
      :
      :
   0.7523
   0.7175
The unit sample response of FIR filter is h(n)=
 Columns 1 through 7
 0.0141    0.0028   -0.0142   -0.0224   -0.0117    0.0133    0.0333
 Columns 8 through 14
    0.0277   -0.0072   -0.0495   -0.0614   -0.0140    0.0895    0.2097
    ---------------------------------------------------------------------------
Columns 29 through 30
   0.0028    0.0141
```


Plot of window function
w (n)
n


Frequency response of the FIR filter
Gain in dBs
Normalized frequency
Phase (degrees)
Normalized frequency (Nyquist == 1)

8TO DESIGN A LOW PASS FIR FILTER USING HAMMING WINDOW

```
% To design a low pass FIR filter using Hamming window
clc
clear all
w1=input('Enter the pass band edge frequency in rads,w1=');
w2=input('Enter the stop band edge frequency in rads,w2=');
k1=input('Enter the pass band attenuation in dB,k1=');
k2=input('Enter the stop band attenuation in dB,k2=');
wt=(w2-w1);
n=ceil((8*pi)/wt);
if rem(n,2)==0
  n=n+1;
end;
disp('The order of the filter is =');
disp(n);
w=hamming(n);
figure(1);
stem(w);
title('Plot of window function');
xlabel('n----------->');
ylabel('w(n)--------->');
disp('The hamming window coefficients are');
disp(w);
hn=fir1(n,wt);
figure(2);
freqz(hn,1,512);
grid on;
xlabel('Normalized frequency');
ylabel('Gain in dBs');
title('Frequency response of the FIR Filter');
disp('The unit sample response of FIR  filter is h(n)');
disp(hn);
```

Example: To design a low pass FIR filter using hamming window for the following specifications.

Passband edge frequency=0.5 rads, Stopband edge frrquency=1 rad
Passband attenuation=1 dB and Stopband attenuation=50 dB.

Result:

```
Enter the pass band edge frequency in rads,w1=0.5
 Enter the stop band edge frequency in rads,w2=1
Enter the pass band attenuation in dB,k1=1
Enter the stop band attenuation in dB,k2=50
The order of the filter is =
51
The hamming window coefficients are
 0.0800
0.0836
0.0945
  :
  :
0.0945
0.0836
0.0800
```

The unit sample response of FIR filter is h(n)

Columns 1 through 7

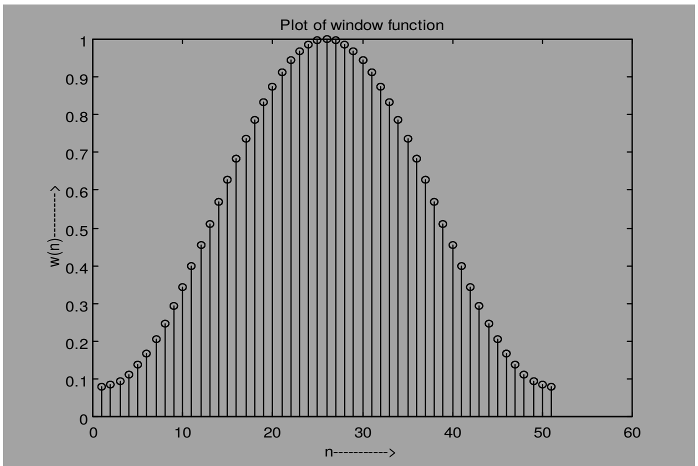
0.0007 0.0008 -0.0009 -0.0011 0.0014 0.0018 -0.0023

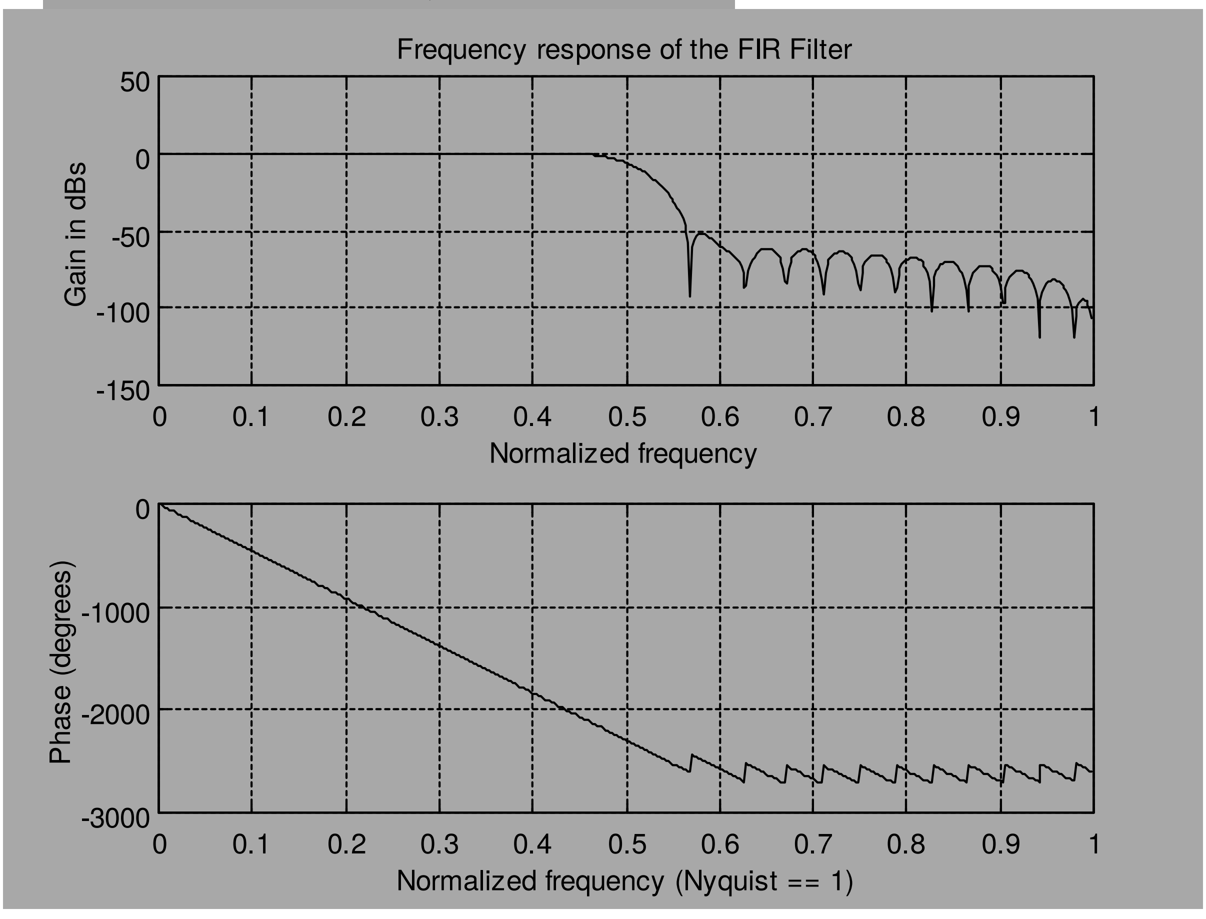
Columns 8 through 14

-0.0029 0.0037 0.0046 -0.0056 -0.0068 0.0083 0.0100

Columns 50 through 52

-0.0009 0.0008 0.0007





9DESIGN OF LOW PASS BUTTERWORTH IIR FILTER

```
% To design low pass Butterworth IIR filter
clc
clear all
f1=input('Enter the Passband frequency in Hz,f1=');
f2=input('Enter the Stopband frequency in Hz,f2=');
k1=input('Enter the Passband attenuation in dB,k1=');
k2=input('Enter the Stopband attenuation in dB,k2=');
fs=input('Enter the Sampling frequency in Hz,fs=');
T=1/fs;
w1=(2*pi*f1*T);
w2=(2*pi*f2*T);
wp=(2/T)*tan((w1)/2);
ws=(2/T)*tan((w2)/2);
[n,wn]=buttord(wp,ws,k1,k2,'s');
disp('The order of the filter is=');
disp(n);
disp('Cut off frequency is =');
disp(wn);
[nu,de]=butter(n,wn,'s');
[b,a]=bilinear(nu,de,fs);
[h,w]=freqz(b,a);
semilogx((w*fs)/(2*pi),20*log10(abs(h)));
axis([0 10000 -10 0])
xlabel('w in rads----------------->');
ylabel('20*abs(Hejw)------------------>');
title('Frequency response of the filter');
disp('The Numerator coefficients of H(s) are=');
disp(nu);
disp('The Denominator coefficients of H(s) are=');
disp(de);
disp('The Numerator coefficients of H(Z) are=');
disp(b);
disp('The Denominator coefficients of H(Z) are=');
disp(a);
```

Example:

To design a lowpass butterworth filter for the following specifications.
Passband frequency=5000Hz, Stopband frequency=25000Hz
Passband attenuation=1.5dB, Stopband attenuation=50dB
Sampling frequency=100000Hz

Result:

```
Enter the Passband frequency in Hz,f1=5000
Enter the Stopband frequency in Hz,f2=25000
Enter the Passband attenuation in dB,k1=1.5
Enter the Stopband attenuation in dB,k2=50
Enter the Sampling frequency in Hz,fs=100000
The order of the filter is=
          4
```

Cut off frequency is =
4.7428e+004

The Numerator coefficients of H(s) are=
1.0e+018 *

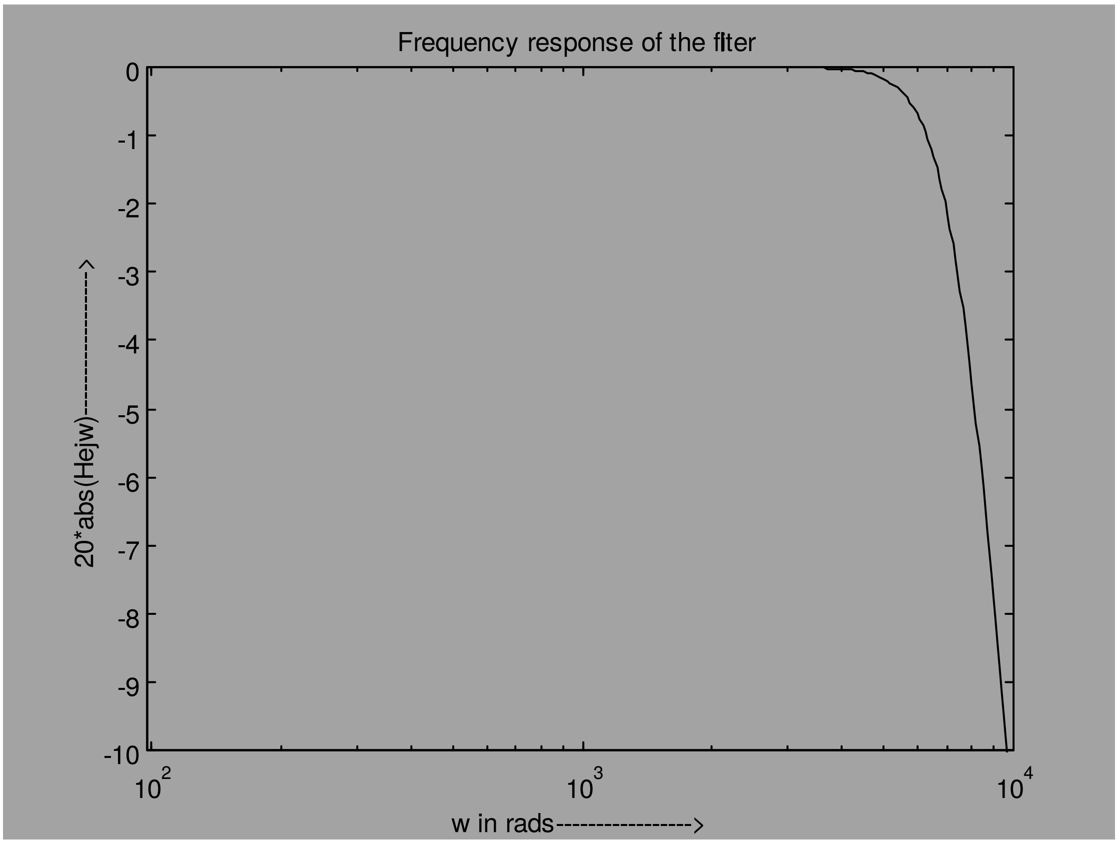
0 0 0 0 5.0597

The Denominator coefficients of H(s) are=
1.0e+018 *

0.0000 0.0000 0.0000 0.0003 5.0597

The Numerator coefficients of H(Z) are=
0.0017 0.0068 0.0103 0.0068 0.0017

The Denominator coefficients of H(Z) are=
1.0000 -2.7881 3.0465 -1.5234 0.2923



10DESIGN LOW PASS TYPE-I CHEBYSHEV IIR FILTER

```
% To design low pass type-i chebyshev iir filter
clc
clear all
f1=input('Enter the Passband frequency in Hz,f1=');
f2=input('Enter the Stopband frequency in Hz,f2=');
k1=input('Enter the Passband attenuation in dB,k1=');
k2=input('Enter the Stopband attenuation in dB,k2=');
fs=input('Enter the Sampling frequency in Hz,fs=');
T=1/fs;
w1=(2*pi*f1*T);
w2=(2*pi*f2*T);
wp=(2/T)*tan((w1)/2);disp(wp);
ws=(2/T)*tan((w2)/2);disp(ws);
[n,wn]=cheb1ord(wp,ws,k1,k2,'s');
disp('The order of the filter is=');
disp(n);
disp('Cut off frequency is =');
disp(wn);
[nu,de]=cheby1(n,k1,wn,'s');
[b,a]=bilinear(nu,de,fs);
[h,w]=freqz(b,a);
semilogx((w*fs)/(2*pi),20*log10(abs(h)));
axis([0 10000 -10 0])
xlabel('w in rads----------------->');
ylabel('20*abs(Hejw)------------------>');
title('Frequency response of the filter');
disp('The Numerator coefficients of H(s) are=');
disp(nu);
disp('The Denominator coefficients of H(s) are=');
disp(de);
disp('The Numerator coefficients of H(Z) are=');
disp(b);
disp('The Denominator coefficients of H(Z) are=');
disp(a);
```

Example:

To design a lowpass butterworth filter for the following specifications.
Passband frequency=5000Hz, Stopband frequency=25000Hz
Passband attenuation=1.5dB, Stopband attenuation=50dB
Sampling frequency=100000Hz

Result:

```
Enter the Passband frequency in Hz,f1=5000
Enter the Stopband frequency in Hz,f2=25000
Enter the Passband attenuation in dB,k1=1.5
Enter the Stopband attenuation in dB,k2=50
Enter the Sampling frequency in Hz,fs=100000
```

3.1677e+004

2.0000e+005

The order of the filter is=
3

Cut off frequency is =
3.1677e+004

The Numerator coefficients of H(s) are=
1.0e+013 *

0 0 0 1.2372

The Denominator coefficients of H(s) are=
1.0e+013 *

0.0000 0.0000 0.0001 1.2372

The Numerator coefficients of H(Z) are=
0.0013 0.0040 0.0040 0.0013

The Denominator coefficients of H(Z) are=
1.0000 -2.6678 2.4468 -0.7683