Independent University Bangladesh

Department of Electrical and Electronics Engineering

Lab Report 09

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Course code: EEE 321L

Couse name: Digital Signal Processing Lab

Lab no: 07

Lab title: Study on DTFT, Circular Folding and Circular Convolution

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1) Function to compute impulse response of ideal low pass filter

Code:

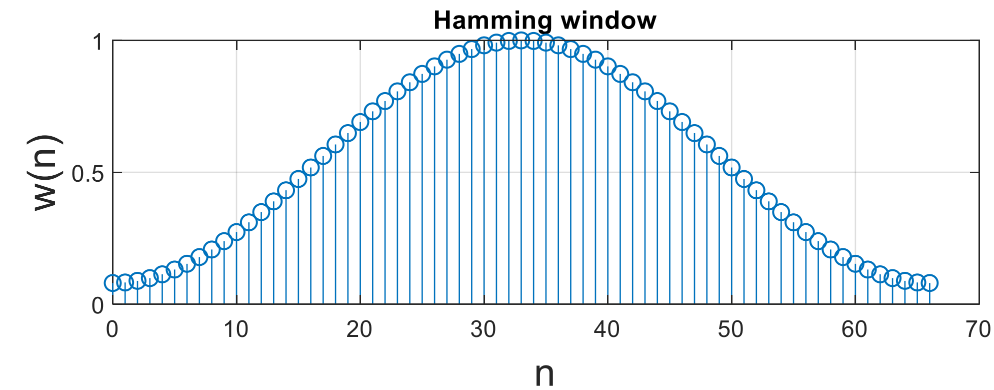
```
function hd=ideal_lp(wc,M)
%Ideal lowpass filter computation
% hd=ideal lowpass impulse response
% wc=cutoff frequency in radians
% M=length of the ideal filter
alpha=(M-1)/2;
n=0:M-1;
m=n-alpha;
fc=wc/pi;
hd=fc*sinc(fc*m);
end
```

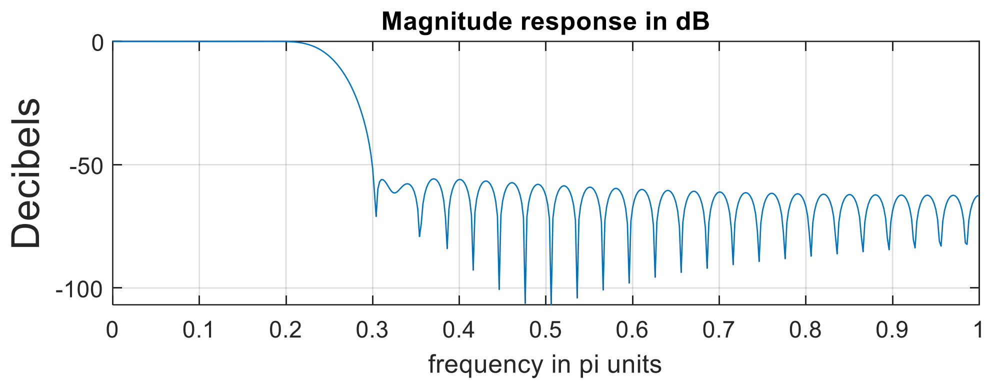
2) FIR low pass filter with wp = 0.2π, ws = 0.3π using Hamming window

Code:

```
%Definition
wp=0.2*pi;
ws=0.3*pi;
tr_width=ws-wp;
M=ceil(6.6*pi/tr_width)+1;
n=0:M-1;
wc=(ws+wp)/2;  %Ideal LPF cutoff frequency

%Impulse response
hd=ideal_lp(wc,M);
w_ham=(hamming(M))';
h=hd.*w_ham;

%Frequency response
[H w]=freqz(h,[1],1000,'whole');
H=(H(1:501))';
w=(w(1:501))';
mag=abs(H);
db=20*log10((mag+eps)/max(mag));

%Plotting
subplot(2,1,1)
stem(n,w_ham); grid
title('Hamming window');
xlabel('n','fontsize',15);
ylabel('w(n)','fontsize',15);
subplot(2,1,2)
plot(w/pi,db); grid
title('Magnitude response in dB');
xlabel('frequency in pi units');
ylabel('Decibels','fontsize',15);
```

Outputs:





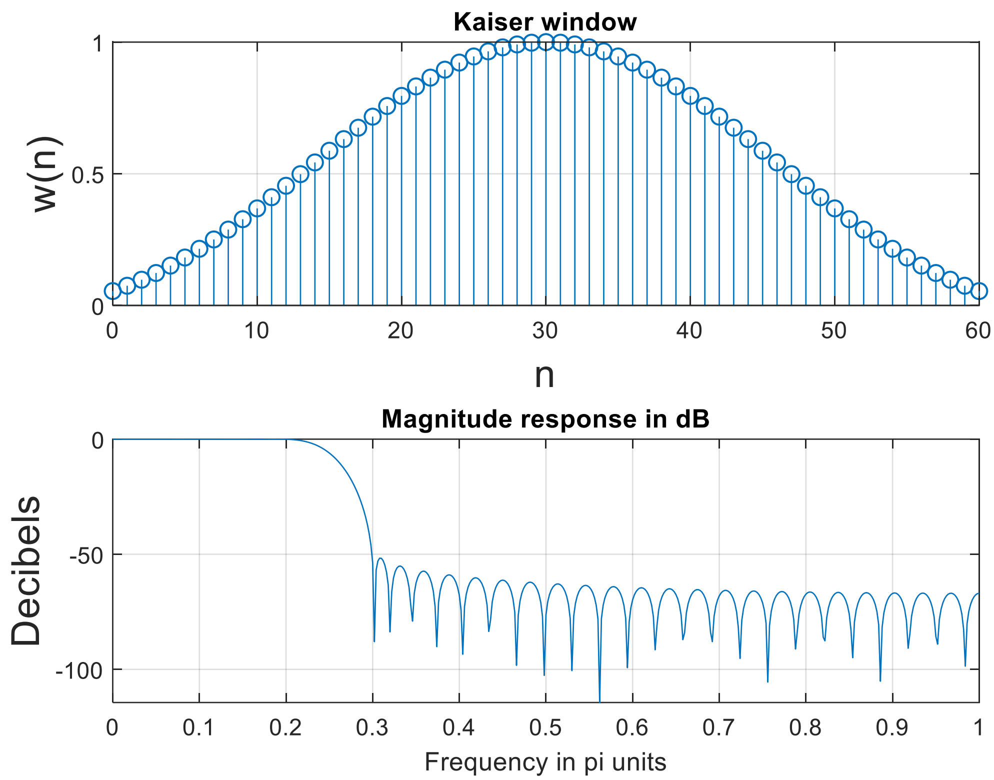
3) FIR low pass filter with wp = 0.2π, ws = 0.3π and As = 50dB using Kaiser window

Code:

```
%Definition
wp=0.2*pi;
ws=0.3*pi;
tr_width=ws-wp;
As=50;
M=ceil((As-7.95)/(2.285*tr_width)+1)+1;
n=0:M-1;
wc=(ws+wp)/2; %Ideal LPF cutoff frequency
beta=0.1102*(As-8.7);

%Impulse response
hd=ideal_lp(wc,M);
w_kai=(kaiser(M,beta))';
h=hd.*w_kai;

%Frequency response
[H w]=freqz(h,[1],1000,'whole');
H=(H(1:501))';
w=(w(1:501))';
mag=abs(H);
db=20*log10((mag+eps)/max(mag));
```

```
%Plotting
subplot(2,1,1)
stem(n,w_kai); grid
title('Kaiser window');
xlabel('n','fontsize',15);
ylabel('w(n)','fontsize',15);
subplot(2,1,2)
plot(w/pi,db); grid
title('Magnitude response in dB');
xlabel('Frequency in pi units');
ylabel('Decibels','fontsize',15);
```

Output:



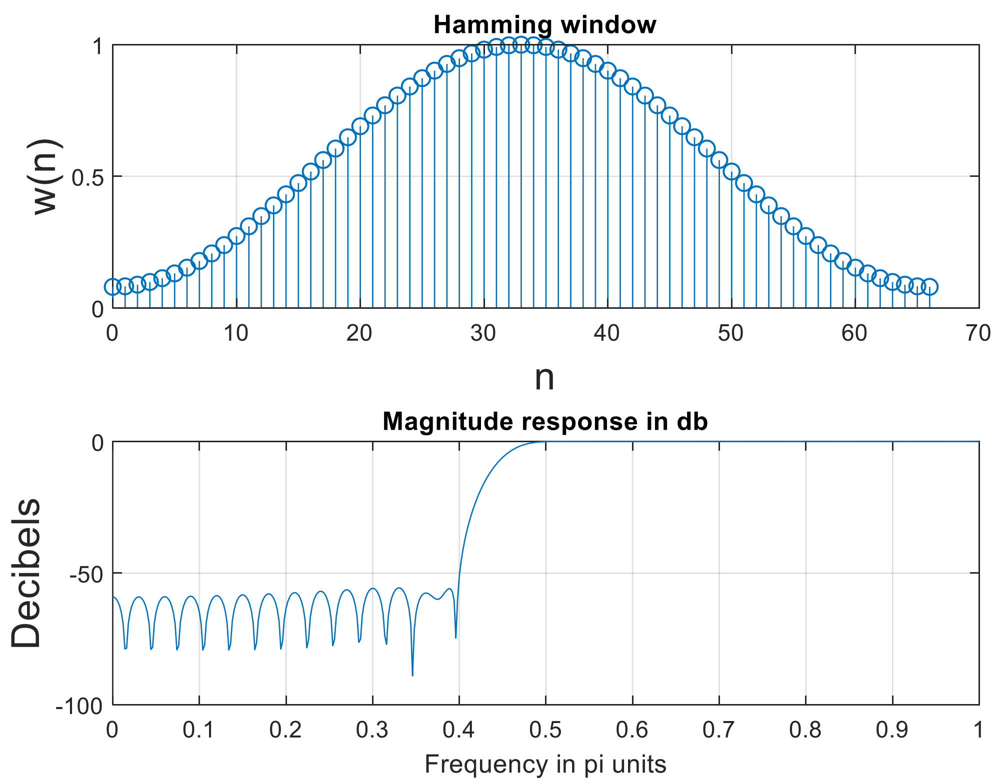
4) FIR high pass filter with wp = 0.4π, ws = 0.5π using Hamming window

Code:

```
%Definiiton
wp=0.4*pi;
ws=0.5*pi;
tr_width=ws-wp;
M=ceil(6.6*pi/tr_width)+1;
n=0:M-1;
wc=(ws+wp)/2;

hd=ideal_lp(pi,M)-ideal_lp(wc,M);
```

```
w_ham=(hamming(M))';
h=hd.*w_ham;

%Frequency response
[H, w]=freqz(h,[1],1000,'whole');
H=(H(1:501))';
w=(w(1:501))';
mag=abs(H);
db=20*log10((mag+eps)/max(mag));

%Plotting
subplot(2,1,1)
stem(n,w_ham); grid
title('Hamming window');
xlabel('n','fontsize',15);
ylabel('w(n)','fontsize',15);
subplot(2,1,2)
plot(w/pi,db); grid
title('Magnitude response in db');
xlabel('Frequency in pi units');
ylabel('Decibels','fontsize',15);
```

Output:



Assignment:

i. Function definition:

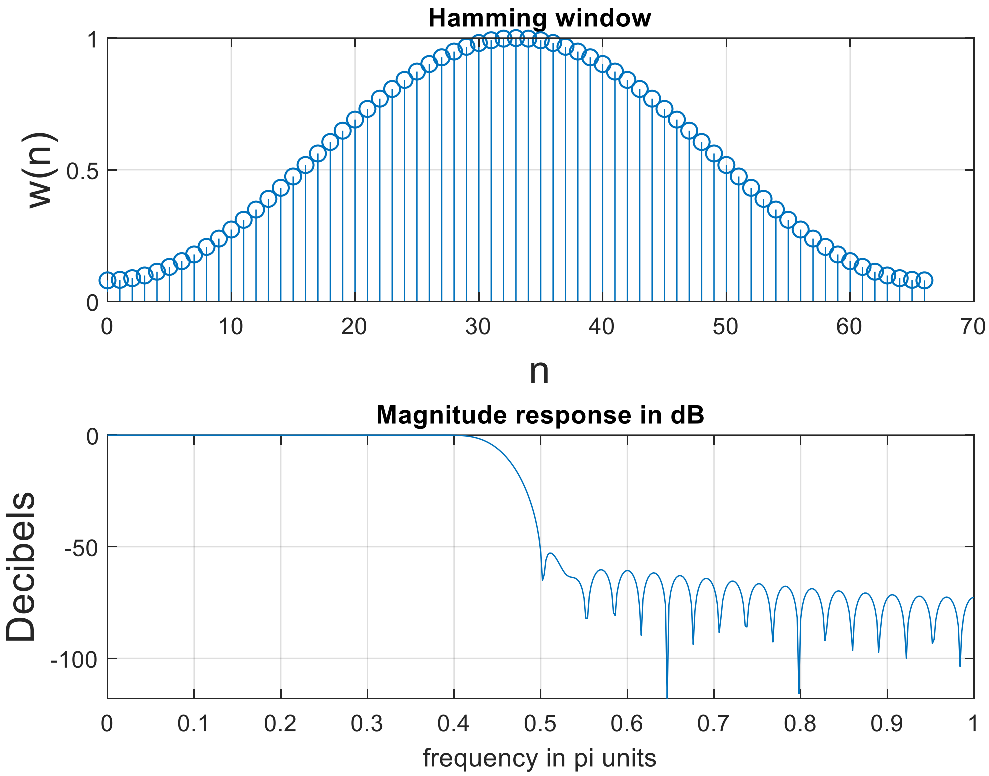
```
% function to plot LPF impulse response from pass and stopband frequency
function [] = fir_lp_hamming(wp,ws)

tr_width=ws-wp;
M=ceil(6.6*pi/tr_width)+1;
n=0:M-1;
wc=(ws+wp)/2;

%Impulse response
hd=ideal_lp(wc,M);
w_ham=(hamming(M))';
h=hd.*w_ham;

%Frequency response
[H w]=freqz(h,[1],1000,'whole');
H=(H(1:501))';
w=(w(1:501))';
mag=abs(H);
db=20*log10((mag+eps)/max(mag));

%Plotting
subplot(2,1,1)
stem(n,w_ham); grid
title('Hamming window');
xlabel('n','fontsize',15);
ylabel('w(n)','fontsize',15);
subplot(2,1,2)
plot(w/pi,db); grid
title('Magnitude response in dB');
xlabel('frequency in pi units');
ylabel('Decibels','fontsize',15);

end
```

ii. Call and output:

Call:

```
wp = 0.4*pi;
ws = 0.5*pi;
fir_lp_hamming(wp,ws);
```

Output:



Hamming window
w(n)
1
0.5
0
0
10
20
30
40
50
60
70
n
Magnitude response in dB
Decibels
0
-50
-100
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
frequency in pi units