DSP EXP 2

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Roll No:-18EC10021

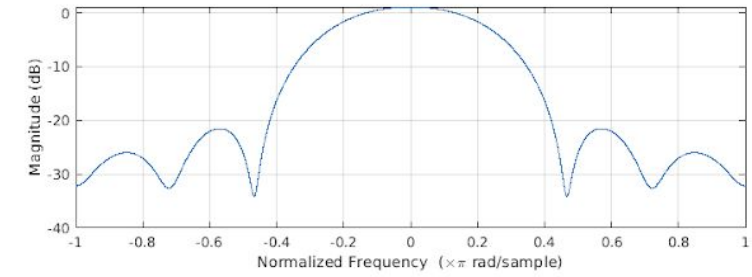
Rectangular window:

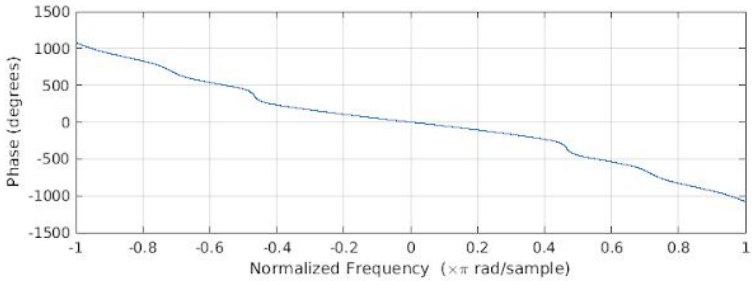
Code:

```
N= 8;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = rectwin(N);
h = hd.*transpose(w);
omega = -pi:pi/10000:pi;
figure(1);
freqz(h,1,omega);

N= 64;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = rectwin(N);
h = hd.*transpose(w);
omega = -pi:pi/10000:pi;
figure(2);
freqz(h,1,omega);

N= 512;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = rectwin(N);
h = hd.*transpose(w);
omega = -pi:pi/10000:pi;
figure(3);
```

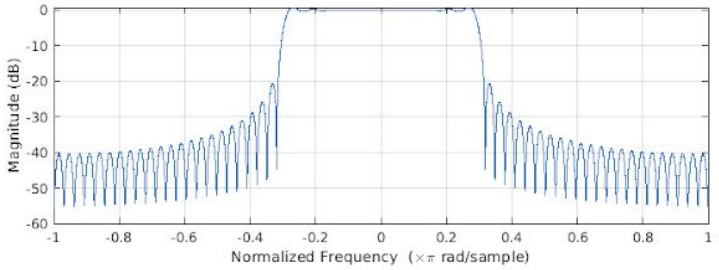
freqz(h,1,omega);

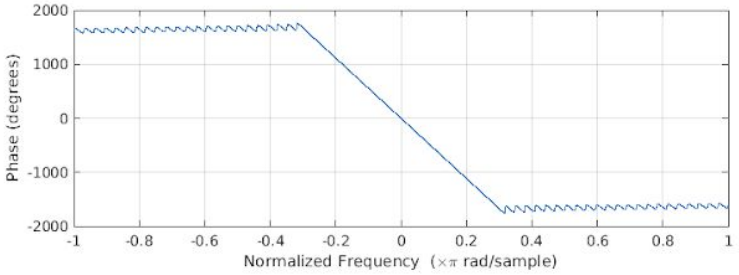
Plots:



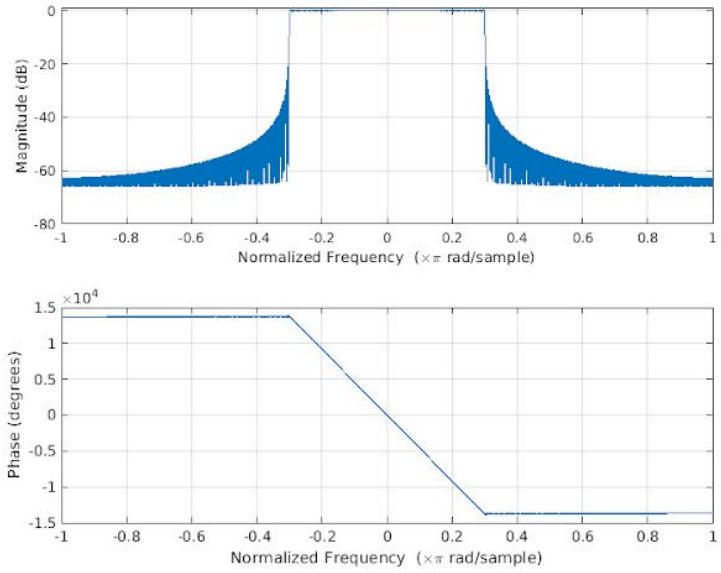


N=8





N=64



N=512

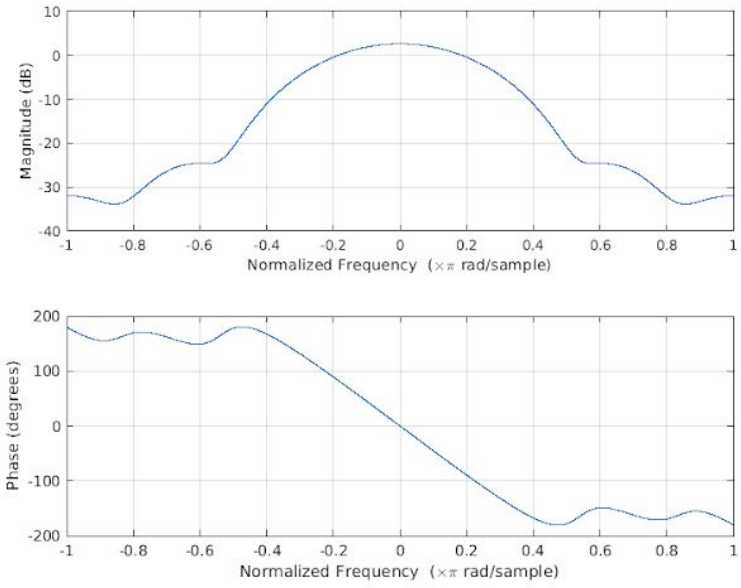
triangular window:

Code:

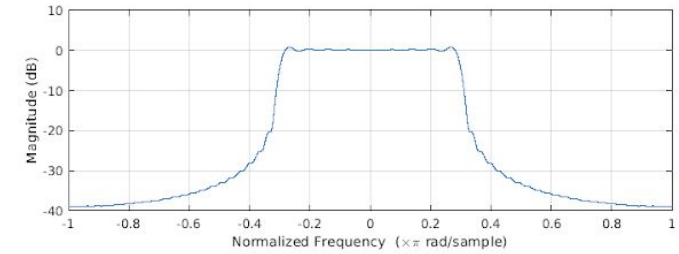
```
N= 8;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=1-2*(i-1-(N-1)/2)/(N-1);
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(1);
freqz(h,1,omega);

N= 64;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=1-2*(i-1-(N-1)/2)/(N-1);
```

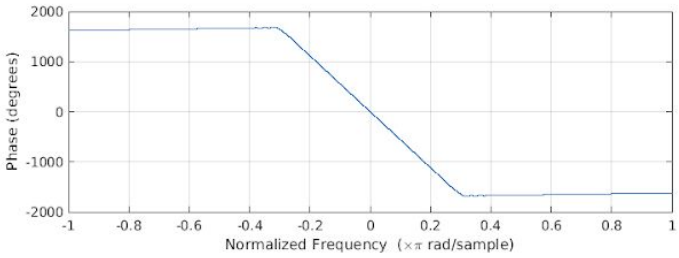
```
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(2);
freqz(h,1,omega);

N= 512;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=1-2*(i-1-(N-1)/2)/(N-1);
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(3);
freqz(h,1,omega);
```

Plots:

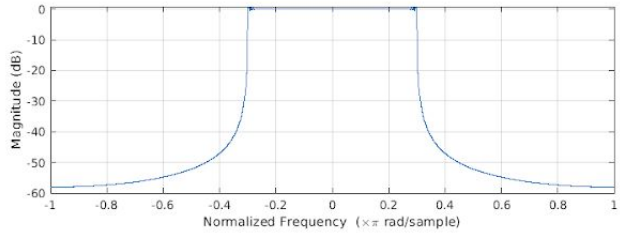


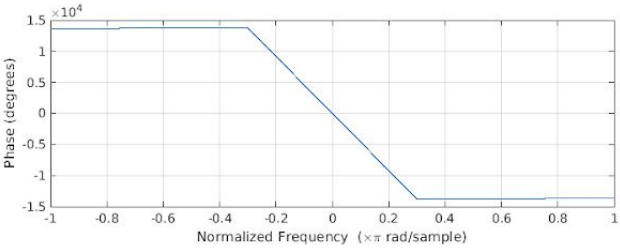
N=8





N=64





N=512

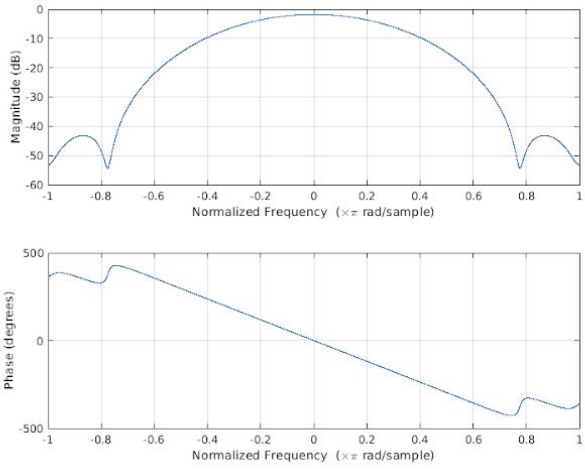
hanning window:

Code:

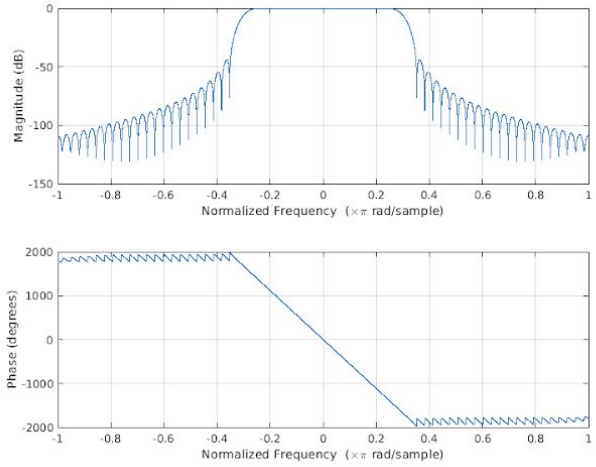
```
N= 8;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
```

```
w(i)=0.5-0.5*cos(2*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(1);
freqz(h,1,omega);

N= 64;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=0.5-0.5*cos(2*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(2);
freqz(h,1,omega);

N= 512;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=0.5-0.5*cos(2*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(3);
freqz(h,1,omega);
```

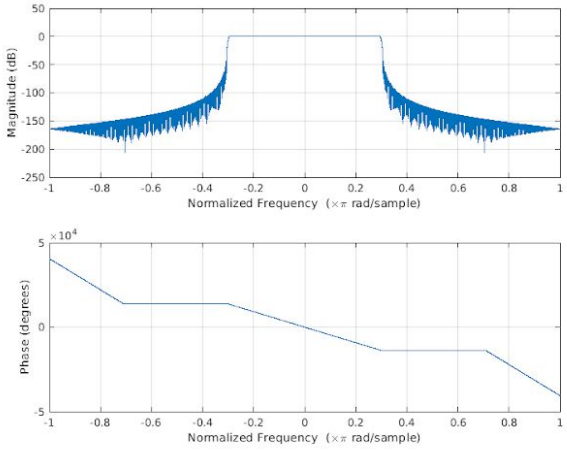
Plots:


Magnitude (dB)
Normalized Frequency (×π rad/sample)
Phase (degrees)
Normalized Frequency (×π rad/sample)

N=8


Magnitude (dB)
Normalized Frequency (×π rad/sample)
Phase (degrees)
Normalized Frequency (×π rad/sample)

N=64


Magnitude (dB)
Normalized Frequency (×π rad/sample)
×10^4
Phase (degrees)
Normalized Frequency (×π rad/sample)

N=512

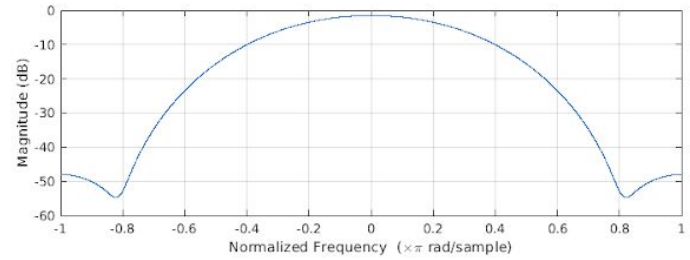
hamming window:

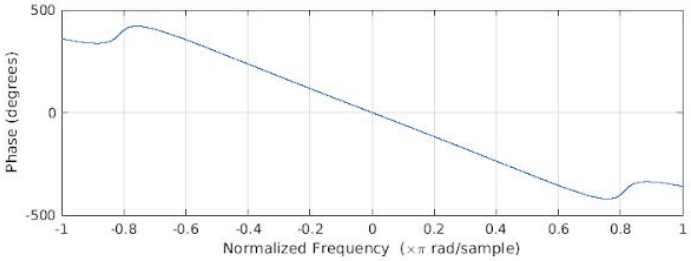
Code:

```
N= 8;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=0.54-0.46*cos(2*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(1);
freqz(h,1,omega);

N= 64;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=0.54-0.46*cos(2*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(2);
freqz(h,1,omega);

N= 512;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=0.54-0.46*cos(2*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(3);
```

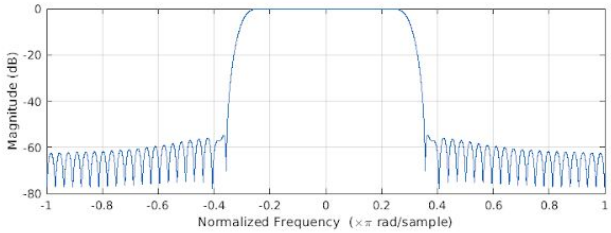
freqz(h,1,omega);

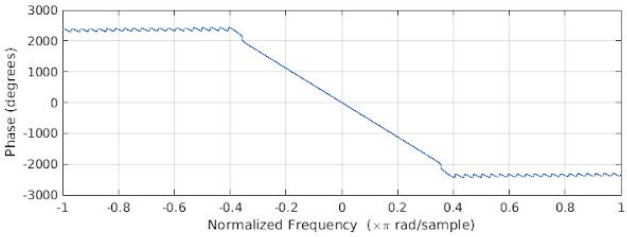
Plots:



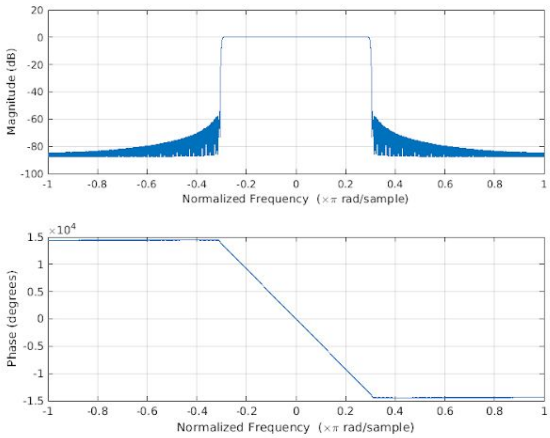


N=8





N=64



N=512

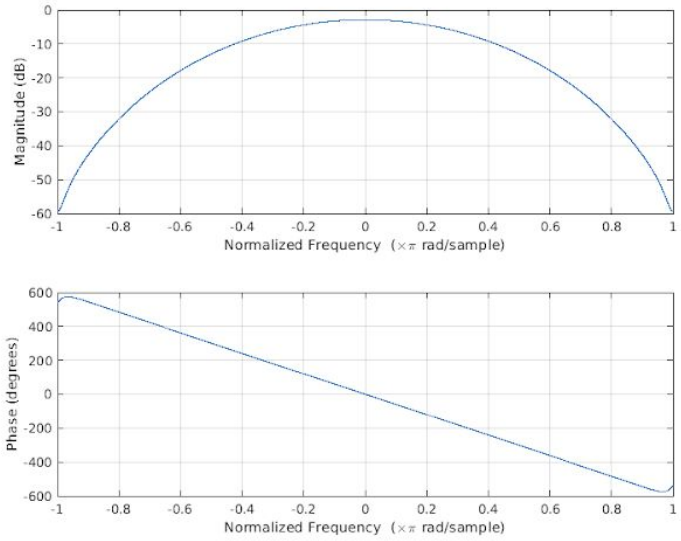
Blackhamnan window:

Code:

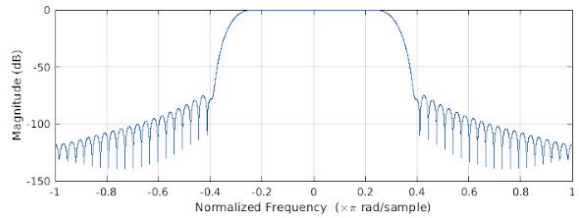
```
N= 8;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=0.42-0.5*cos(2*pi*((i-1)/(N-1)))+0.08*cos(4*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(1);
freqz(h,1,omega);

N= 64;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=0.42-0.5*cos(2*pi*((i-1)/(N-1)))+0.08*cos(4*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(2);
freqz(h,1,omega);
```

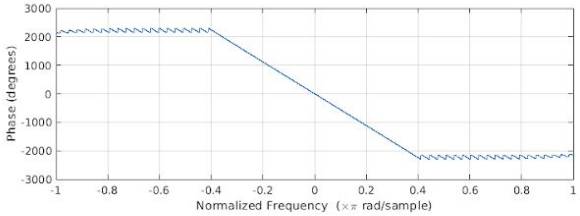
```
N= 512;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = zeros(1,N);
for i=1:N
w(i)=0.42-0.5*cos(2*pi*((i-1)/(N-1)))+0.08*cos(4*pi*((i-1)/(N-1)));
end
h = hd.*w;
omega = -pi:pi/10000:pi;
figure(3);
freqz(h,1,omega);
```

Plots:

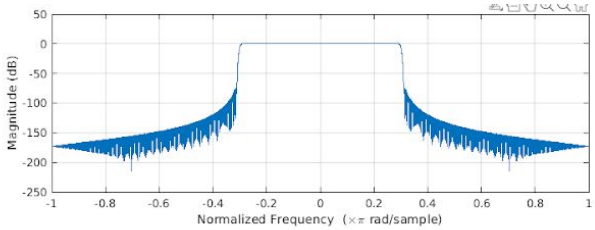


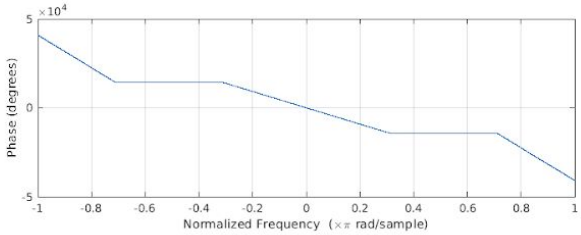
N=8





N=64





N=512

SNR Calculation:

Rectangular window:

```
Np=10000;
l=0:1:Np;
x=cos(0.1*pi*l)+cos(0.9*pi*l);
y=x+2*transpose(randn(Np+1,1));
s=2*transpose(randn(Np+1,1));
freq=linspace(-pi,pi,length(x))/pi;
%%
N= 8;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
```

```
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;
w = rectwin(N);
h = hd.*transpose(w);
figure(1);
subplot(221)
plot(freq,abs(fftshift(fft(x)))/Np);
out=filtfilt(h,1,x);
subplot(222)
plot(freq,abs(fftshift(fft(out)))/Np);
power_signal = sum(out.^2);
subplot(223)
plot(freq,abs(fftshift(fft(y)))/Np);
out2=filtfilt(h,1,y);
subplot(224)
plot(freq,abs(fftshift(fft(out2)))/Np);
noise_signal = sum(out2.^2) -power_signal;
SNR = 10*log10(power_signal/noise_signal);
SNR1 = snr(s,out);
disp(SNR);
disp(SNR1);
%%
N= 64;
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = rectwin(N);
h = hd.*transpose(w);
figure(2);
subplot(221)
plot(freq,abs(fftshift(fft(x)))/Np);
out=filtfilt(h,1,x);
subplot(222)
plot(freq,abs(fftshift(fft(out)))/Np);
power_signal = sum(fftshift(fft(out)).^2);
subplot(223)
plot(freq,abs(fftshift(fft(y)))/Np);
out2=filtfilt(h,1,y);
subplot(224)
plot(freq,abs(fftshift(fft(out2)))/Np);
noise_signal = sum((fftshift(fft(out2))).^2) -power_signal;
SNR = 10*log10(power_signal/noise_signal);
SNR1 = snr(s,out);
disp(SNR1);
%%
N= 512;
```

```
hd = zeros(1,N);
k= ceil((N-1)/2);
for i=1:N
if(i==k)
continue
end
hd(i)= (sin(0.3*pi*(i-k)))/(pi*(i-k));
end
hd(k) = 0.3;

w = rectwin(N);
h = hd.*transpose(w);
figure(3);
subplot(221)
plot(freq,abs(fftshift(fft(x)))/Np);
out=filtfilt(h,1,x);
subplot(222)
plot(freq,abs(fftshift(fft(out)))/Np);
power_signal = sum(fftshift(fft(out)).^2);
subplot(223)
plot(freq,abs(fftshift(fft(y)))/Np);
out2=filtfilt(h,1,y);
subplot(224)
plot(freq,abs(fftshift(fft(out2)))/Np);
noise_signal = sum((fftshift(fft(out2))).^2) -power_signal;
SNR = 10*log10(power_signal/noise_signal);
SNR1 = snr(s,out);
disp(SNR1);
```

Plots:

Figure-1

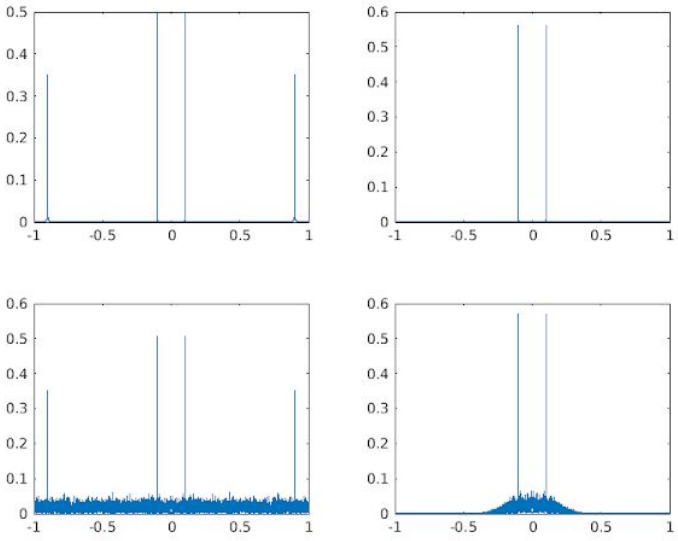


Figure-2

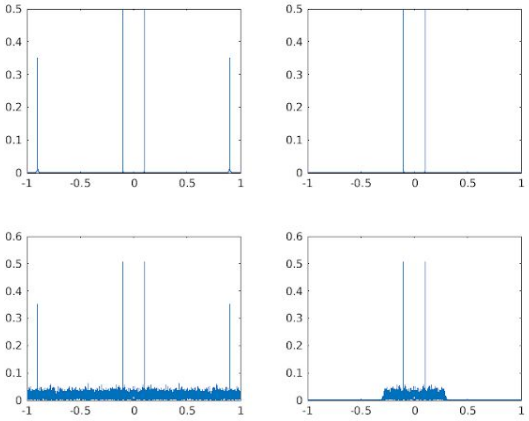


Figure-3