1.

```
function [ IO ] = myBessel( x )
 IO=1;
    for m=1:20
    a=((x/2)^m)/factorial(m);
    a=a^2;
    IO=IO+a;
    end
    disp(IO)
end
```

2.

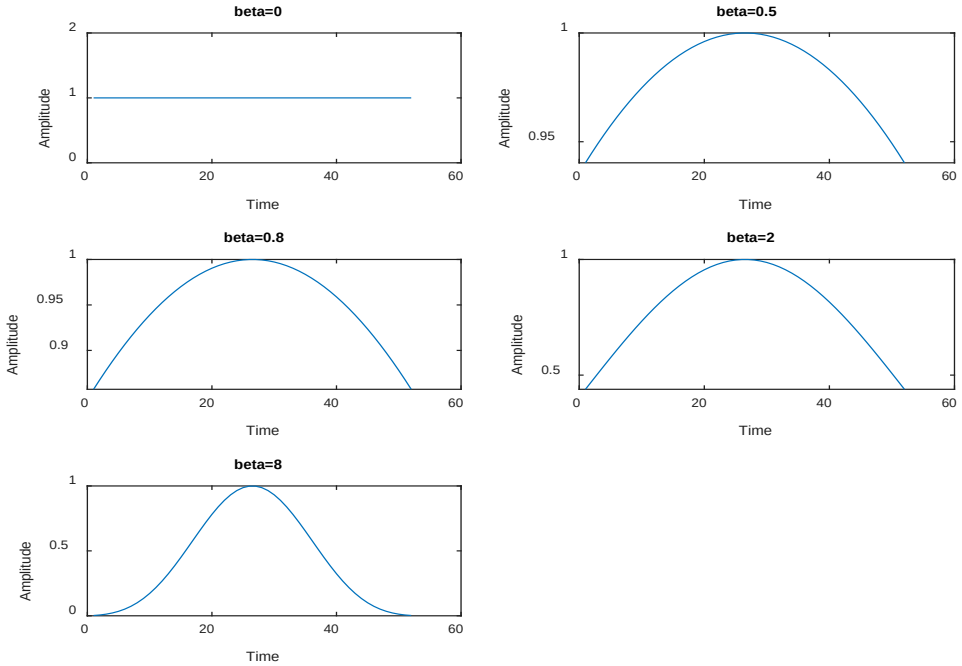
```
function [w] = myKaiser(beta, M)
alpha=M/2;
for n=0:M
   if (n>=0 && n<=M)
      x=beta*sqrt(1-((n-alpha)/alpha)^2);
      w(n+1)=myBessel(x)/myBessel(beta);
   end
end
end
```

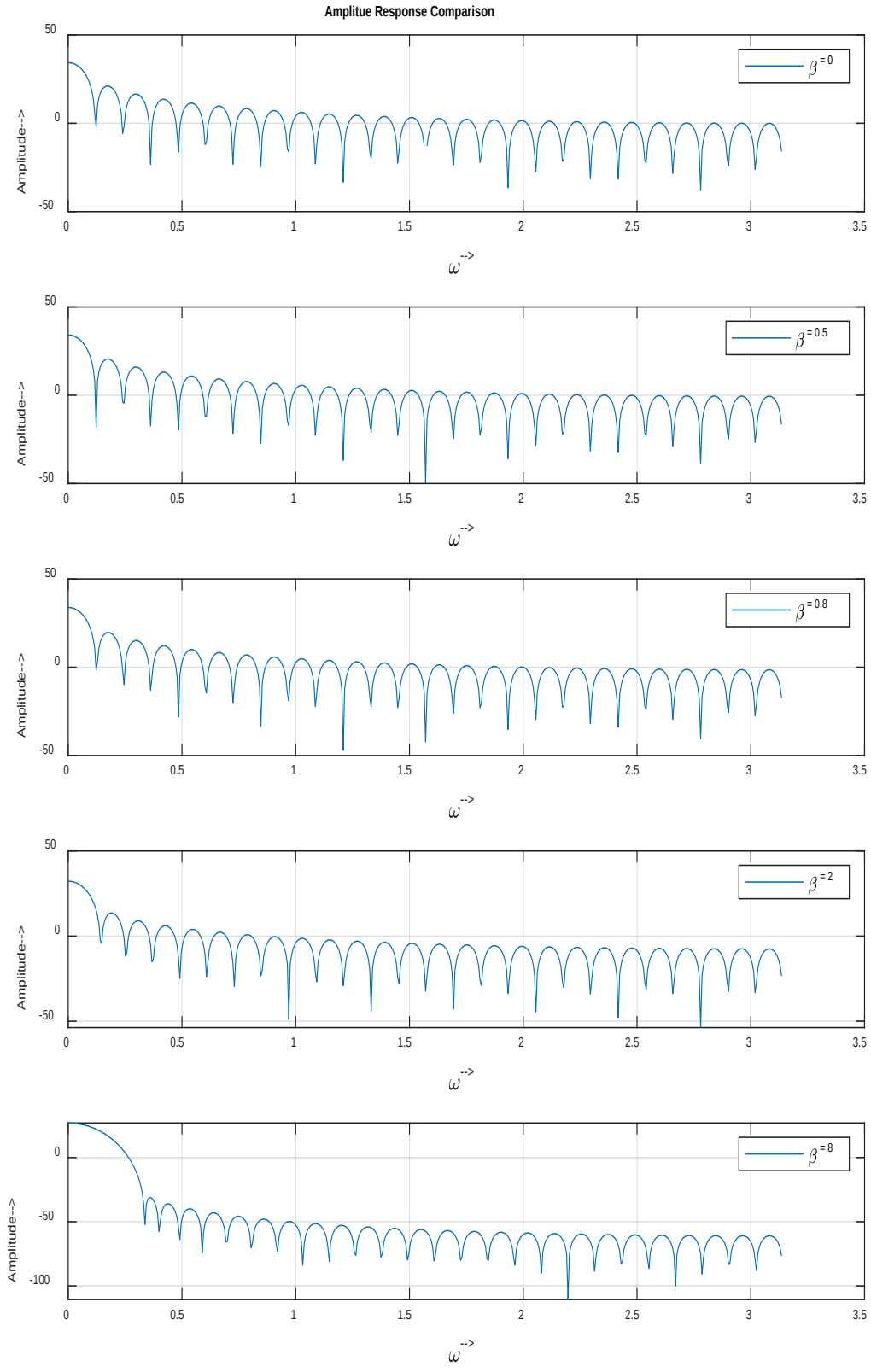
3.

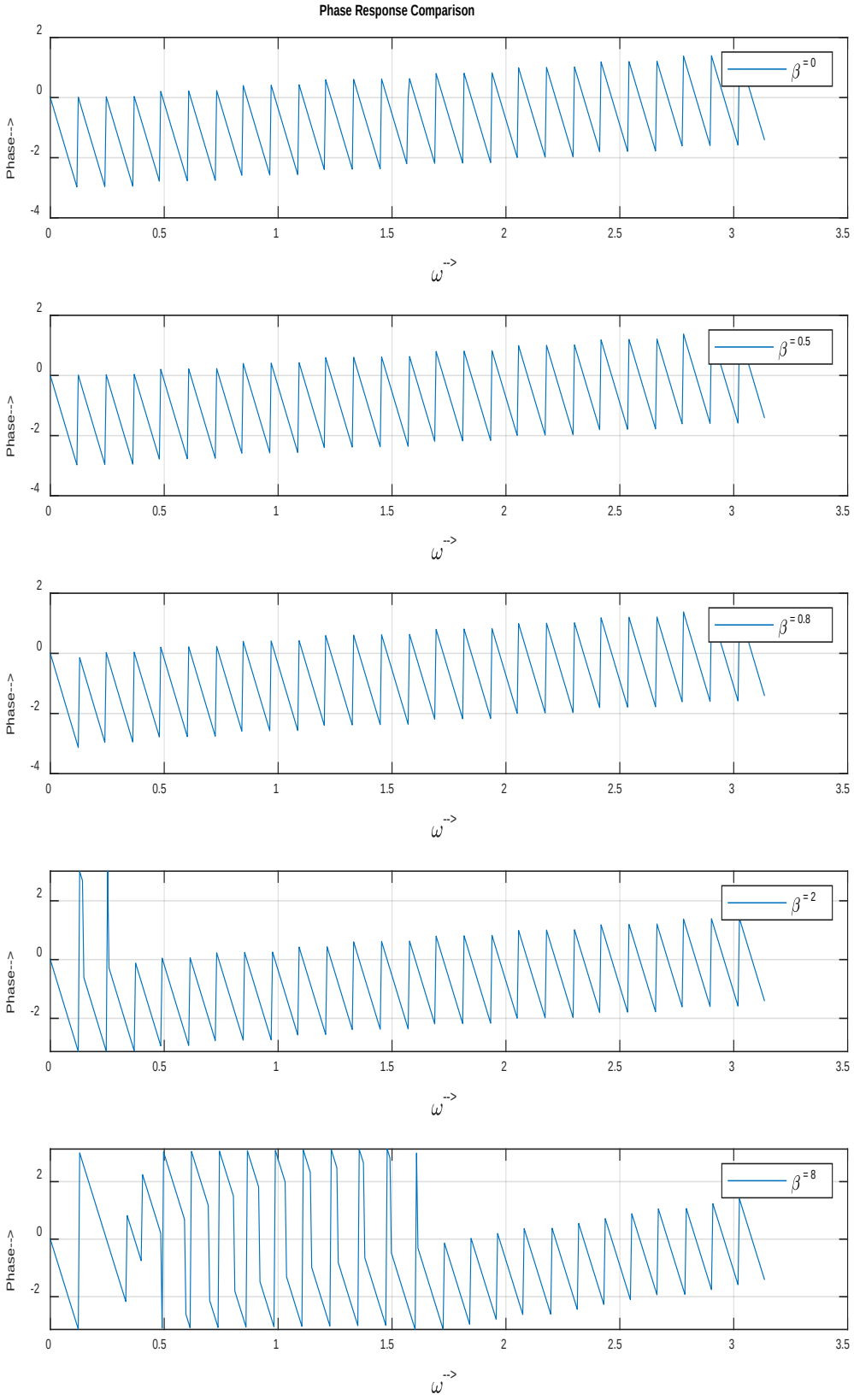
```
[w1]= myKaiser(0,51)
[w2]= myKaiser(0.5,51)
[w3]= myKaiser(0.8,51)
[w4]= myKaiser(2,51)
[w5]= myKaiser(8,51)


%PLOTS
figure
subplot(321)
plot(w1)
title('beta=0');
xlabel('Time');
ylabel('Amplitude');
subplot(322)
plot(w2)
title('beta=0.5');
xlabel('Time');
ylabel('Amplitude');
subplot(323)
plot(w3)
title('beta=0.8');
xlabel('Time');
ylabel('Amplitude');
subplot(324)
plot(w4)
title('beta=2');
xlabel('Time');
ylabel('Amplitude');
subplot(325)
plot(w5)
title('beta=8');
xlabel('Time');
ylabel('Amplitude');



figure
subplot(511)
[H1,W1]=freqz(w1,1)
l1=abs(H1);
p1=20*log10(l1);
plot(W1,p1)
xlabel('\omega-->');
ylabel('Amplitude-->');
title('Amplitue Response Comparison');
legend('\beta = 0')
```

```
grid on;
subplot(512)
[H2,W2]=freqz(w2,1)
l2=abs(H2);
p2=20*log10(l2);
plot(W2,p2)
xlabel('\omega-->');
ylabel('Amplitude-->');
legend('\beta = 0.5')
grid on;
subplot(513)
[H3,W3]=freqz(w3,1)
l3=abs(H3);
p3=20*log10(l3);
plot(W3,p3)
xlabel('\omega-->');
ylabel('Amplitude-->');
legend('\beta = 0.8')
grid on;
subplot(514)
[H4,W4]=freqz(w4,1)
l4=abs(H4);
p4=20*log10(l4);
plot(W4,p4)
xlabel('\omega-->');
ylabel('Amplitude-->');
legend('\beta = 2')
grid on;
subplot(515)
[H5,W5]=freqz(w5,1)
l5=abs(H5);
p5=20*log10(l5);
plot(W5,p5)
xlabel('\omega-->');
ylabel('Amplitude-->');
legend('\beta = 8')
set(gcf, 'Position', [0, 0, 700, 800])
grid on;

figure
subplot(511)
plot(W1,angle(H1))
xlabel('\omega-->');
ylabel('Phase-->');
title('Phase Response Comparison');
legend('\beta = 0')
grid on;
subplot(512)
plot(W2,angle(H2))
xlabel('\omega-->');
```

```
ylabel('Phase-->');
legend('\beta = 0.5')
grid on;
subplot(513)
plot(W3,angle(H3))
xlabel('\omega-->');
ylabel('Phase-->');
legend('\beta = 0.8')
grid on;
subplot(514)
plot(W4,angle(H4))
xlabel('\omega-->');
ylabel('Phase-->');
legend('\beta = 2')
grid on;
subplot(515)
plot(W5,angle(H5))
xlabel('\omega-->');
ylabel('Phase-->');
legend('\beta = 8')
set(gcf, 'Position', [0, 0, 700, 800])
grid on;
```



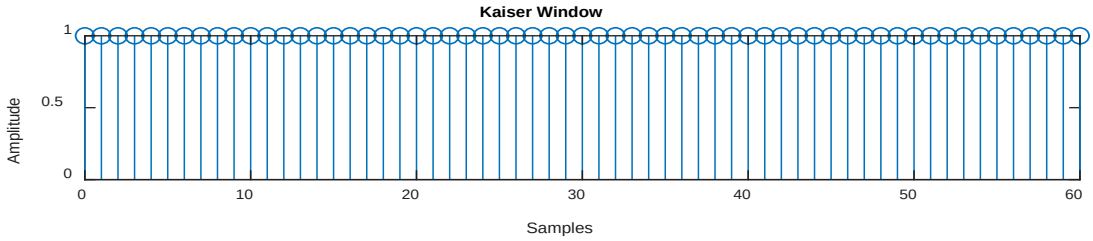

Amplitue Response Comparison
Amplitude-->
50
0
-50
0
0.5
1
1.5
2
2.5
3
3.5
ω-->
β = 0
β = 0.5
β = 0.8
β = 2
β = 8
-100

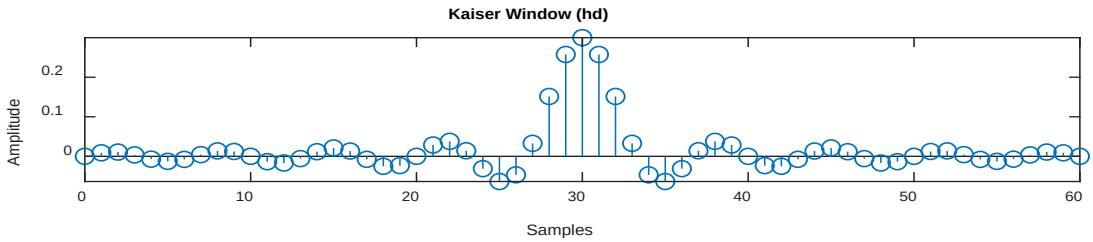

Phase Response Comparison
Phase-->
ω-->
β = 0
β = 0.5
β = 0.8
β = 2
β = 8

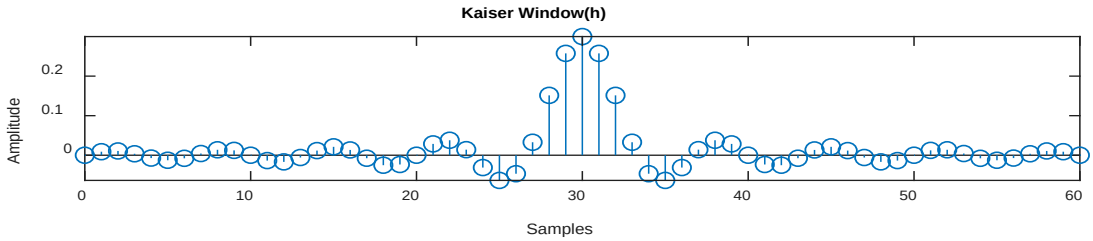
4.

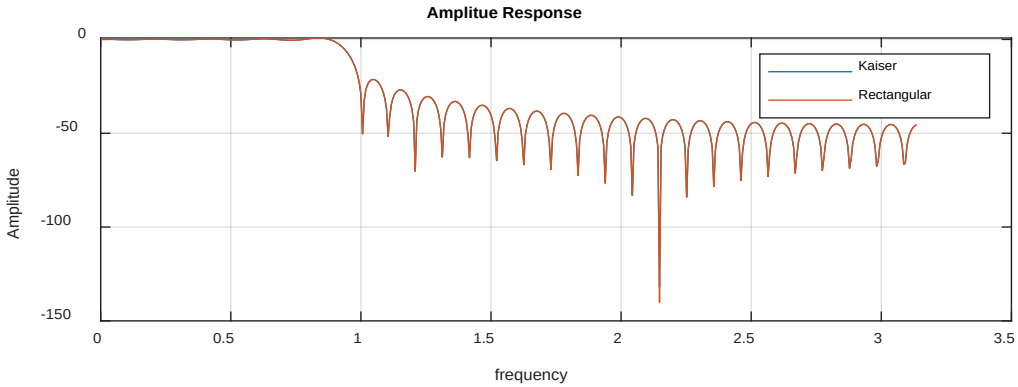
```
clc;
clear all;
close all;

%Required Specification
wp=0.25*pi;            %pass band edge frequency
ws=0.35*pi;            %stop band edge frequency
Ap=0.1;                %pass band ripple
As=50;                 %minimum stop band attenuation

%Calculation of delta_p and delta_s
delta_p=(10^(0.05*Ap)-1)/(10^(0.05*Ap)+1)
delta_s=10^(-0.05*As)

delta=min(delta_s,delta_p)

%Cutoff frequency
wc=(wp+ws)/2

%Design parameter
A= - 20*log10(delta)
delta_w = ws-wp

%value of beta
if (A<21)
   beta=0;
elseif (A>=21&&A<=50)
   beta=(0.5842*((A-21)^0.4))-(0.07886*(A-21));
elseif (A>50)
   beta=0.1102*(A-87);
end


%Order of the filter
M=(A-8)/(2.285*delta_w)
M=ceil(M)+1

%Window function w(n):KAISER Window
w=myKaiser(beta, M);

%Desired Impulse Response
for n=0:1:M
   hd(n+1)=(sin(wc*(n-M/2)))/(pi*(n-M/2));
end
hd((M/2)+1)=(wc)/pi;


%Actuall Impulse Response h(n):
```

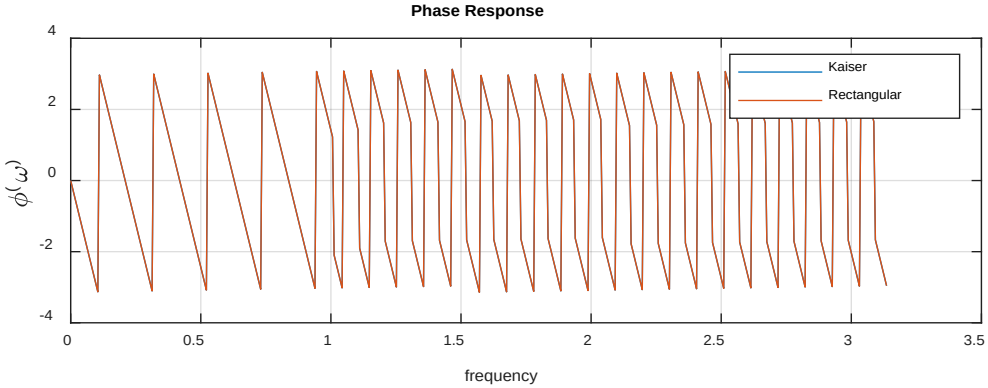
```
h=hd.*w
figure
subplot(311)
stem(0:M, w);
xlabel('Samples');
ylabel('Amplitude');
title('Kaiser Window');

subplot(312)
stem(0:M, hd);
xlabel('Samples');
ylabel('Amplitude');
title('Kaiser Window (hd)');

subplot(313)
stem(0:M, h);
xlabel('Samples');
ylabel('Amplitude');
title('Kaiser Window(h)');

figure
subplot(211)
[H,W]=freqz(h,1)
a=abs(H);
m=20*log10(a);
plot(W,m)
hold on;

[H1,W1]=freqz(hd,1)
n=abs(H1);
q=20*log10(n);
plot(W1,q)
xlabel('frequency');
ylabel('Amplitude');
title('Amplitue Response');
legend('Kaiser', 'Rectangular')
grid on;

subplot(212)
plot(W,angle(H))
hold on;
plot(W1,angle(H1))
xlabel('frequency');
ylabel('\phi(\omega)');
title('Phase Response ');
legend('Kaiser', 'Rectangular')
grid on
```


Kaiser Window
Amplitude
Samples


Kaiser Window (hd)
Amplitude
Samples


Kaiser Window(h)
Amplitude
Samples


Amplitue Response
Kaiser
Rectangular
Amplitude
frequency


Phase Response
Kaiser
Rectangular
frequency

5.

```
clc;clear;close all;
%Required Specification
Fp1=8000;
Fp2=12000;
delta_f=3000;
Fs1=Fp1-delta_f;
Fs2=Fp2+delta_f;
Fsample=44100;                %sampling frequency
wp1=2*pi*(Fp1/Fsample);
wp2=2*pi*(Fp2/Fsample);       %pass band edge frequency
ws1=2*pi*(Fs1/Fsample);
ws2=2*pi*(Fs2/Fsample);       %stop band edge frequency
Ap=-20*log10(0.01)            %pass band ripple
As=-20*log10(0.001)           %minimum stop band attenuatio
%Calculation of delta_p and delta_s
delta_p=(10^(0.05*Ap)-1)/(10^(0.05*Ap)+1)
delta_s=10^(-0.05*As)

delta=min(delta_s,delta_p)

%Cutoff frequency
wc1=(wp1+ws1)/2
wc2=(wp2+ws2)/2

%Design parameter
A= - 20*log10(delta)
delta_w = wp1-ws1

%value of beta
if (A<21)
   beta=0;
elseif (A>=21&&A<=50)
   beta=(0.5842*((A-21)^0.4))-(0.07886*(A-21));
elseif (A>50)
   beta=0.1102*(A-87);
end


%Order of the filter
M=(A-8)/(2.285*delta_w)
M=ceil(M)
%Window function w(n):BLACKMAN Window
w=myWindows('Hamming',M );


%Desired Impulse Response

for n=0:M
   %if((n>=0)&&(n<=(M/2-1)))&&((n>=(M/2+1))&&(n<=M))
```

```
      hd(n+1)=((sin(wc2*(n-M/2)))-(sin(wc1*((n-M/2)))))/(pi*(n-M/2));
    %end
end
hd((M/2)+1)=(wc2-wc1)/pi

%Actuall Impulse Response h(n):
h=hd.*w;

figure
subplot(311)
stem(0:M, w);
xlabel('Samples');
ylabel('Amplitude');
title('Kaiser Window');

subplot(312)
stem(0:M, hd);
xlabel('Samples');
ylabel('Amplitude');
title('Kaiser Window (hd)');

subplot(313)
stem(0:M, h);
xlabel('Samples');
ylabel('Amplitude');
title('Kaiser Window(h)');

figure
subplot(211)
[H,W]=freqz(h,1)
a=abs(H);
m=20*log10(a);
plot(W,m)
hold on;

[H1,W1]=freqz(hd,1)
n=abs(H1);
q=20*log10(n);
plot(W1,q)
xlabel('frequency');
ylabel('Amplitude');
title('Amplitue Response');
legend('Kaiser', 'Rectangular')
grid on;

subplot(212)
plot(W,angle(H))
hold on;
plot(W1,angle(H1))
xlabel('frequency');
```

```
ylabel('\phi(\omega)');
title('Phase Response ');
legend('Kaiser', 'Rectangular')
grid on
```