Q1.

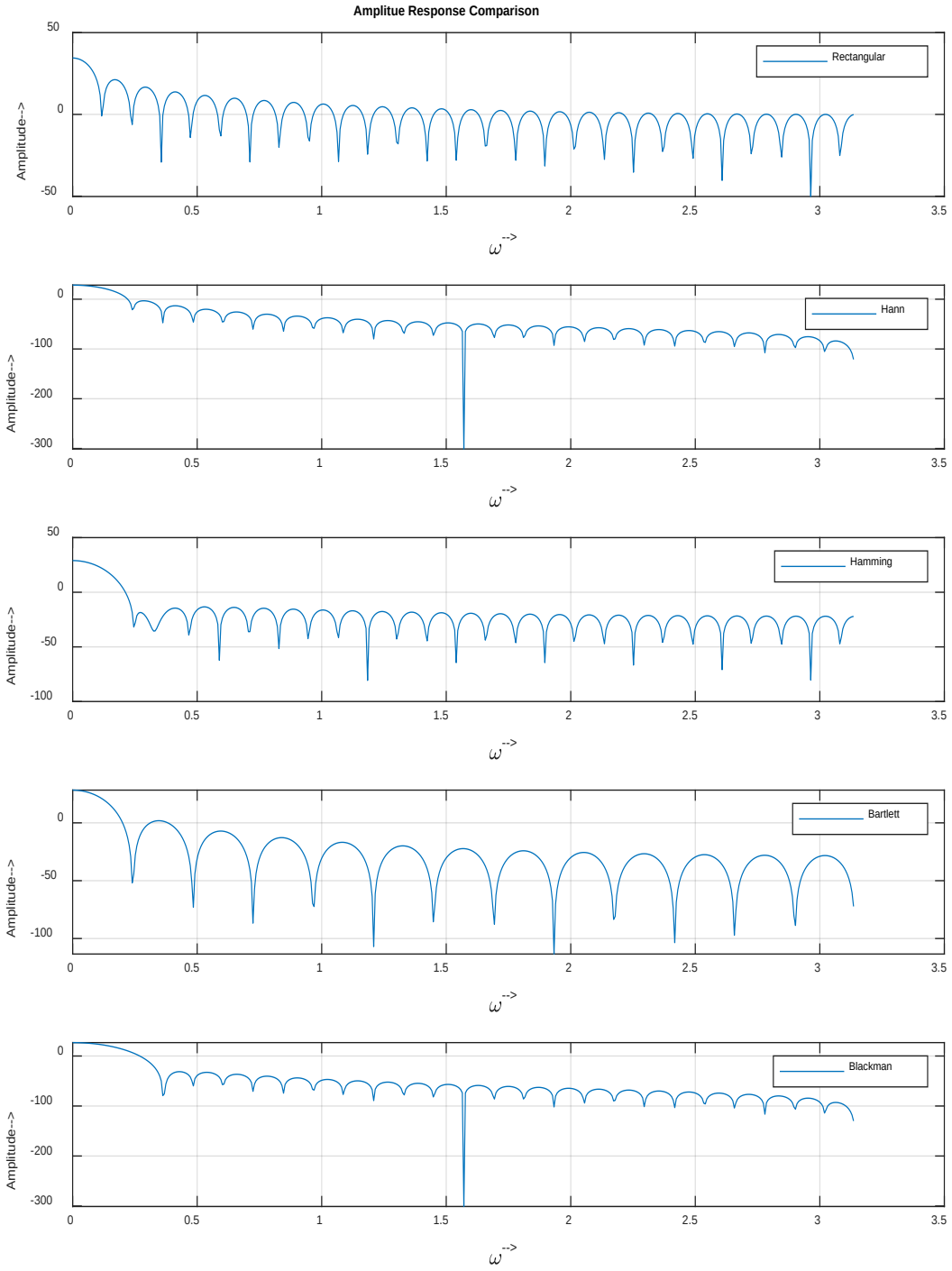
```
function [w] = myWindows(windowName, M)
switch windowName
   case 'Rectangular'
      for n=0:(M)
         if (n>=0) && (n<= M)
            w(n+1)=1;
         else
            w(n+1)=0;
         end
      end
   case 'Hann'
      for n=0:(M)
         if (n>=0) && (n<=M)
            w(n+1)= 0.5-0.5*cos(2*pi*n/M);
         else
            w(n+1)=0;
         end
      end
   case 'Hamming'
      for n=0:(M)
         if (n>=0) && (n<=M)
            w(n+1)= 0.54-0.46*cos(2*pi*n/M);
         else
            w(n+1) = 0;
         end
      end

   case'Bartlett'
      if mod(M,2)==0
      for n=0:(M)
         if (n>=0) && (n<=M/2)
            w(n+1)= 2*n/M;
         elseif (n>=M/2) && (n<=M)
            w(n+1)=2 -(2*n/M);
         else
            w(n+1) = 0;
         end
      end
      else
         disp('Error!!! Enter Even Order')
      end
   case'Blackman'
      for n=0:M
         if (n>=0) && (n<=M)
            w(n+1)= 0.42-0.5*cos(2*pi*n/M)+0.08*cos(4*pi*n/M);
         else
            w(n+1) = 0;
         end
```

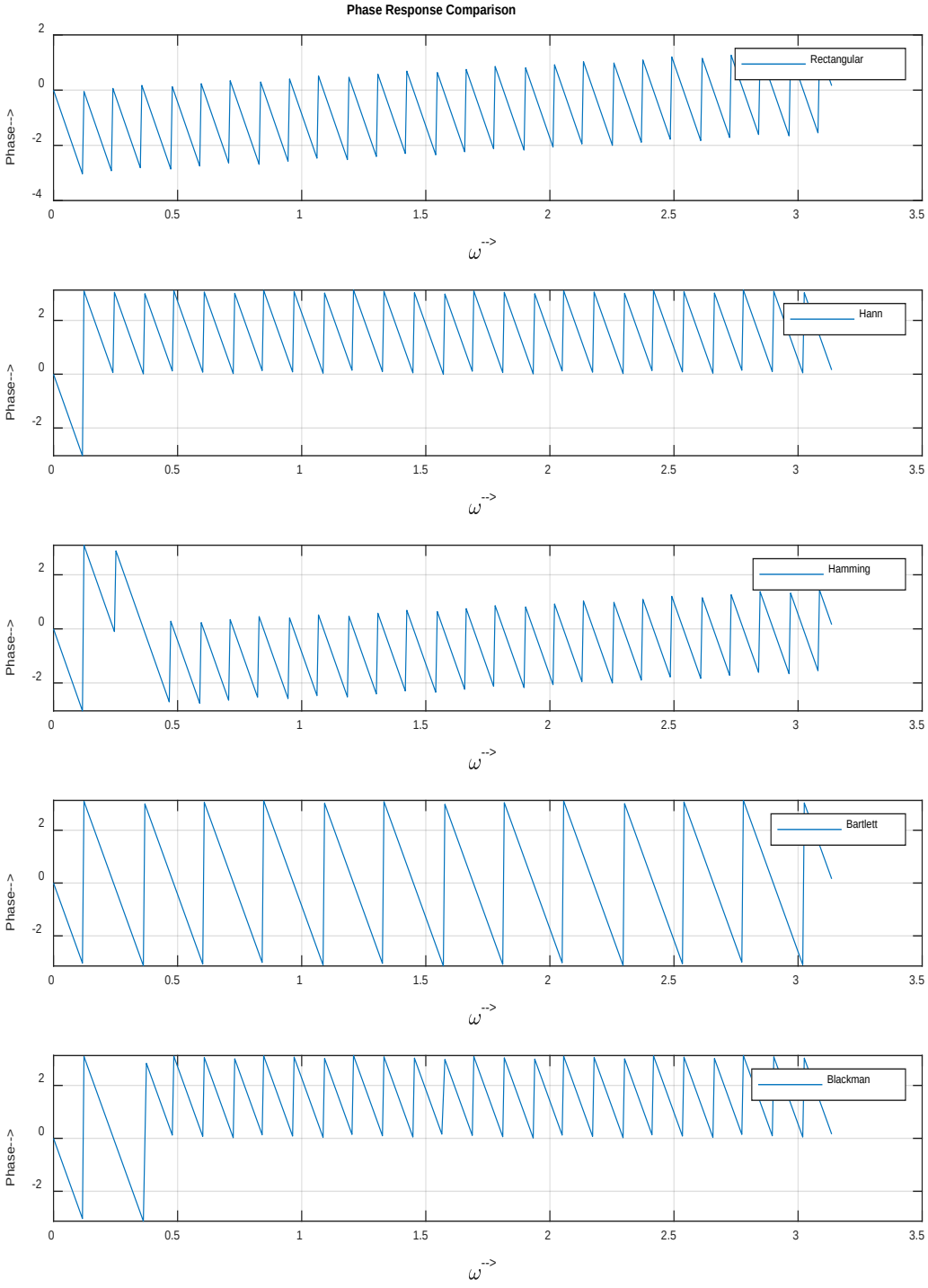
```
    end

end
end
```

```
clc;clear all;close all;
[w1] = myWindows('Rectangular', 52)
[w2] = myWindows('Hann', 52)
[w3] = myWindows('Hamming', 52)
[w4] = myWindows('Bartlett', 52)
[w5] = myWindows('Blackman', 52)

%PLOTS
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('Rectangular')
grid on;
subplot(512)
[H2,W2]=freqz(w2,1)
l2=abs(H2);
p2=20*log10(l2);
plot(W2,p2)
xlabel('\omega-->');
ylabel('Amplitude-->');
legend('Hann')
grid on;
subplot(513)
[H3,W3]=freqz(w3,1)
l3=abs(H3);
p3=20*log10(l3);
plot(W3,p3)
xlabel('\omega-->');
ylabel('Amplitude-->');
legend('Hamming')
grid on;
subplot(514)
[H4,W4]=freqz(w4,1)
l4=abs(H4);
p4=20*log10(l4);
plot(W4,p4)
```

```
xlabel('\omega-->');
ylabel('Amplitude-->');
legend('Bartlett')
grid on;
subplot(515)
[H5,W5]=freqz(w5,1)
l5=abs(H5);
p5=20*log10(l5);
plot(W5,p5)
xlabel('\omega-->');
ylabel('Amplitude-->');
legend('Blackman')
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('Rectangular')
grid on;
subplot(512)
plot(W2,angle(H2))
xlabel('\omega-->');
ylabel('Phase-->');
legend('Hann')
grid on;
subplot(513)
plot(W3,angle(H3))
xlabel('\omega-->');
ylabel('Phase-->');
legend('Hamming')
grid on;
subplot(514)
plot(W4,angle(H4))
xlabel('\omega-->');
ylabel('Phase-->');
legend('Bartlett')
grid on;
subplot(515)
plot(W5,angle(H5))
xlabel('\omega-->');
ylabel('Phase-->');
legend('Blackman')
set(gcf, 'Position', [0, 0, 700, 800])
grid on;
```

Q1


Amplitue Response Comparison
Rectangular
Hann
Hamming
Bartlett
Blackman
Amplitude-->
ω-->
50
0
-50
-100
-200
-300
0
0.5
1
1.5
2
2.5
3
3.5


Phase Response Comparison
Rectangular
Hann
Hamming
Bartlett
Blackman
Phase-->
ω-->
2
0
-2
-4
0
0.5
1
1.5
2
2.5
3
3.5

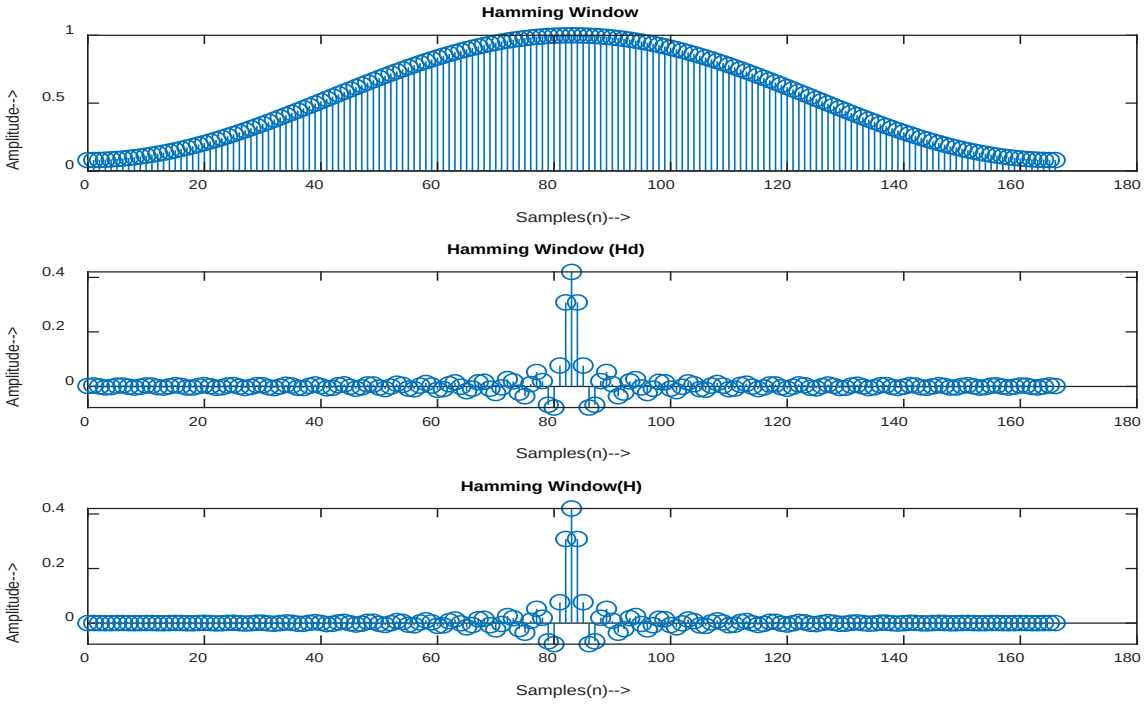
```
function [w]= WindowSelector(A,M)
if A>=0 && A<=21
   [w]=myWindows('Rectangular',M)
elseif A>=21 && A<=26
   [w]=myWindows('Bartlett',M)
elseif A>=26 && A<=44
   [w]=myWindows('Hann',M)
elseif A>=44 && A<=53
   [w]=myWindows('Hamming',M)
else
   [w]=myWindows('Blackman',M)
end
end
```

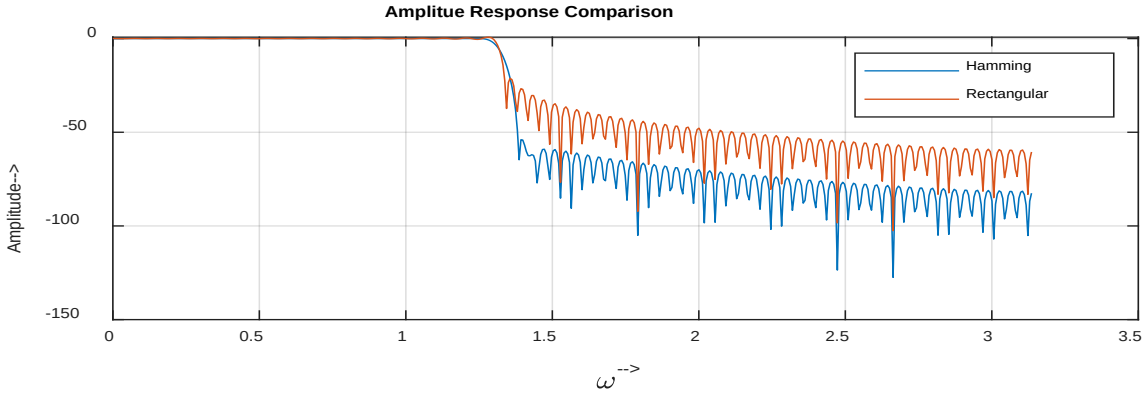
Q2

```
clc;
clear all;
close all;

%Required Specification
fp=2000;
d_f=200;
fs=fp+d_f;
Fsamp=10000;
wp=2*pi*fp/Fsamp;
ws=2*pi*fs/Fsamp;
Ap=0.1;
As=50;

%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

%Order of the filter
L=ceil(6.6*pi/delta_w)
L=L+mod(L+1,2)
M=L-1
```

```
%Window function w(n):Hamming Window
w= WindowSelector(A,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

%plots
figure
subplot(311)
stem(0:M, w);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window');

subplot(312)
stem(0:M, hd);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window (Hd)');

subplot(313)
stem(0:M, h);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window(H)');

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

[H1,W1]=freqz(hd,1)
n=abs(H1);
o=20*log10(n);
plot(W1,o)
xlabel('\omega-->');
ylabel('Amplitude-->');
title('Amplitue Response Comparison');
legend('Hamming', 'Rectangular')
```

Q2


Hamming Window
Amplitude-->
Samples(n)-->
Hamming Window (Hd)
Amplitude-->
Samples(n)-->
Hamming Window(H)
Amplitude-->
Samples(n)-->


Amplitue Response Comparison
Hamming
Rectangular
Amplitude-->
ω-->
Phase Response Comparison
Hamming
Rectangular
ϕ(ω)-->
ω -->>

```
grid on;

subplot(212)
plot(W,angle(H))
hold on;
plot(W1,angle(H1))
xlabel('\omega -->');
ylabel('\phi(\omega)-->');
title('Phase Response Comparison');
legend('Hamming', 'Rectangular')
grid on

%Checking the result
%h1=fir1(M,wc/pi,w);
                %[(0:M)' h1 h1' h-h1]
```

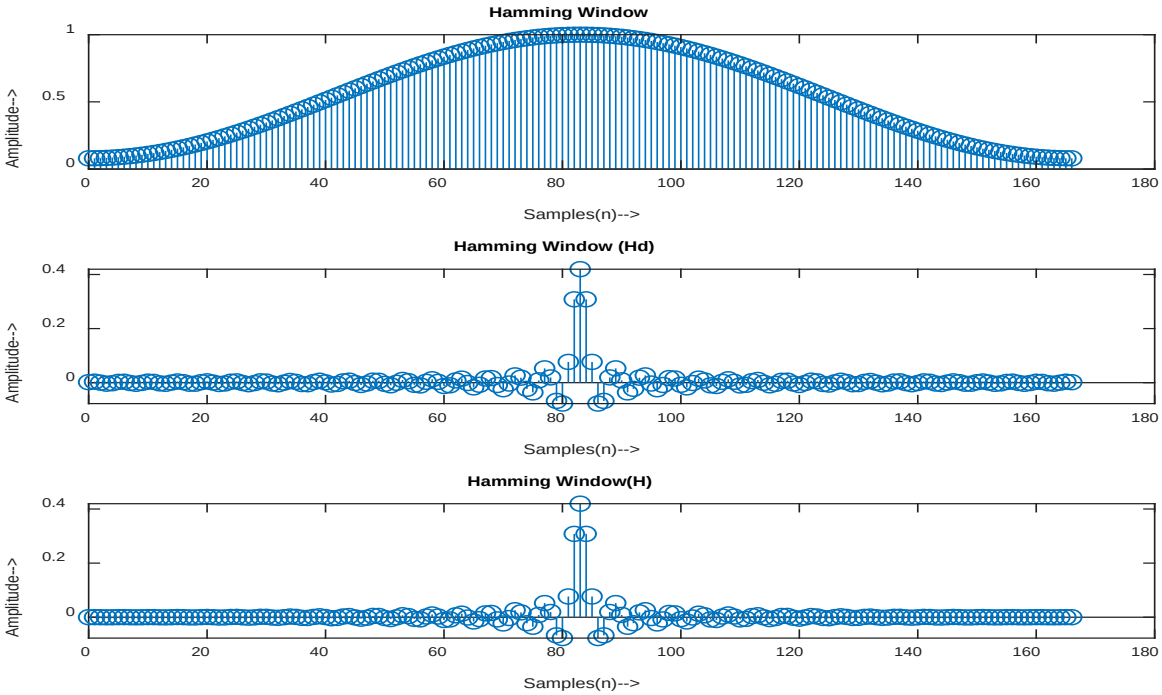
Q3

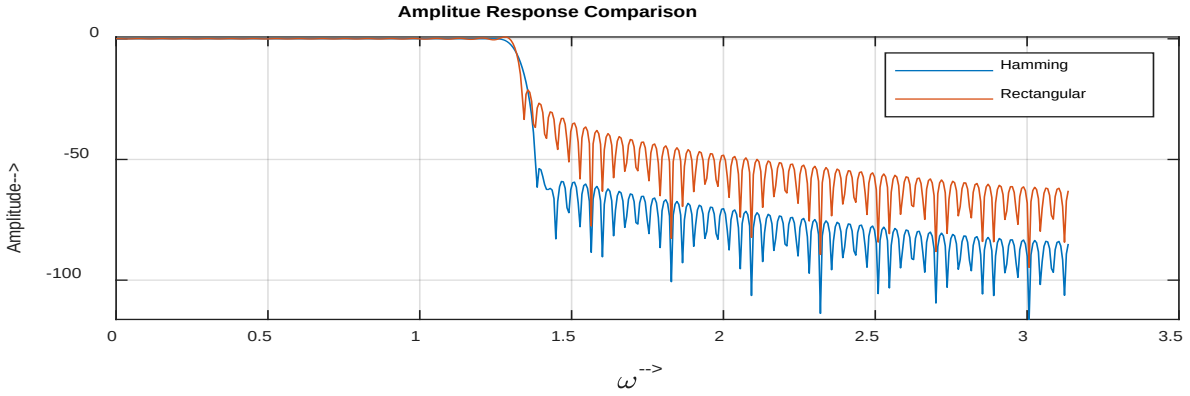
```
clc;
clear all;
close all;

%Required Specification
wp=1.256;
ws=1.3816;
Ap=0.1;
As=50;

%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

%Order of the filter
L=ceil(6.6*pi/delta_w)
L=L+mod(L+1,2)
M=L-1

%Window function w(n):Hamming Window
w = myWindows( 'Hamming',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

%plots
figure
subplot(311)
stem(0:M, w);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window');

subplot(312)
stem(0:M, hd);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window (Hd)');

subplot(313)
stem(0:M, h);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window(H)');

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

[H1,W1]=freqz(hd,1)
n=abs(H1);
o=20*log10(n);
plot(W1,o)
xlabel('\omega-->');
ylabel('Amplitude-->');
title('Amplitue Response Comparison');
legend('Hamming', 'Rectangular')
grid on;

subplot(212)
plot(W,angle(H))
hold on;
```

```
plot(W1,angle(H1))
xlabel('\omega -->');
ylabel('\phi(\omega)-->');
title('Phase Response Comparison');
legend('Hamming', 'Rectangular')
grid on
%Checking the result
%h1=fir1(M,wc/pi,w);
%[(0:M)' h1 h1' h-h1]
```

Q3


Hamming Window
Amplitude-->
Samples(n)-->
Hamming Window (Hd)
Amplitude-->
Samples(n)-->
Hamming Window(H)
Amplitude-->
Samples(n)-->

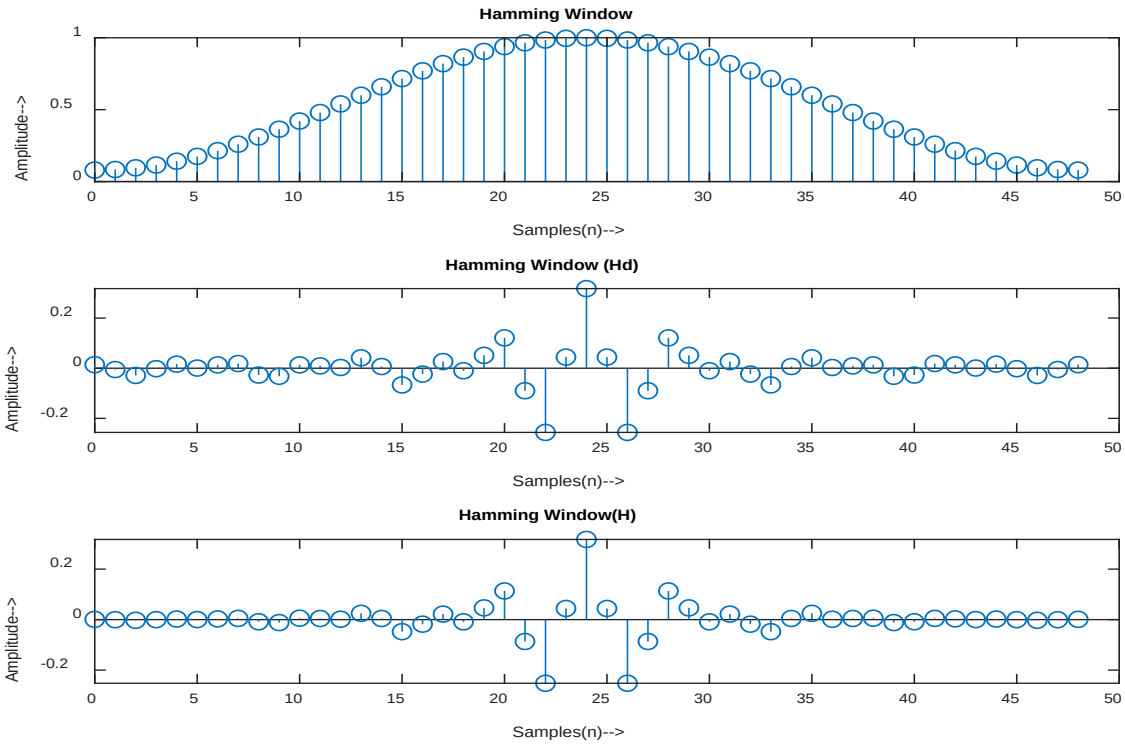

Amplitue Response Comparison
Amplitude-->
Hamming
Rectangular
ω -->
Phase Response Comparison
Hamming
Rectangular
ϕ(ω)-->
ω -->

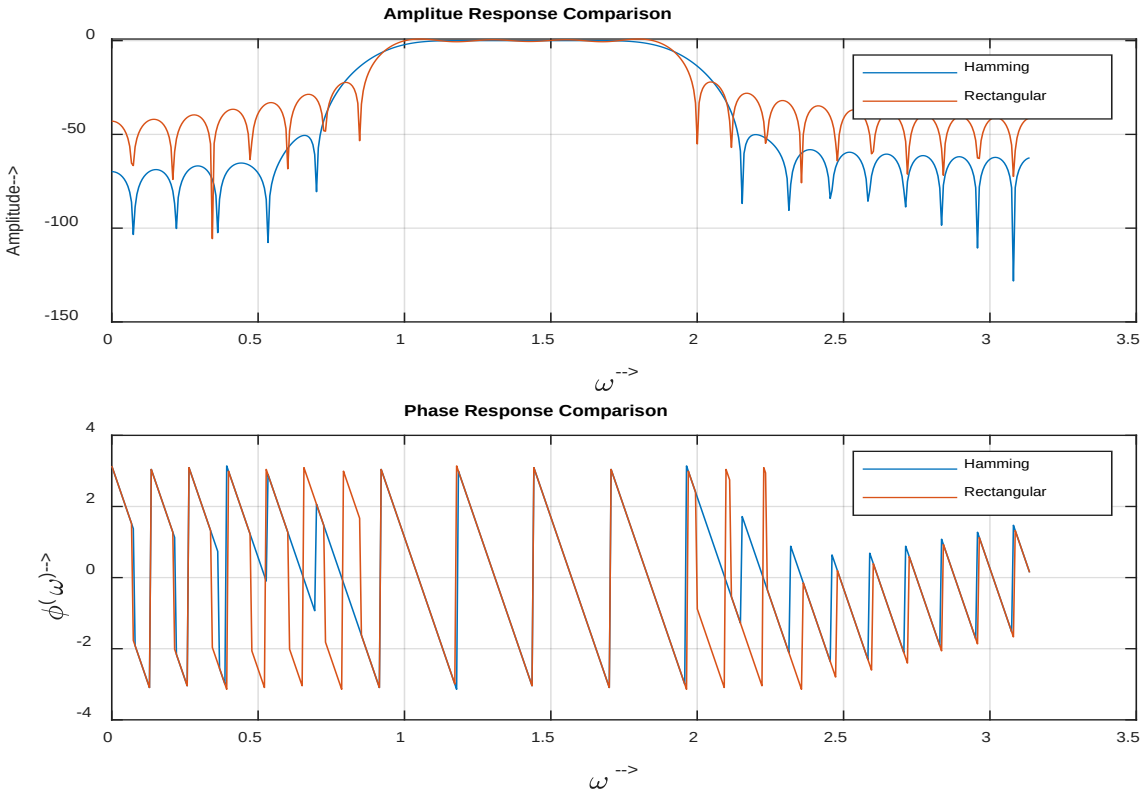
```
clc;
clear all;
close all;

%Required Specification
Fs=44100;
fp1=8000;
fp2=12000;
d_f=3000;
fs1=fp1-d_f;
fs2=fp2+d_f;
wp1=2*pi*(fp1/Fs);
wp2=2*pi*(fp2/Fs);
ws1=2*pi*(fs1/Fs);
ws2=2*pi*(fs2/Fs);

Ap=0.1;
As=0.001;

%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_w1=ws1-wp1
delta_w2=ws2-wp2

%Order of the filter
L=ceil(6.6*pi/delta_w2)
L=L+mod(L+1,2)
M=L-1

%Window function w(n):Hamming Window
w = myWindows( 'Hamming',M);

%Desired Impulse Response
for n=0:M
   hd(n+1)=(sin(wc2*(n-M/2))-sin(wc1*(n-M/2)))/(pi*(n-M/2));
end
hd((M/2)+1)=(wc2-wc1)/pi;
```

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

%plots
figure
subplot(311)
stem(0:M, w);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window');

subplot(312)
stem(0:M, hd);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window (Hd)');

subplot(313)
stem(0:M, h);
xlabel('Samples(n)-->');
ylabel('Amplitude-->');
title('Hamming Window(H)');

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

[H1,W1]=freqz(hd,1)
n=abs(H1);
o=20*log10(n);
plot(W1,o)
xlabel('\omega-->');
ylabel('Amplitude-->');
title('Amplitue Response Comparison');
legend('Hamming', 'Rectangular')
grid on;

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

```
xlabel('\omega -->');
ylabel('\phi(\omega)-->');
title('Phase Response Comparison');
legend('Hamming', 'Rectangular')
grid on

%Checking the result
%h1=fir1(M,wc/pi,w);
%[(0:M)' h1 h1' h-h1]
```

Q4


Hamming Window
Amplitude-->
Samples(n)-->
Hamming Window (Hd)
Amplitude-->
Samples(n)-->
Hamming Window(H)
Amplitude-->
Samples(n)-->


Amplitue Response Comparison
Amplitude-->
Hamming
Rectangular
ω -->
Phase Response Comparison
ϕ(ω)-->
Hamming
Rectangular
ω -->