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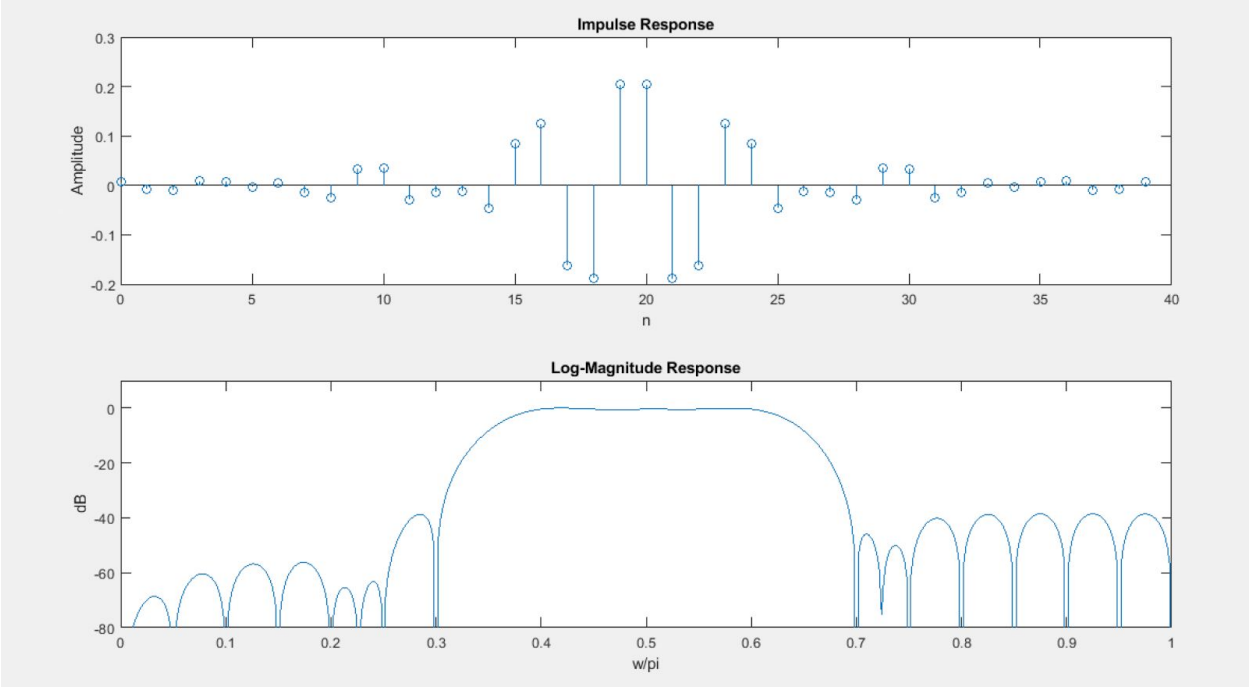
HW 5 EE 442

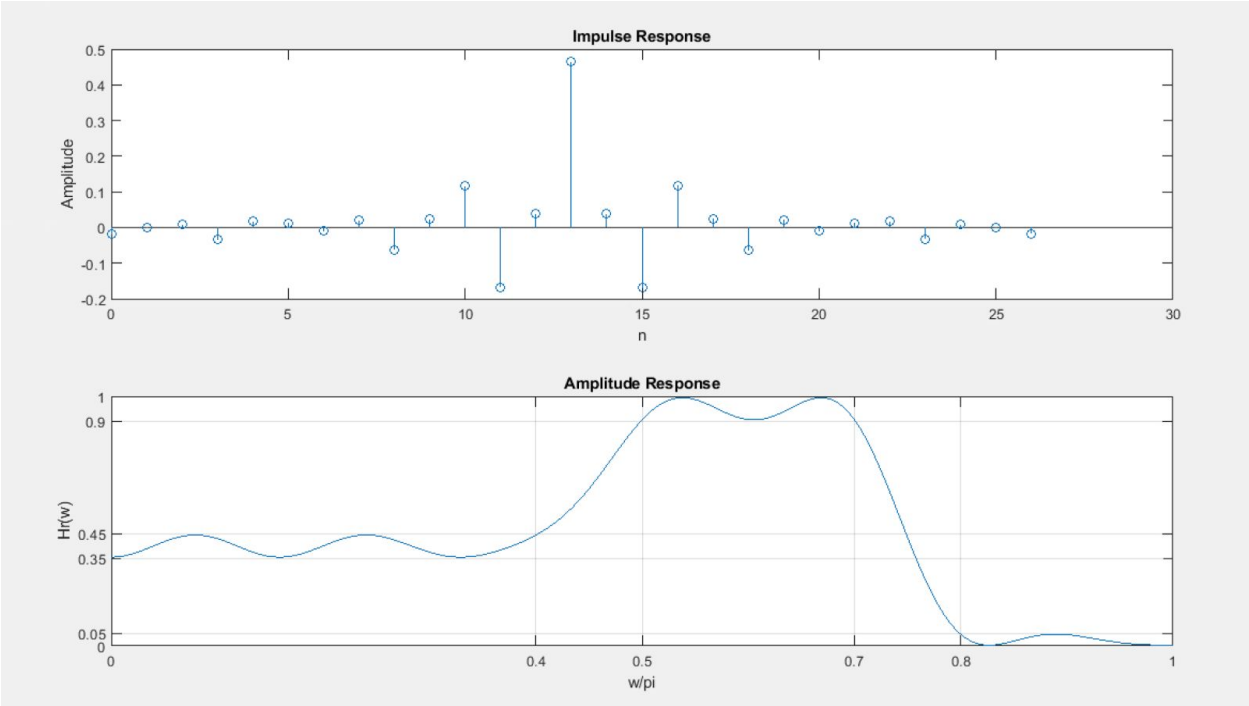
1.
As = 38




```
ws1 = 0.3*pi;
wp1 = 0.4*pi;
ws2 = 0.7*pi;
wp2 = 0.6*pi;
Rp = 0.5;
As = 40;
M = 40;
alpha = (M-1)/2;
T1 = 0.405;
l = 0:M-1;
w1 = (2*pi/M)*l;
Hrs = [zeros(1,7),T1,ones(1,5),T1,zeros(1,13),T1,ones(1,5),T1,zeros(1,6)];
Hdr = [0,0,1,1,0,0];
wd1 = [0, 0.3,0.4,0.6,0.7,1];
k1 = 0:floor((M-1)/2);
k2 = floor((M-1)/2)+1 : M-1;
angH = [-alpha*(2*pi)/M*k1, alpha*(2*pi)/M*(M-k2)];
H = Hrs.*exp(j*angH);
h = real(ifft(H,M));
[db, mag,pha,grd,w] = freqz_m(h,1);
n = 0:M-1;
deltaW = pi/500;
```

```
Asd = floor(-max(db(ceil(ws2/deltaW)+2:end)))

figure;
subplot(2,1,1);
stem(n,h);
xlabel('n');
ylabel('Amplitude');
title('Impulse Response');
subplot(2,1,2);
plot(w/pi,db);
axis([0,1 ,-80,10]);
xlabel('w/pi');
ylabel('dB');
title('Log-Magnitude Response');
```

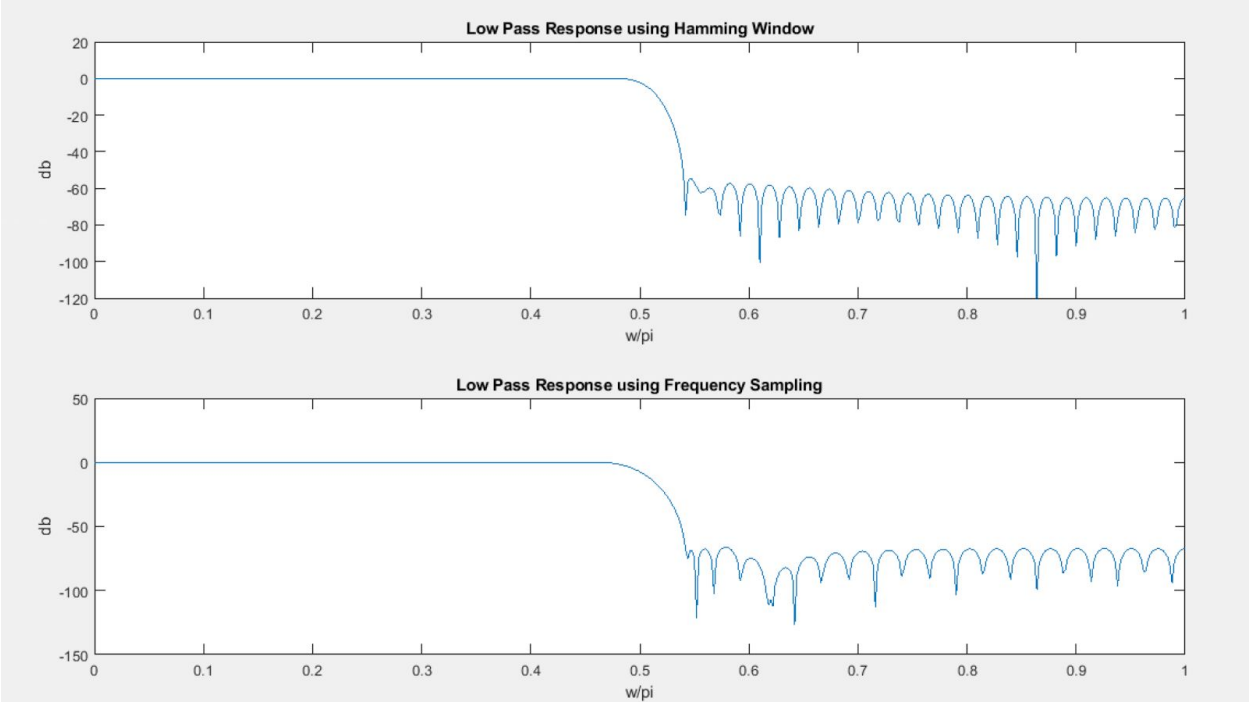
2.




```
delta1 = 0.05;
delta2 = 0.05;
delta3 = 0.025;
weights = [delta3/delta2,delta3/delta2,1];
f = [0, 0.4,0.5,0.7,0.8,1];
m = [0.4,0.4,0.95,0.95,0.025,0.025];
deltaF = 0.05;
As = -20*log10(0.05);
M = ceil((-20*log10(sqrt(delta2*delta3))-13)/(14.6*deltaF) + 1);
deltaW = pi/500;
%h = firpm(M-1,f,m,weights);
%[db, mag,pha,grd,w] = freqz_m(h,1);
%Asd = floor(-max(db((0.8*pi/deltaW)+1:501)));
```

```
%decrease M

%M = M-2;
%h = firpm(M-1,f,m,weights);
%[db, mag,pha,grd,w1] = freqz_m(h,1);
%Asd = floor(-max(db((0.8*pi/deltaW)+1:501)));

%Increase M
%M = M+4;
%h = firpm(M-1,f,m,weights);
%[db, mag,pha,grd,w1] = freqz_m(h,1);
%Asd = floor(-max(db((0.8*pi/deltaW)+1:501)));

M = M+4;
h = firpm(M-1,f,m,weights);
[db, mag,pha,grd,w1] = freqz_m(h,1);
Asd = floor(-max(db((0.8*pi/deltaW)+1:501)));
n = 0:M-1;
%get Desired Value
%From impulse response, we see it is type 1 response.
[Hr,w,c,L] = Ampl_res(h);

figure;
subplot(2,1,1);
stem(n,h);
xlabel('n');
ylabel('Amplitude');
title('Impulse Response');
subplot(2,1,2);
plot(w/pi,Hr);
xlabel('w/pi');
ylabel('Hr(w)');
title('Amplitude Response');
set(gca,'XTick',f,'YTick',[0, 0.05,0.35,0.45,0.9,1]);
Grid;
```

3.

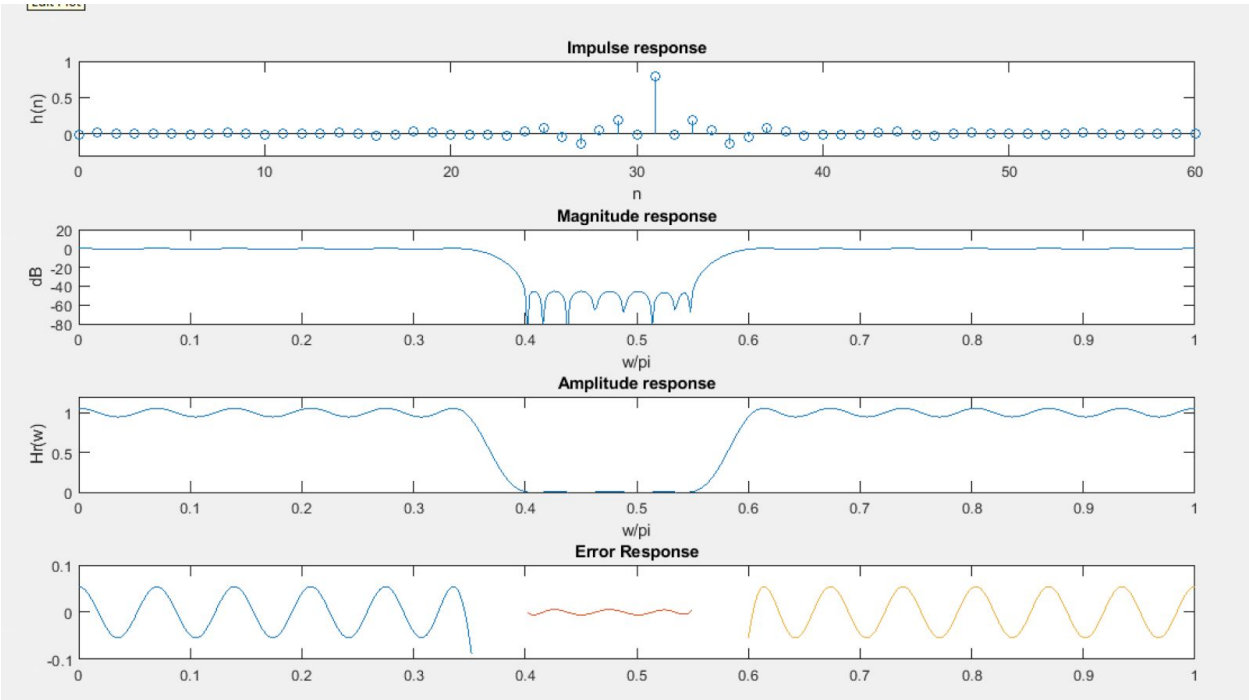



```
%Hamming Window
wp = 0.48*pi;
ws = 0.54*pi;
wd = ws-wp;
M = ceil(6.6*pi/wd) +1;
wc = (ws+wp)/2;
hd = ideal_lp(wc,M);
w_ham = (hamming(M)');
h = hd.*w_ham;
[db, mag,pha,grd,w] = freqz_m(h,1);
figure;
subplot(2,1,1);
plot(w/pi,db);
xlabel('w/pi');
ylabel('db');
title('Low Pass Response using Hamming Window');
axis([0,1,-120,20]);

%Frequency Sampling
M = 81;
alpha = (M-1)/2;
l = 0:M-1;
wl = (2*pi/M)*l;
T1 =0.107;
T2 = 0.58895;
Hrs = [ones(1,20) T2 T1 zeros(1,38) T1 T2 ones(1,19)];
Hdr = [1,1,0,0];
wdl = [0,0.48,0.54,1];
```

```
k1 = 0:floor((M-1)/2); k2 = floor((M-1)/2)+1:M-1;
angH = [-alpha*(2*pi)/M*k1, alpha*(2*pi)/M*(M-k2)];
H = Hrs.*exp(j*angH); h = real(ifft(H,M));
[db,mag,pha,grd,w] = freqz_m(h,1);
subplot(2,1,2);
plot(w/pi,db);
xlabel('w/pi');
ylabel('db');
title('Low Pass Response using Frequency Sampling');
%axis([0,1,-120,20]);
```

3c)
Using Hamming window, we see that the ripple is much more uniform than using frequency sampling. M = 111 for Hamming Window.

4.




M = 63
As Desired = 45.3905

```
wp1 = 0.35*pi;
ws1 = 0.4*pi;
ws2 = 0.55*pi;
wp2 = 0.6*pi;
Rp = 1.0;
As = 45;
delta1 = (10^(Rp/20)-1)/(10^(Rp/20)+1);
delta2 = (1+delta1)*(10^(-As/20));
weights = [delta2/delta1 1 delta2/delta1];
```

```
delta_f = min((wp2-ws2)/(2*pi), (ws1-wp1)/(2*pi));
M = ceil((-20*log10(sqrt(delta1*delta2))-13)/(14.6*delta_f)+1);
f = [0 wp1/pi ws1/pi ws2/pi wp2/pi 1];
m = [1 1 0 0 1 1];
deltaW = pi/500;
Asd = 0;

%While loop to increase M everytime Asd < As
while(Asd < As)
h = remez(M-1,f,m,weights);
[db, mag,pha,grd,w] = freqz_m(h,1);
ws1i = floor(ws1/deltaW)+1;
wp1i = floor(wp1/deltaW)+1;
ws2i = floor(ws2/deltaW)+1;
wp2i = floor(wp2/deltaW)+1;
Asd = -max(db(ws1i:ws2i));
M = M+2;
end
%Decrease M for final answer
M = M-2;
[db1, mag,pha,grd,w2] = freqz_m(h,1);
Asd = -max(db(ws1i:ws2i));
n = 0:1:M-1;
%Type 1 function;
[Hr,w,c,L] = Ampl_res(h);
figure;
subplot(4,1,1);
stem(n,h);
axis([0, 60 , -0.3,1]);
xlabel('n');
ylabel('h(n)');
title('Impulse response');
subplot(4,1,2);
plot(w2/pi,db1);
axis([0 ,1, -80, 20]);
xlabel('w/pi');
ylabel('dB');
title('Magnitude response');
subplot(4,1,3);
plot(w/pi,Hr);
axis([0, 1 , 0,1.2]);
xlabel('w/pi');
ylabel('Hr(w)');
title('Amplitude response');
passBandw1 = w(1:wp1i+1)/pi;
passBande1 = Hr(1:wp1i+1)-1;
passBandw2 = w(wp2i:501)/pi;
passBande2 = Hr(wp2i:501)-1;
stopBandw = w(ws1i+1:ws2i)/pi;
stopBande = Hr(ws1i+1:ws2i);
```

```
subplot(4,1,4);
plot(passBandw1,passBande1,stopBandw,stopBande,passBandw2,passBande2);
axis([0, 1 , -0.1,0.1]);
title('Error Response');
```