ECE 311 Lab 4

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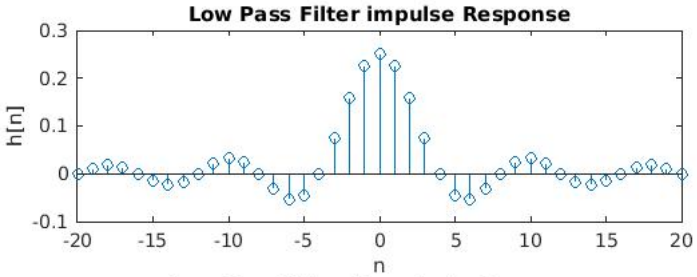
March 14, 2017

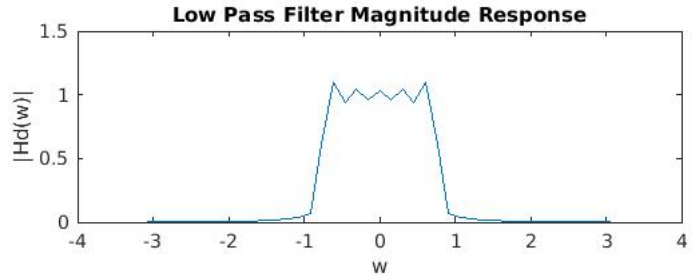
Report Item 1

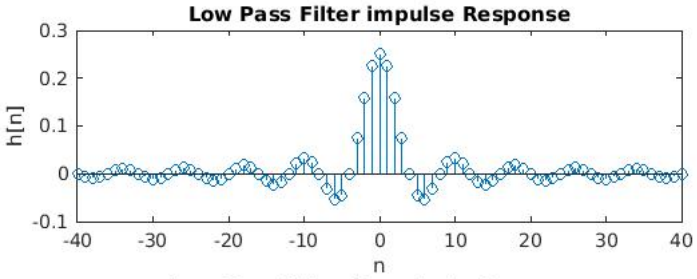
```
function [  ] = filters(N,wc,w0 )
    d = zeros(1,N*2 + 1);
    d(N+1) = 1; % delta function
    n = N*2+1;
    w = fftshift((0:n-1)/n*2*pi);
    w(1:n/2) = w(1:n/2) - 2*pi;
    N = linspace(-N,N,(N*2)+1); % create -N to N array
    lpi = (wc/pi).*sinc(wc.*N./pi);
    lpm = fftshift(fft(lpi));
    hpi = d-lpi;
    hpm = fftshift(fft(hpi));
    bpi = cos(w0.*N).*lpi;
    bpm = fftshift(fft(bpi));

    figure;
    subplot(211);
    stem(N,lpi);
    title('Low Pass Filter impulse Response');
    ylabel('h[n]');
    xlabel('n');
    subplot(212);
    plot(w,abs(lpm));
    title('Low Pass Filter Magnitude Response');
    ylabel('|Hd(w)|');
    xlabel('w');

    figure;
    subplot(211);
    stem(N,hpi);
    title('High Pass Filter impulse Response');
    ylabel('h[n]');
    xlabel('n');
    subplot(212);
    plot(w,abs(hpm));
    title('High Pass Filter Magnitude Response');
    ylabel('|Hd(w)|');
    xlabel('w');

    figure;
    subplot(211);
    stem(N,bpi);
    title('Band Pass Filter impulse Response');
```

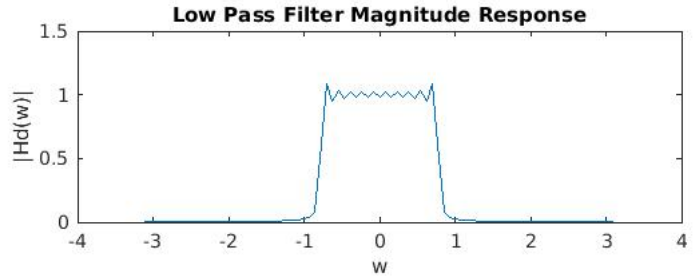
```
    ylabel('h[n]');
    xlabel('n');
    subplot(212);
    plot(w,abs(bpm));
    title('Band Pass Filter Magnitude Response');
    ylabel('|Hd(w)|');
    xlabel('w');
end
```

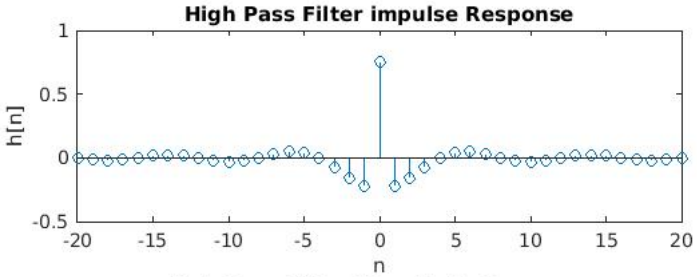
filters.m

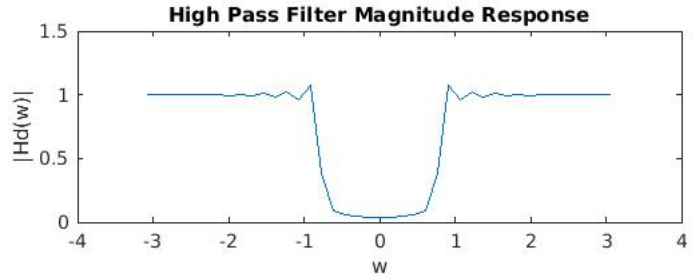

Low Pass Filter impulse Response
h[n]
n

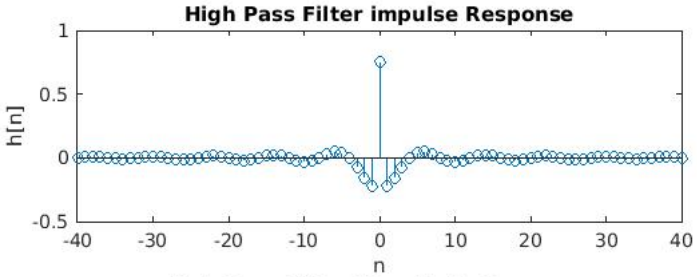

Low Pass Filter Magnitude Response
|Hd(w)|
w

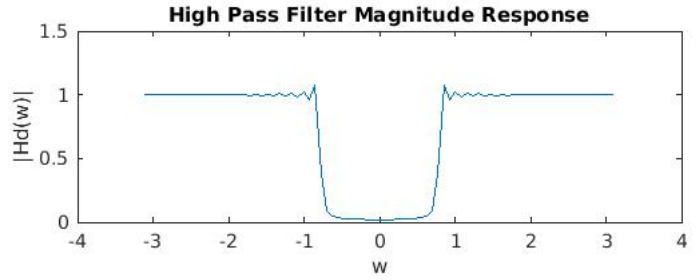

Low Pass Filter impulse Response
h[n]
n

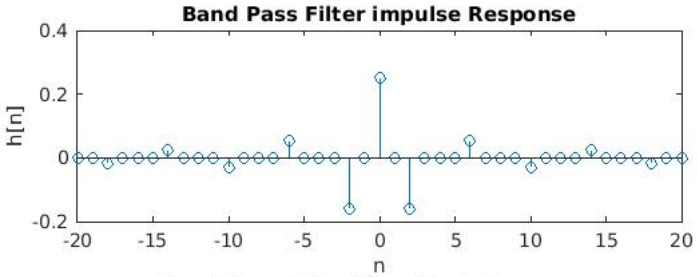

Low Pass Filter Magnitude Response
|Hd(w)|
w

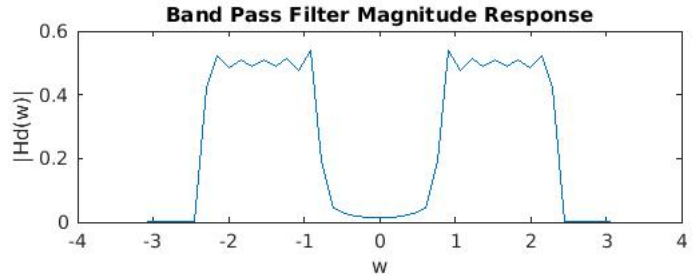

High Pass Filter impulse Response
h[n]
n

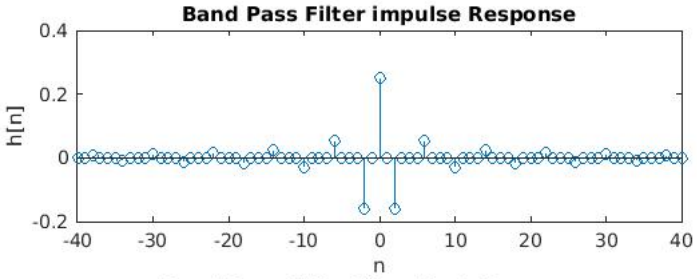

High Pass Filter Magnitude Response
|Hd(w)|
w

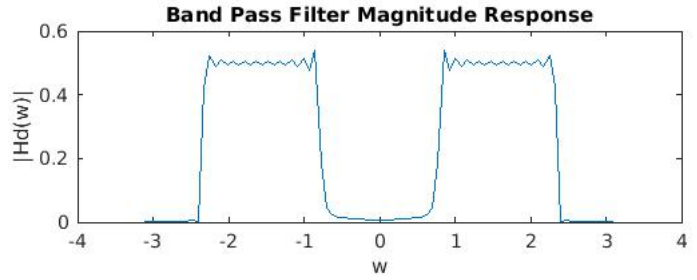

High Pass Filter impulse Response
h[n]
n


High Pass Filter Magnitude Response
|Hd(w)|
w


Band Pass Filter impulse Response
h[n]
n

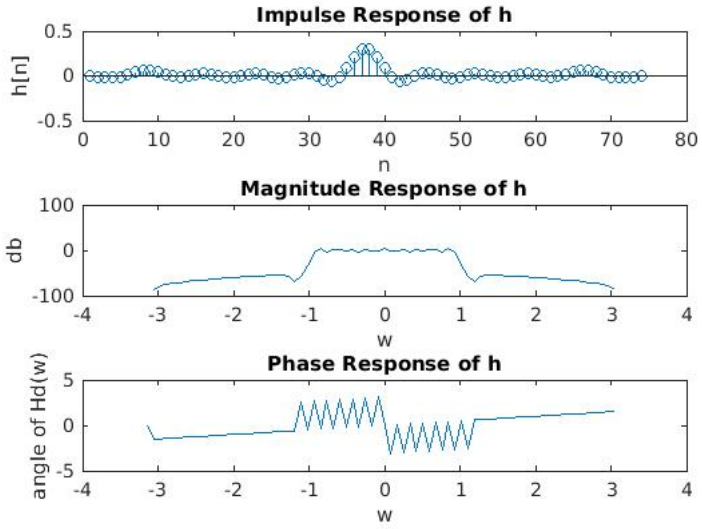

Band Pass Filter Magnitude Response
|Hd(w)|
w


Band Pass Filter impulse Response
h[n]
n


Band Pass Filter Magnitude Response
|Hd(w)|
w

```
load impulseresponse.mat
% variable name is h
figure;
subplot
subplot(311);
stem(h);
n = 74;
w = fftshift((0:n-1)/n*2*pi);
w(1:n/2) = w(1:n/2) - 2*pi;
title('Impulse Response of h');
xlabel('n');
ylabel('h[n]');
subplot(312);
h_m = abs(fftshift(fft(h)));
h_m = mag2db(h_m);
plot(w,h_m);
title('Magnitude Response of h');
xlabel('w');
ylabel('db');
subplot(313);
h_p = angle(fftshift(fft(h)));
plot(w,h_p);
title('Phase Response of h');
xlabel('w');
ylabel('angle of Hd(w)');

%find pass band ripple
top = max(h_m);
bottom_range = h_m(28:48);
bottom = min(bottom_range);
passband_ripple = top - bottom;
% result is 8.0126
%passband edge is approximately .75 rad to 1.25 rad so .5 rad
```

impresp.m



```
N = 25;
M = (N-1)/2;
w = fftshift((0:N-1)/N*2*pi); % 1. define omega as you would for
    FFT
w(1:N/2) = w(1:N/2) - 2*pi;    %
i=sqrt(-1);
for j=1:N
    if(abs(w(j)) < pi/3), % 2.
        g_w(j) = 1 * exp(-i*M*w(j));
    else
        g_w(j) = 0;
    end
end

g_n = ifft(fftshift(g_w)); % 3. find g[n], should be shifted
w_n = hamming(N)'; % window (transposed)
h_n = g_n .* w_n;% h_n is impulse response
figure;
subplot(311);
plot(abs(h_n));
title('Magnitude of h[n]');
xlabel('n');
ylabel('abs(h[n])');
subplot(312);
plot(w,mag2db(abs(fftshift(fft(h_n)))));
title('Magnitude of Hd(w)');
xlabel('w');
ylabel('db');
subplot(313);
plot(w,angle(fftshift(fft(h_n))));
title('Phase of Hd(w)');
xlabel('w');
ylabel('radians');
```

FIR_FILTER.m