ICS 311 Digital Signal Processing

Lab 10: FIR Filters

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Design a linear phase FIR low pass filter using rectangular window by taking 7 samples of window sequence and with cut-off frequency wc=0.2pi rad/s. Determine the frequency response of the filter and verify the design by sketching its magnitude response. Plot both magnitude and frequency response.

Design the low pass filter with the above parameters using different windows.

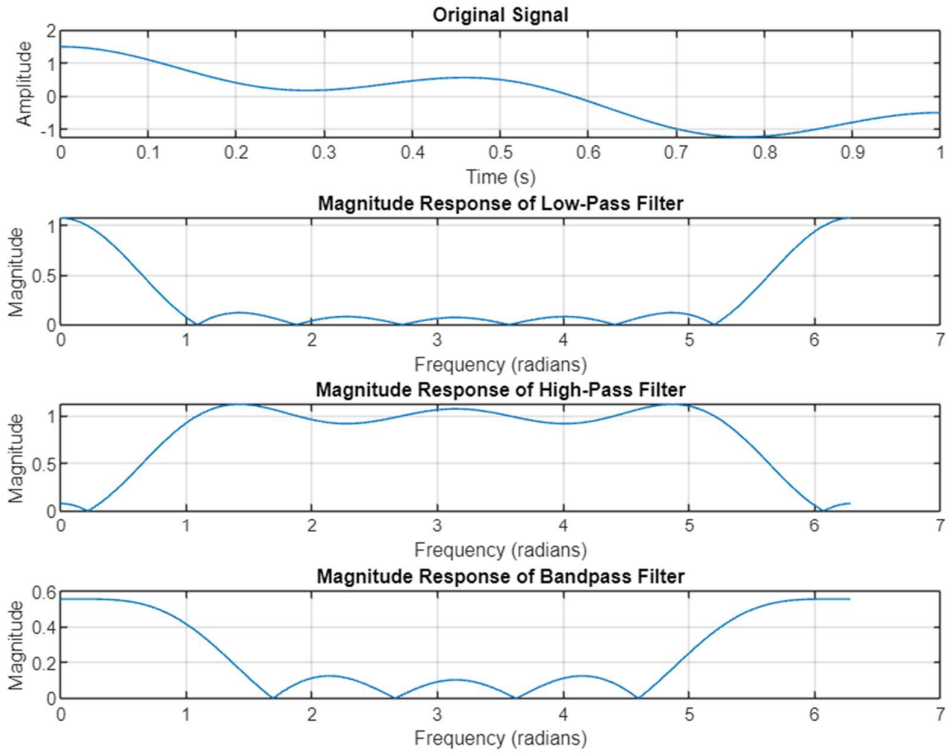
Design high pass and bandpass FIR filter.

Code 1 :

```
% Original signal

%Abhishek harsh 2021bcs0036
Fs = 1000;
t = 0:1/Fs:1;
original_signal = cos(2 * pi * 0.5 * t) + 0.5 * cos(2 * pi * 2 * t);

% Filter parameters
N = 7;
wc = 0.2 * pi;

% Create the rectangular window sequence
window = rectwin(N);

n = -(N-1)/2 : (N-1)/2;
h_lowpass = wc/pi * sinc(wc/pi * n);


h_highpass = -h_lowpass;
h_highpass((N+1)/2) = h_highpass((N+1)/2) + 1;


fc1 = 0.1 * pi;
fc2 = 0.3 * pi;


h_bandpass = wc/pi * (sinc(wc/pi * n) - sinc(fc1/pi * n) + sinc(fc2/pi * n));

% Compute the frequency responses
w = linspace(0, 2*pi, 1000);
H_lowpass = fft(h_lowpass, 1000);
```

```
H_highpass = fft(h_highpass, 1000);
H_bandpass = fft(h_bandpass, 1000);

% Calculate the magnitude responses
H_mag_lowpass = abs(H_lowpass);
H_mag_highpass = abs(H_highpass);
H_mag_bandpass = abs(H_bandpass);

% Plot the original signal
figure;
subplot(4,1,1);
plot(t, original_signal);
title('Original Signal');
xlabel('Time (s)');
ylabel('Amplitude');
grid on;

% Plot the magnitude responses
subplot(4,1,2);
plot(w, H_mag_lowpass);
title('Magnitude Response of Low-Pass Filter');
xlabel('Frequency (radians)');
ylabel('Magnitude');
grid on;

subplot(4,1,3);
plot(w, H_mag_highpass);
title('Magnitude Response of High-Pass Filter');
xlabel('Frequency (radians)');
ylabel('Magnitude');
grid on;

subplot(4,1,4);
plot(w, H_mag_bandpass);
title('Magnitude Response of Bandpass Filter');
xlabel('Frequency (radians)');
ylabel('Magnitude');
grid on;
```

Output:

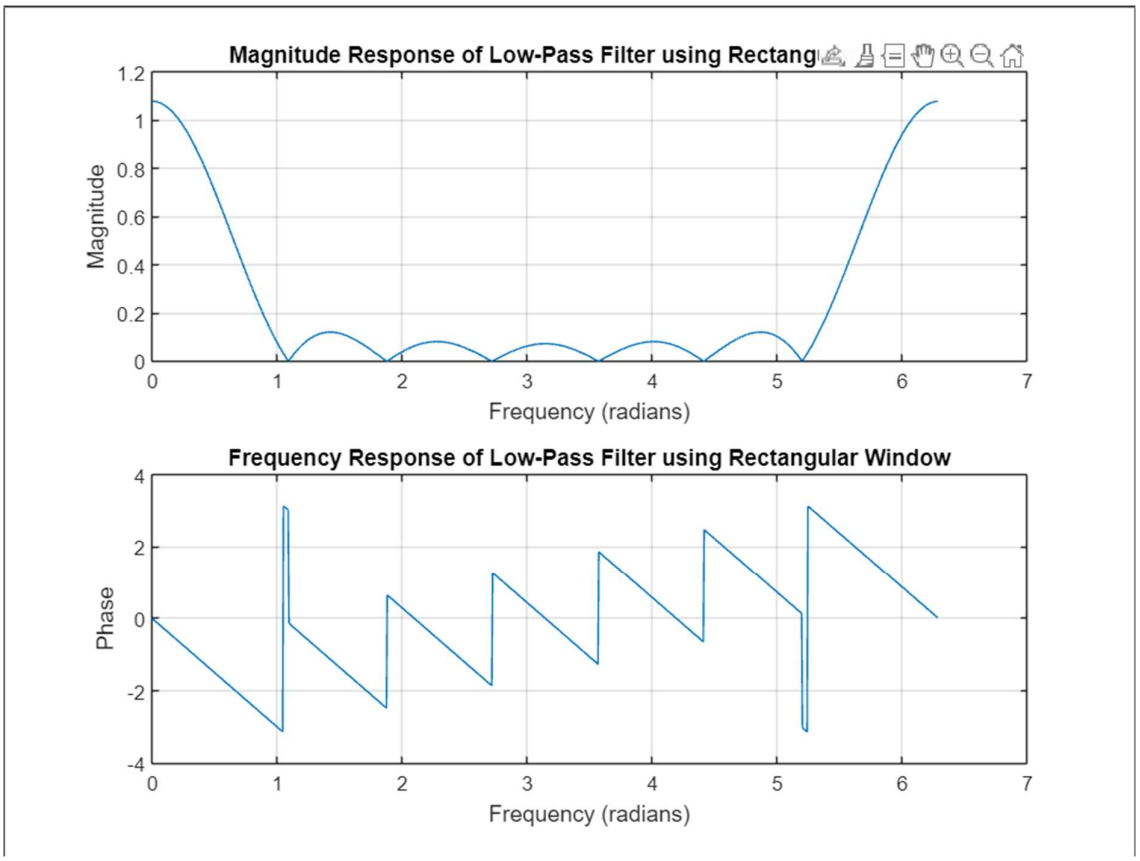


Code 2:

```
% Filter parameters
%Abhishek 2021bcs0036
N = 7;
wc = 0.2 * pi;

% Create the rectangular window sequence
window = hamming(N);

n = -(N-1)/2 : (N-1)/2;
h_lowpass = wc/pi * sinc(wc/pi * n);

% Compute the frequency response
w = linspace(0, 2*pi, 1000);
H_lowpass = fft(h_lowpass, 1000);

% Calculate the magnitude response
H_mag_lowpass = abs(H_lowpass);

% Plot the magnitude response of the low-pass filter
figure;
subplot(2, 1, 1);
plot(w, H_mag_lowpass);
title('Magnitude Response of Low-Pass Filter using Rectangular Window');
xlabel('Frequency (radians)');
ylabel('Magnitude');
grid on;
```

```
% Plot the frequency response of the low-pass filter
subplot(2, 1, 2);
plot(w, angle(H_lowpass));
title('Frequency Response of Low-Pass Filter using Rectangular Window');
xlabel('Frequency (radians)');
ylabel('Phase');
grid on;
```

output:

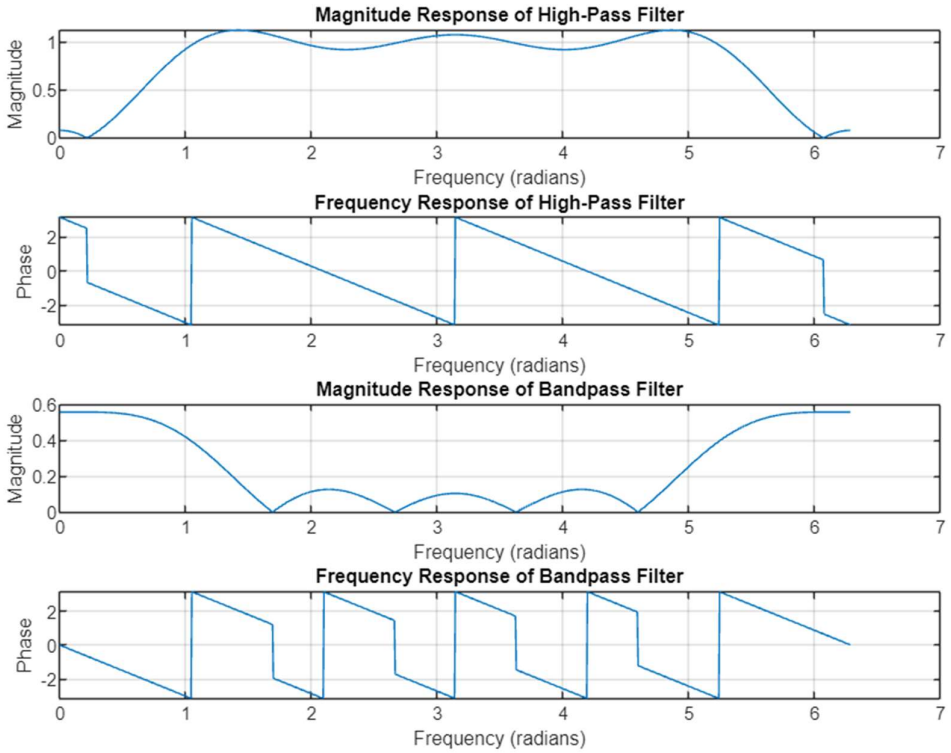


Code 3:

```
% Filter parameters
N = 7;
wc = 0.2 * pi;
fc1 = 0.1 * pi;
fc2 = 0.3 * pi;

% Design high-pass filter
n = -(N-1)/2:(N-1)/2;
h_highpass = -wc/pi * sinc(wc/pi * n);
h_highpass((N+1)/2) = h_highpass((N+1)/2) + 1;

% Design bandpass filter
h_bandpass = wc/pi * (sinc(wc/pi * n) - sinc(fc1/pi * n) + sinc(fc2/pi * n));

% Compute the frequency response for high-pass and bandpass filters
w = linspace(0, 2*pi, 1000);
```

```
H_highpass = fft(h_highpass, 1000);
H_bandpass = fft(h_bandpass, 1000);

% Calculate the magnitude response for high-pass and bandpass filters
H_mag_highpass = abs(H_highpass);
H_mag_bandpass = abs(H_bandpass);

% Plot the magnitude response and frequency response for high-pass filter
figure;
subplot(4, 1, 1);
plot(w, H_mag_highpass);
title('Magnitude Response of High-Pass Filter');
xlabel('Frequency (radians)');
ylabel('Magnitude');
grid on;

subplot(4, 1, 2);
plot(w, angle(H_highpass));
title('Frequency Response of High-Pass Filter');
xlabel('Frequency (radians)');
ylabel('Phase');
grid on;

% Plot the magnitude response and frequency response for bandpass filter
subplot(4, 1, 3);
plot(w, H_mag_bandpass);
title('Magnitude Response of Bandpass Filter');
xlabel('Frequency (radians)');
ylabel('Magnitude');
grid on;

subplot(4, 1, 4);
plot(w, angle(H_bandpass));
title('Frequency Response of Bandpass Filter');
xlabel('Frequency (radians)');
ylabel('Phase');
grid on;
```

Output:


Magnitude Response of High-Pass Filter
Magnitude
Frequency (radians)
Frequency Response of High-Pass Filter
Phase
Frequency (radians)
Magnitude Response of Bandpass Filter
Magnitude
Frequency (radians)
Frequency Response of Bandpass Filter
Phase
Frequency (radians)