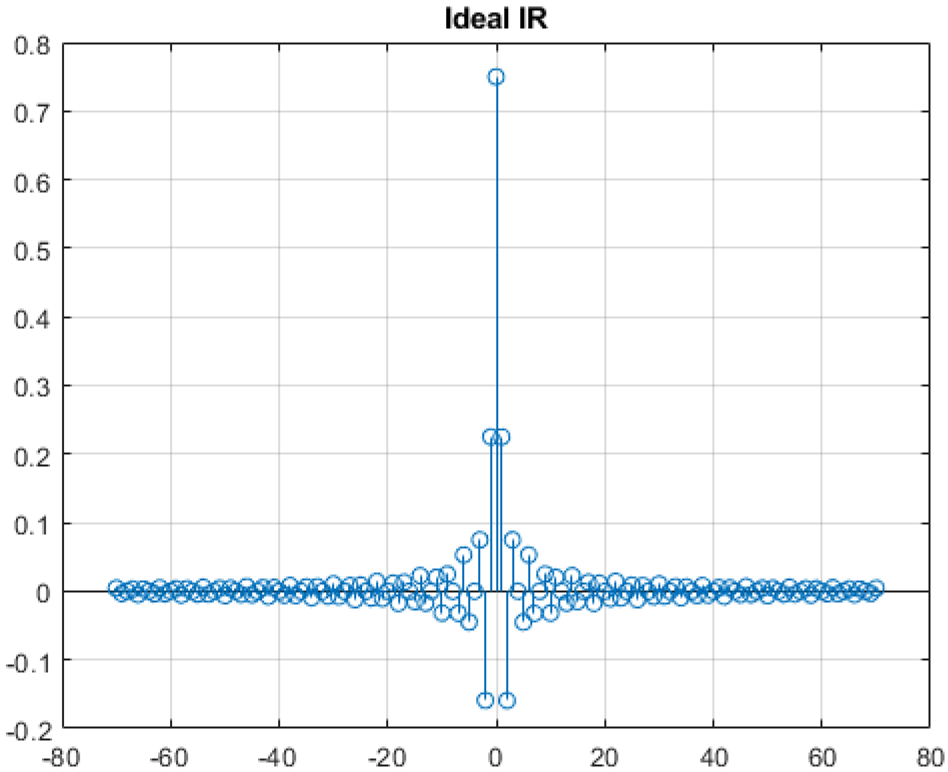
Table of Contents


```
% Use windowed Fourier series method and design a FIR-type (causal) lowpass
% filter with cutoff frequency w_c = 3*pi/4.
% Impulse response of an ideal lowpass filter with cutoff frequency at w_c
% in matlab is w_c/pi*sinc(w_c/pi *n), where w_c = 2*pi*f_c/fs and 'n' is
% sample index.
clf;
fs = 8000;
n = (-70:70);
% h_d[n] = sin(3*pi/4*n) / (pi*n) = (3/4)*sinc(3/4*n)
h_d = 3/4*sinc(3/4*n);

figure(1)
stem(n,h_d)
title('Ideal IR')
grid on
```

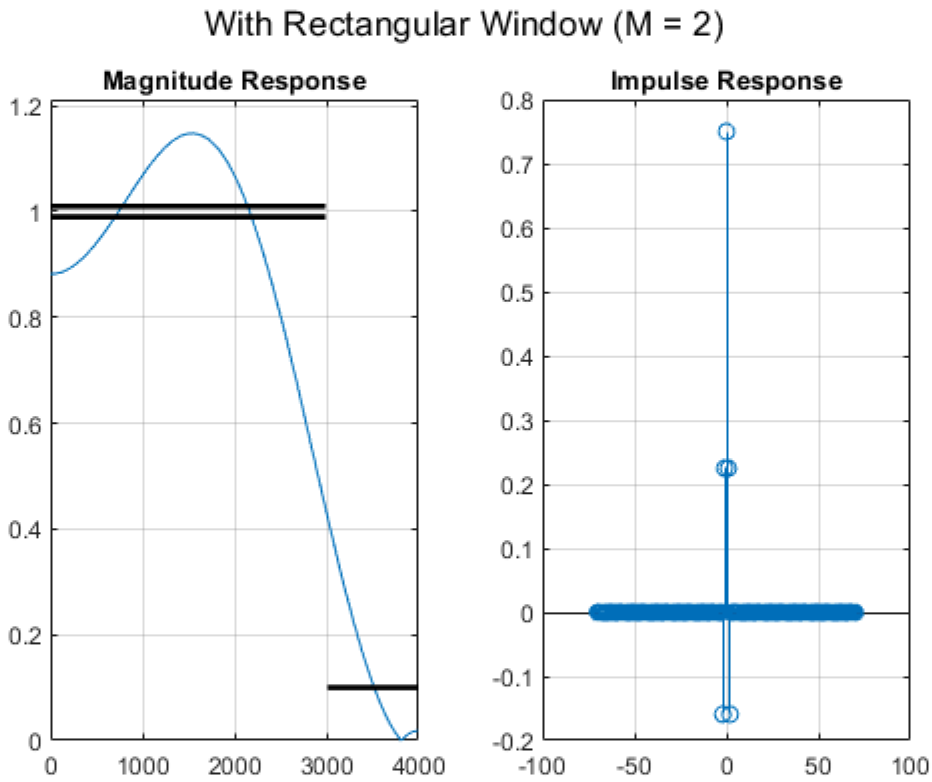


Task a)

generate 4th order FIR lowpass filter by windowing ideal impulse resonse with rectangular window: w_r[n] = 1, -M =< n =< M, M = 2 and else 0. Plot the impulse response and magnitude response

```
M = 2;

w_lowpass = zeros(1, length(n));
w_lowpass(n >= -M & n <= M) = 1;


% Windowed impulse response using H(n) = w(n) . h(n)
wir = w_lowpass .* h_d;

[wfr, f] = freqz(wir, 1, 512, fs);

wmr = abs(wfr);

% Plot in linear graph
figure(2);
subplot(1, 2, 1)
plot(f, wmr)
hold on

speksitFIR([3/4*fs/2-10 fs/2*3/4+10], [1 0], [0.01 0.1], fs);
hold off; grid on; title('Magnitude Response');
```

```
hold on
subplot(1, 2, 2)
stem(n, wir)
hold off; grid on; title('Impulse Response');

sgtitle('With Rectangular Window (M = 2)');
```

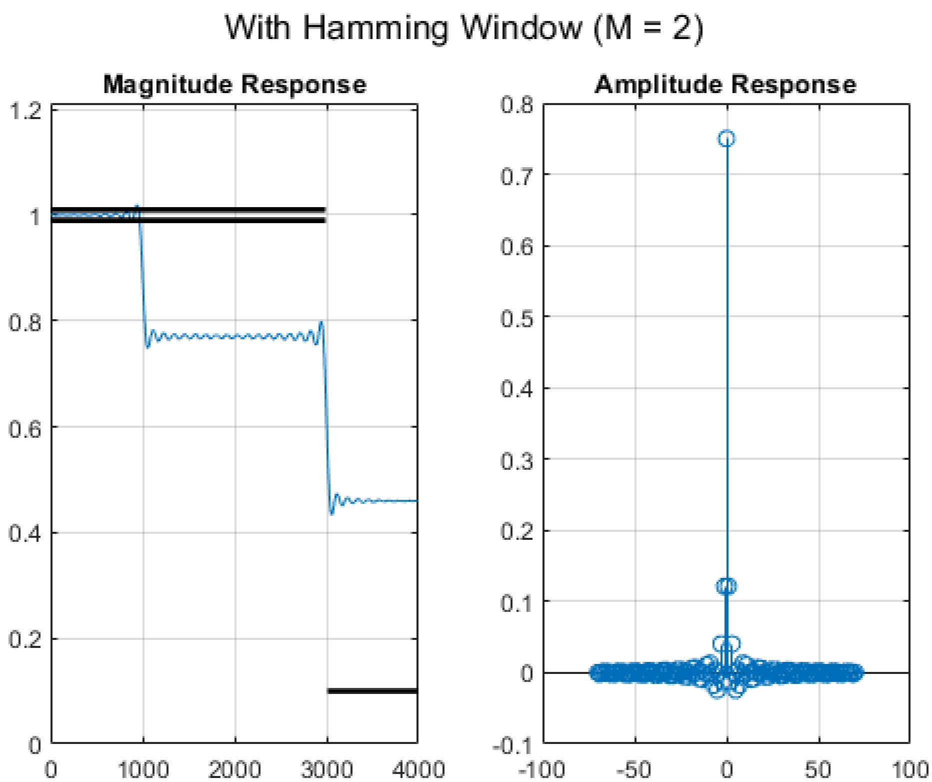


Task b)

generate 4th order FIR lowpass filter by windowing ideal impulse resonse with Hamming window: w_h[n] = 0.54+0.46*cos(pi*n/M), -M =< n =< M, M = 2. Plot the impulse response and magnitude response

```
M = 2;
w_hamming = 0.54 + 0.46 * cos(pi * n / M);
w_hamming(n < -M & n > M) = 0;

% Hamming impulse response
wir_hamming = h_d .* w_hamming;

[wfr_hamming, f] = freqz(wir_hamming, 1, 512, fs);

wmr_hamming = abs(wfr_hamming);

% Plot in linear graph
```

```
figure(3)
subplot(1,2,1)
plot(f, wmr_hamming)
hold on

speksitFIR([3/4*fs/2-10 fs/2*3/4+10], [1 0], [0.01 0.1], fs);
hold off; grid on; title('Magnitude Response')

hold on;
subplot(1,2,2)
stem(n, wir_hamming)
hold off; grid on; title('Amplitude Response');

sgtitle('With Hamming Window (M = 2)');
```

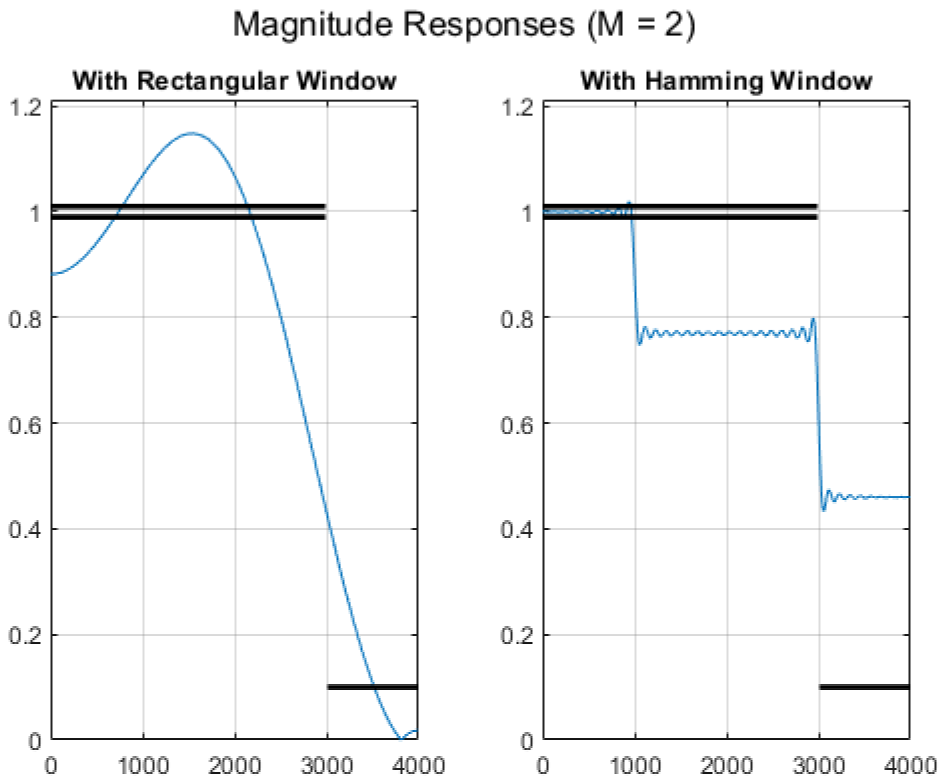


Task c)

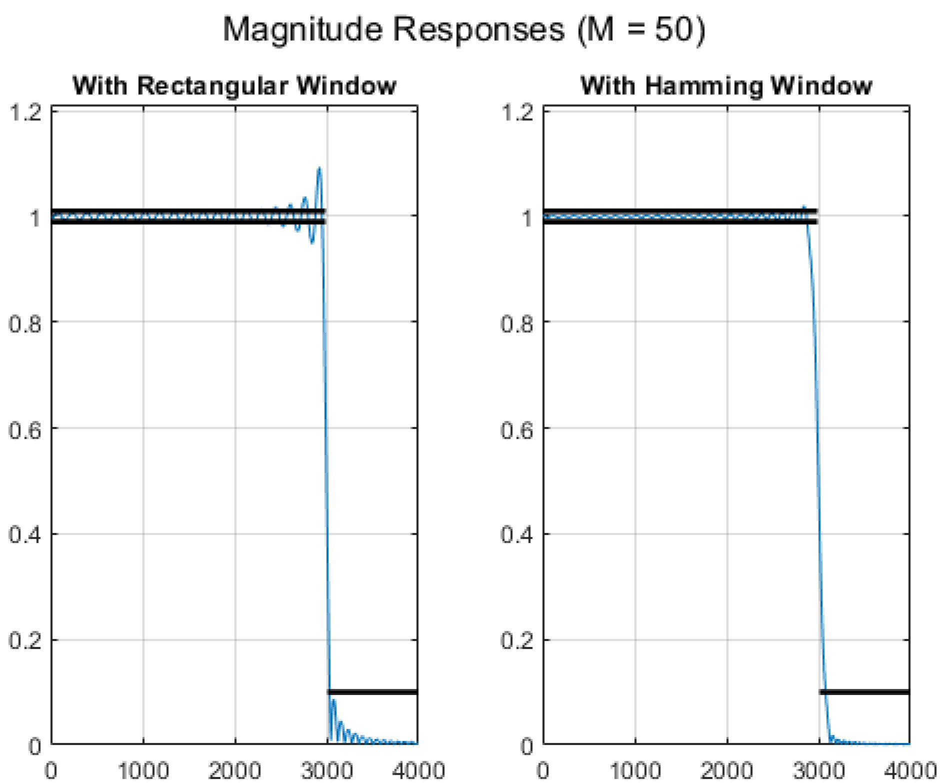
Compare how the magnitude responses of the filters designed in (a) and (b) differ. Then do the same as in a) and b) but use filter order of 100 (M=50).

```
figure(4);
subplot(1, 2, 1)
plot(f, wmr)
title('With Rectangular Window')
hold on
speksitFIR([3/4*fs/2-10 fs/2*3/4+10], [1 0], [0.01 0.1], fs);
```

```
hold off; grid on;
subplot(1, 2, 2)
plot(f, wmr_hamming)
title('With Hamming Window')
hold on
speksitFIR([3/4*fs/2-10 fs/2*3/4+10], [1 0], [0.01 0.1], fs);
hold off; grid on;

sgtitle('Magnitude Responses (M = 2)')


M = 50;

w_lowpass_50 = zeros(1, length(n));
w_lowpass_50(n >= -M & n <= M) = 1;
wir_50 = w_lowpass_50 .* h_d;
[wfr_50, f] = freqz(wir_50, 1, 512, fs);
wmr_50 = abs(wfr_50);

w_hamming_50 = 0.54 + 0.46 * cos(pi * n / M);
w_hamming_50(n < -M & n > M) = 0;
wir_hamming_50 = h_d .* w_hamming_50;
[wfr_hamming_50, f] = freqz(wir_hamming_50, 1, 512, fs);
wmr_hamming_50 = abs(wfr_hamming_50);

figure(5);
subplot(1, 2, 1)
plot(f, wmr_50)
title('With Rectangular Window')
hold on
speksitFIR([3/4*fs/2-10 fs/2*3/4+10], [1 0], [0.01 0.1], fs);
hold off; grid on;
subplot(1, 2, 2)
plot(f, wmr_hamming_50)
title('With Hamming Window')
hold on
speksitFIR([3/4*fs/2-10 fs/2*3/4+10], [1 0], [0.01 0.1], fs);
hold off; grid on;

sgtitle('Magnitude Responses (M = 50)')
```



Magnitude Responses (M = 2)
With Rectangular Window
With Hamming Window
1.2
1
0.8
0.6
0.4
0.2
0
0
1000
2000
3000
4000



Magnitude Responses (M = 50)
With Rectangular Window
With Hamming Window
1.2
1
0.8
0.6
0.4
0.2
0
0
1000
2000
3000
4000

Published with MATLAB® R2021b