```
% Kaiser window
clear all;
close all;
clc;
% Problem 1
% (a)
% M1+1 is the minimum length of the impulse response
% beta the estimated parameter
bands = [.25 .35 .6 .65];
desiredAmplitude = [0 1 0];
tolerances = [.01 .1 .01];
[M1,Wn,beta,filtype] = kaiserord(bands,desiredAmplitude,tolerances);

% b) The delay is (M1+1)/2

% c) ideal impulse response h_d[n]
filter1 = fir1(M1,Wn);

% d) plotting the Fourier transform of h_d[]*w[n]
kw = kaiser(M1+1,beta)'; % w[n]
transform = abs(fftshift(fft(filter1.*kw)));
freqVector = linspace(-pi,pi,length(transform));
plot(freqVector,transform);
xlim([min(freqVector),max(freqVector)]);
ylim([0,max(transform)+.1]);
xlabel('Frequency');
ylabel('Amplitude');
title('Problem 1');

% Problem 2
% (a)
deltaS = .01; % tolerance in stopband
deltaP = .1; % tolerance in passband
% transition band
wS = .6*pi;
wP = .4*pi;
% Minimum length of the impulse response from the Prandoni % Vetterli
M = round((-10*log10(deltaS*deltaP)-13)/(2.324*(wS-wP)) + 1) + 1;
% (b)
desiredAmplitudes = [1 1 0 0];
lowPassBands = [0 wP/pi wS/pi 1];
filter2 = firpm(M,lowPassBands,desiredAmplitudes);
transform2 = abs(fftshift(fft(filter2)));
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```
freqVector2 = linspace(-pi,pi,length(transform2));
figure
plot(freqVector2,transform2);
xlim([min(freqVector2),max(freqVector2)]);
ylim([0,max(transform2)+.1]);
xlabel('Frequency');
ylabel('Amplitude');
title(['Problem 2, length: ' num2str(M)]);

% The filter seems to satisfy the frequency-amplitude specifications but if
% we increase the number of taps to 50 for example we get much better result.
filter3 = firpm(50,[0 wP/pi wS/pi 1],[1 1 0 0]);
transform3 = abs(fftshift(fft(filter3)));
freqVector3 = linspace(-pi,pi,length(transform3));
figure
plot(freqVector3,transform3);
xlim([min(freqVector3),max(freqVector3)]);
ylim([0,max(transform3)+.1]);
xlabel('Frequency');
ylabel('Amplitude');
title(['Problem 2, length: ' num2str(50)]);

% Problem 3
% transition band and stop bands
bands3 = [.3 .4 .6 .8];
desiredAmplitude3 = [0 1 0]; % desired amplitudes for the bands
deltaP = 1; % the passband ripple 1dB
deltaS = 1.0000e-008; % the stop band 80 dB
tolerances2 = [.01 deltaP .01]; % tolerances for the bands
[M3,Wn3,beta3,filtype3] = kaiserord(bands3,desiredAmplitude3,tolerances2);
% The estimated impulse response
filter3 = fir1(M3,Wn3);
transform4 = abs(fftshift(fft(filter3)));
freqVector4 = linspace(-pi,pi,length(transform4));
figure
plot(freqVector4,transform4);
xlim([min(freqVector4),max(freqVector4)]);
ylim([0,max(transform4)+.1]);
xlabel('Frequency');
ylabel('Amplitude');
title('Problem 3');
```