DSP HW #5

1a) Time of ~~D~~ DTFT, N^2 multiples

$$\boxed{\text{Time} = 1024^2 \cdot 1\mu s = 1,048 \text{ seconds}}$$

b) Time of FFT, $\frac{N}{2}\log_2(N)$

$$\boxed{\text{Time} = \frac{1024}{2}\log_2(1024) \cdot 1\mu s = .005 \text{ seconds}}$$

c) $\boxed{4096 \text{ PT} : 4096^2 \cdot 1\mu s = 16.77 \text{ sec}} \rightarrow$ DTFT

$$\boxed{\text{FFT}: \frac{4096}{2}\log_2(4096) \cdot 1\mu s = .024 \text{ sec}}$$

2 a) $F_s = 4096$

$F_s \geq 2B \rightarrow \frac{4096}{2} \geq F_{Highest}$

$$\boxed{F_{max} = 2048 \text{ Hz}}$$

b) $\boxed{1 \text{ Hz}}$

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%!---------------------------------------------------------------------------
%! DSP HW5 #3
%!  - Compute DTFT of x(n)
%!  - Take 10-pt DFT and 200-pt DFT
%!  - Plot and comment of differences
%!---------------------------------------------------------------------------

%! Enviorment
n = 0:199;
w = (0:199)*pi/100;

%! Signal
x = zeros(200, 1);
x(1:50) = n(1:50) + 1;
x(51:100) = 100-n(51:100);

% DTFT and DFT
x_dtft = dtft(x, n, w);
y1k = x_dtft(1:20:200);    % 10-pt DFT
y2k = x_dtft;              % 200-pt DFT

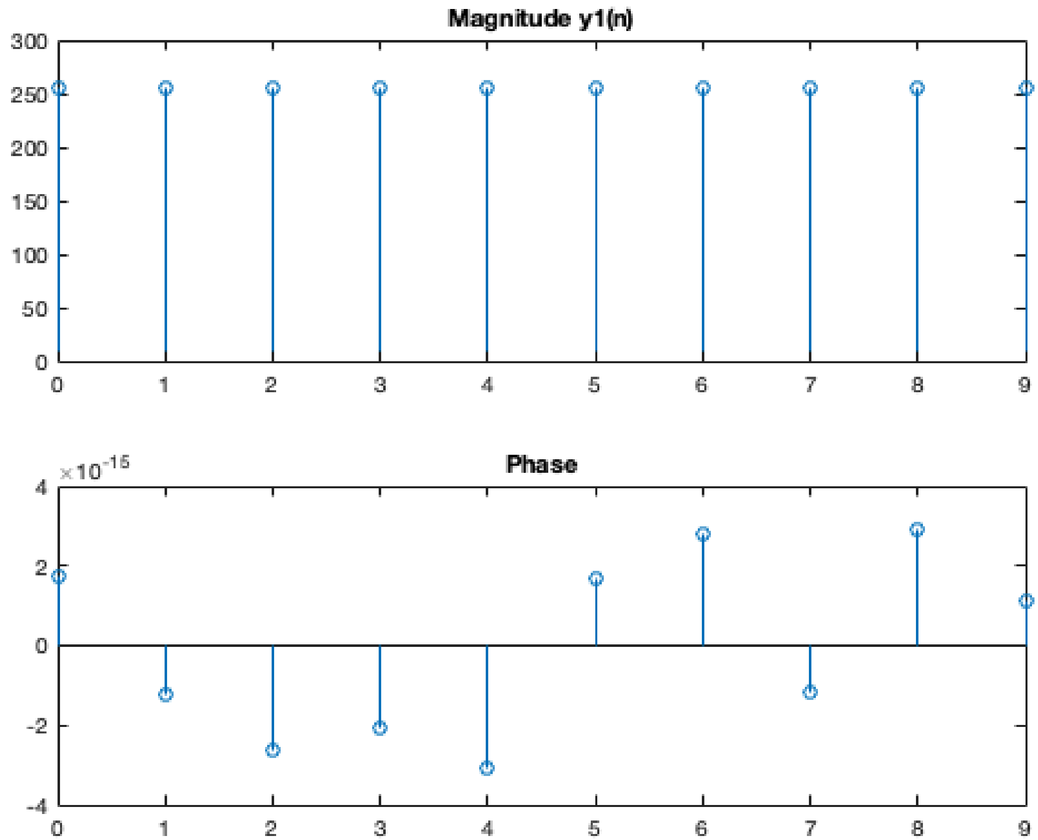
% IDFT
y1 = idft(y1k, 10);
y2 = idft(y2k, 200);

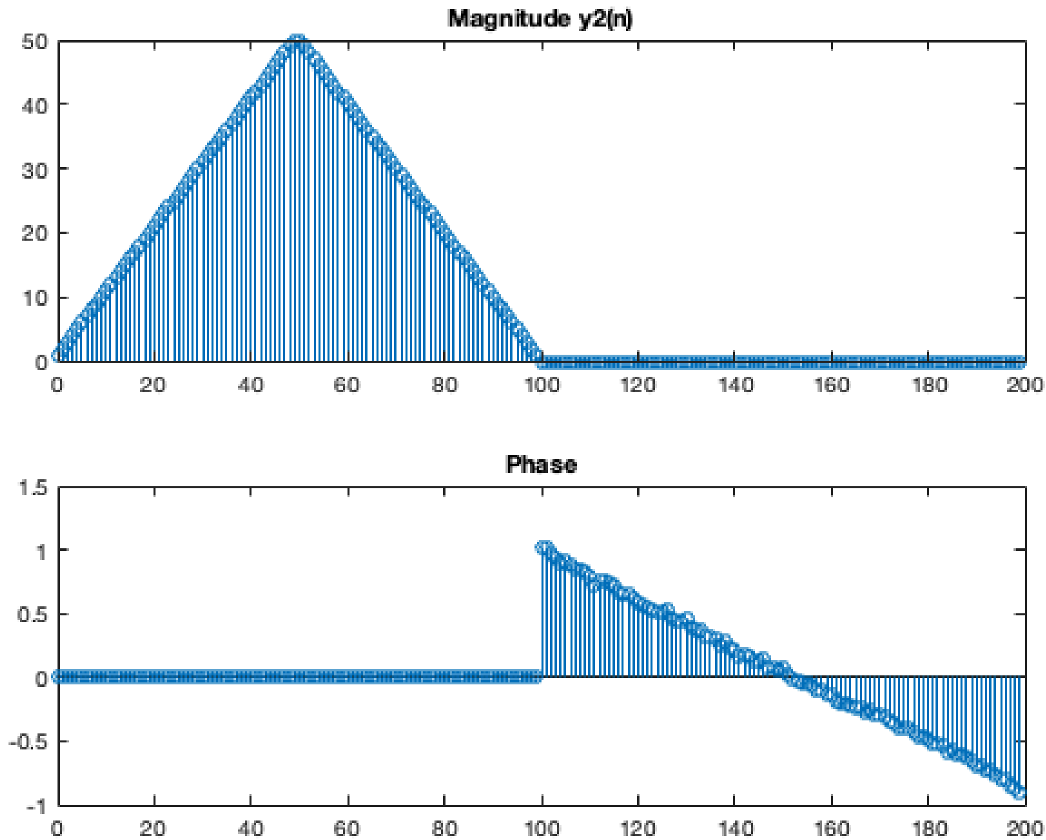
% Plot
figure(1)
subplot(2,1,1)
stem(0:9, abs(y1))
title('Magnitude y1(n)')
subplot(2,1,2)
stem(0:9, angle(y1))
title('Phase')

figure(2)
subplot(2,1,1)
stem(0:199, abs(y2))
title('Magnitude y2(n)')
subplot(2,1,2)
stem(0:199, angle(y2))
title('Phase')

% Comment on DFT
disp(['Since the DFT in part a is only N=10 and L=100, the signal y1(n) cannot
 be reconstructed' ...
'into x(n), but since the DFT in part b is N=200 and L=100 N > L and the
 signal y2(n) can be reconstructed into x(n)'])
```

Since the DFT in part a is only N=10 and L=100, the signal y1(n) cannot be reconstructedinto x(n), but since the DFT in part b is N=200 and L=100 N > L and the signal y2(n) can be reconstructed into x(n)


Magnitude y1(n)
300
250
200
150
100
50
0
0 1 2 3 4 5 6 7 8 9
×10^-15
Phase
4
2
0
-2
-4
0 1 2 3 4 5 6 7 8 9



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%!--------------------------------------------------------------------------
%! DSP HW5 #4
%!  - Take 256pt FFT at 100ms, 300ms and 450ms
%!  - Display FFT magnitude for positive frequencies
%!  - Identify frequency bands of interferece
%!--------------------------------------------------------------------------

%! Enviorment
load HW5_Sig    % Sig and Fs
block_size = 128;

% Take FFT
fft_100ms = fft(Sig(6*block_size:7*block_size-1));
fft_300ms = fft(Sig(17*block_size:18*block_size-1));
fft_450ms = fft(Sig(26*block_size:27*block_size-1));

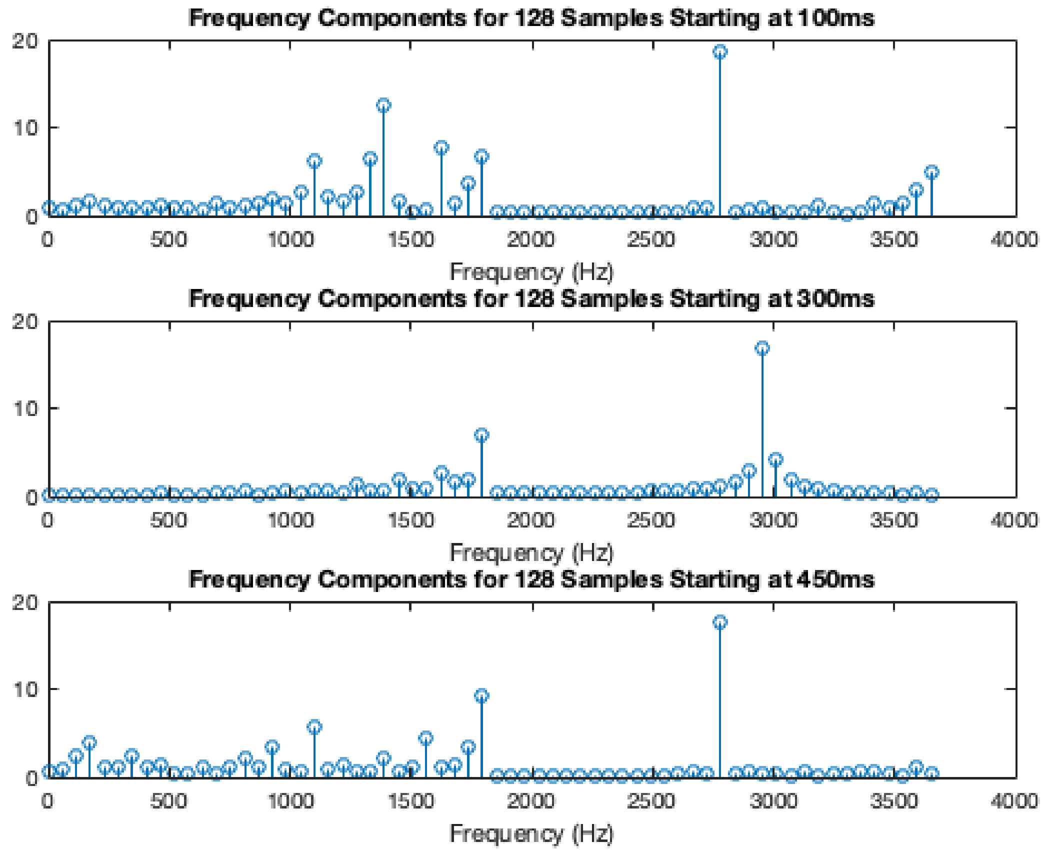
% Plot FFT
f = (0:63)*Fs/block_size;
subplot(3,1,1)
stem(f, fftshift(abs(fft_100ms(65:end))))
title('Frequency Components for 128 Samples Starting at 100ms')
xlabel('Frequency (Hz)')

subplot(3,1,2)
stem(f, fftshift(abs(fft_300ms(65:end))))
title('Frequency Components for 128 Samples Starting at 300ms')
xlabel('Frequency (Hz)')

subplot(3,1,3)
stem(f, fftshift(abs(fft_450ms(65:end))))
title('Frequency Components for 128 Samples Starting at 450ms')
xlabel('Frequency (Hz)')


disp(['The frequency components that should be filtered'...
'out are from about 2750Hz to about 3100Hz, the '...
'impulses from the beep sine waves.'])
```

The frequency components that should be filteredout are from about 2750Hz to about 3100Hz, the impulses from the beep sine waves.



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%!-----------------------------------------------------------------------------
%! DSP HW5 #5
%!  - Create signal with three sinusiod and a noise component
%!  - Display the magnitude for two different window functions
%!  - Comment on displayed results
%!-----------------------------------------------------------------------------

%! Enviorment
Fs = 200000;
Ts = 1/Fs;
f1 = 46000;
f2 = 46380;
f3 = 54000;
a1 = 1;
a2 = .4;
a3 = .002;
variance = 10e-5;
n = 0:1023;

% Singal
x = a1*cos(2*pi*f1*Ts*n) + a2*cos(2*pi*f2*Ts*n) + a3*cos(2*pi*f3*Ts*n);
noise = variance*randn(1,1024);
x = x + noise;

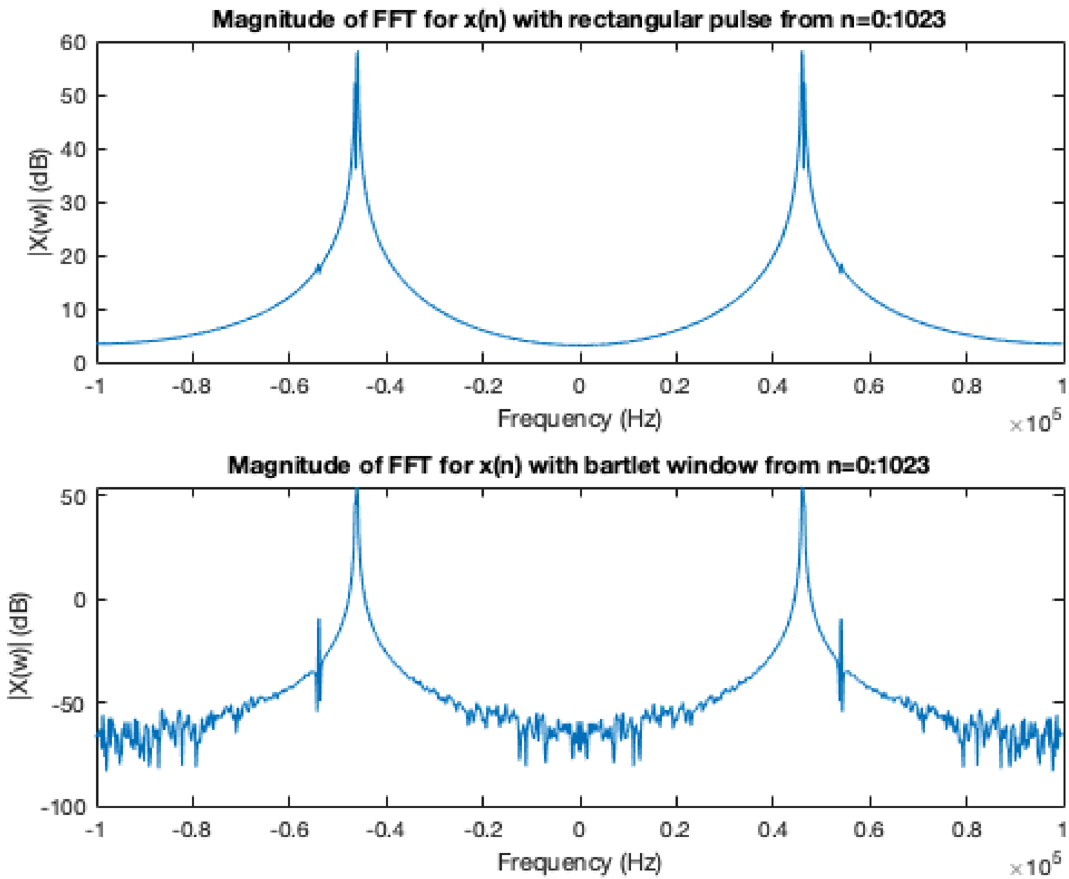
% Window
bartlet_window = zeros(1, 1024);
bartlet_window(1:512) = n(1:512) / 512;
bartlet_window(513:end) = (1024 - n(513:end)) / 512;
x_window = x .* bartlet_window;

% FFT
xf = fftshift(abs(fft(x)));
xf_window = fftshift(abs(fft(x_window)));

% Plot
f = (-512:511)*Fs/length(n);
subplot(2,1,1)
plot(f, 10*log(xf))
title('Magnitude of FFT for x(n) with rectangular pulse from n=0:1023')
ylabel('|X(w)| (dB)')
xlabel('Frequency (Hz)')
subplot(2,1,2)
plot(f, 10*log(xf_window))
title('Magnitude of FFT for x(n) with bartlet window from n=0:1023')
ylabel('|X(w)| (dB)')
xlabel('Frequency (Hz)')

disp(['With the rectangular pulse you can see the three'...
'frequencies in the magnitude of the spectrum. In the'...
'magnitude of the spectrum windowed with the barlet function'...
'you can really only see the main wave and the wave at f3.'...
'When windowed with barlet you can also see more noise in the spectrum.'])
```

```
With the rectangular pulse you can see the threefrequencies in the magnitude
 of the spectrum. In themagnitude of the spectrum windowed with the barlet
 functionyou can really only see the main wave and the wave at f3.When
 windowed with barlet you can also see more noise in the spectrum.
```



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