Lab 3

27 September 2015

GPGN 404

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1. See Appendix I

2. Amplitude and Phase Spectra

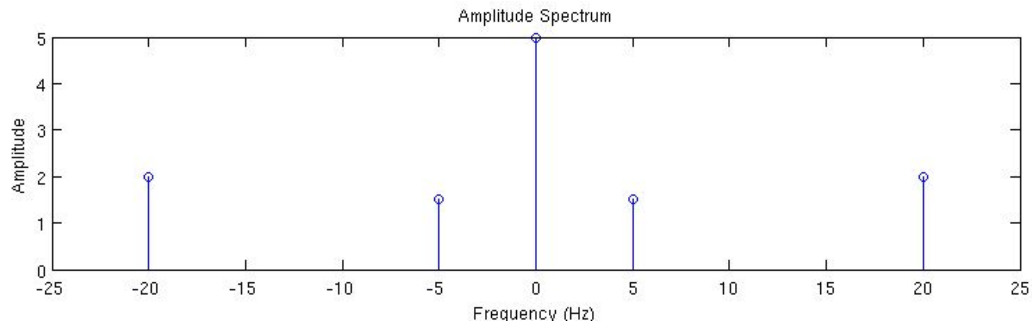

Figure 1: Amplitude Spectrum

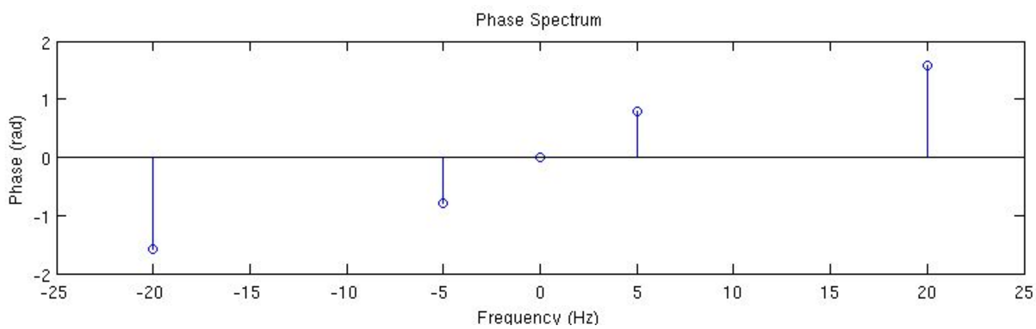

Figure 2: Phase Spectrum

3. Pot of the time signal $x(t)$.

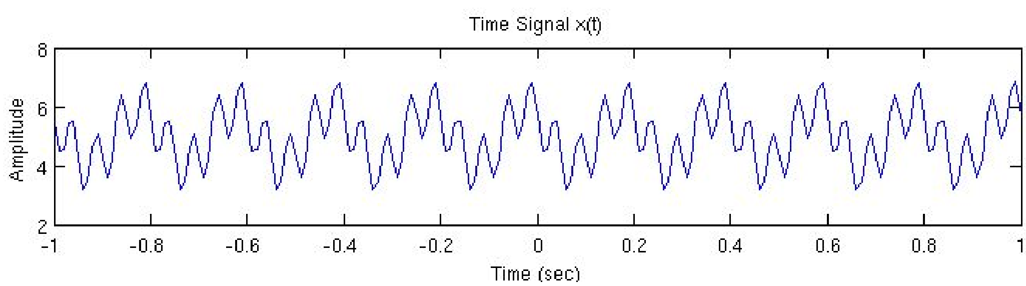

Figure 3: Time Signal corresponding to spectra in number 2

4. Fast Fourier Transform of the time signal from number 3.

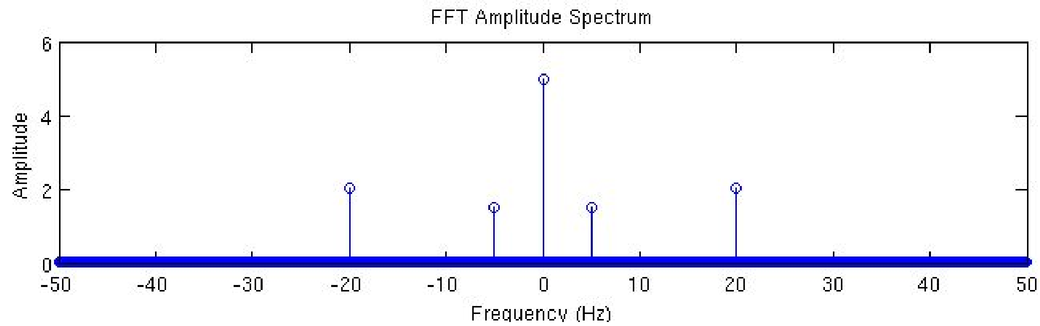

Figure 4: Amplitude spectrum produced by FFT

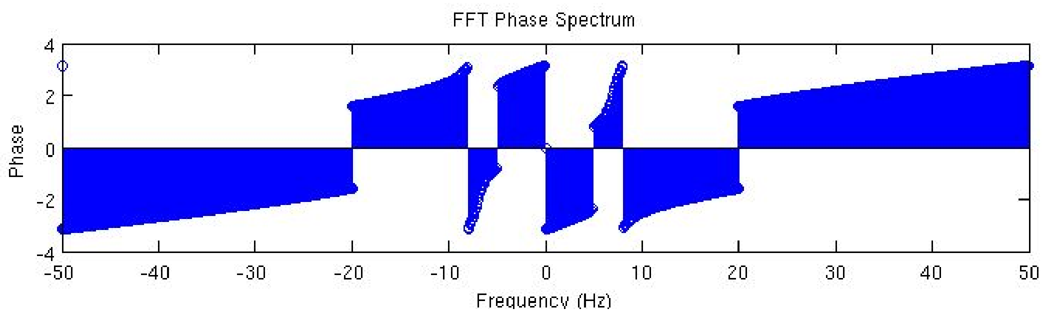

Figure 5: Phase spectrum produced from FFT

These spectra do not exactly match the spectra from the analysis in question 2 however the correct spectra are a subset of the data contained in the above plots. If interpreted correctly or filtered for frequencies with amplitudes above 0.001 the above plots contain the same information as the spectra plots in question 2.

5. Plot the time series contained in the data file.

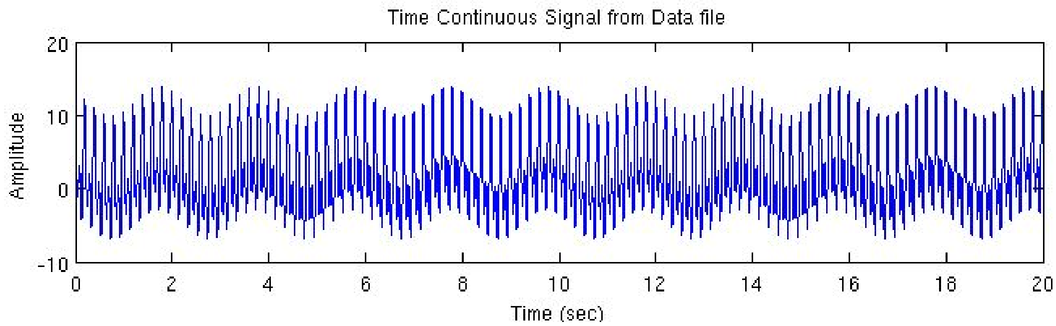

Figure 6: Line Plot of time signal from data file

a. I guess the time period is 2.0 seconds.

b. $\{f_k, X_k\} = \{(0,2),(0.5,e^{i\frac{\pi}{4}}),(-0.5,e^{-i\frac{\pi}{4}}),(5,2.5e^{i\pi}),(-5,2.5e^{-i\pi}),(10,2.5e^{i\frac{\pi}{6}}),(-10,2.5e^{-i\frac{\pi}{6}})\}$

c. Plots of the two-sided FFT amplitude and phase spectrum

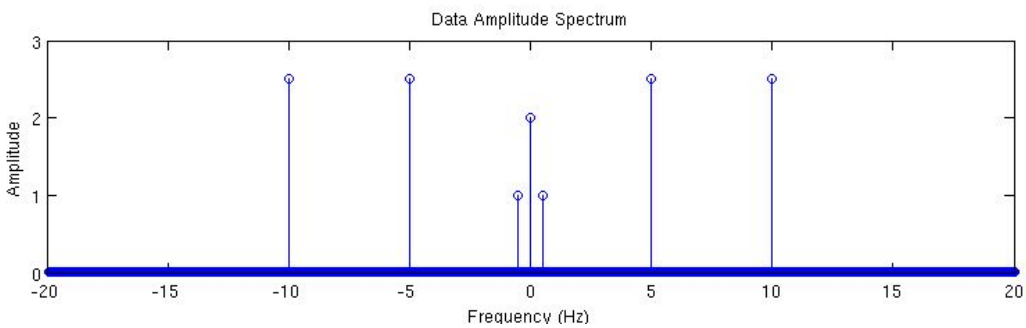

Figure 7: FFT amplitude spectrum of the provided data file time signal

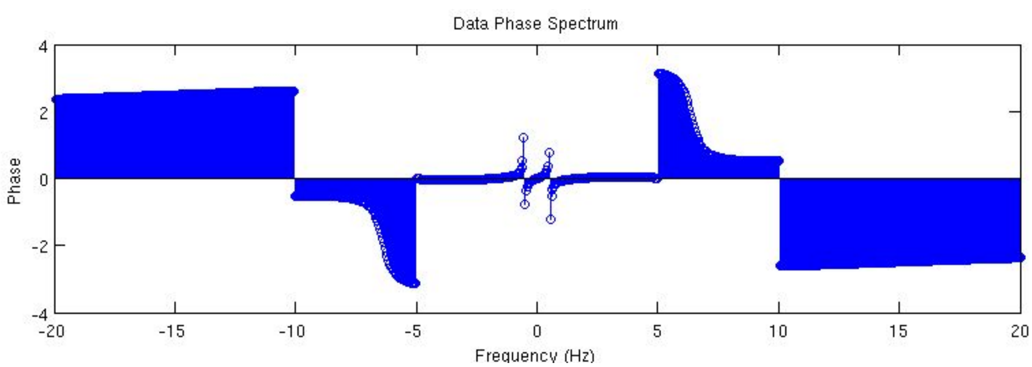

Figure 8: FFT phase spectrum of the provided data file time signal

d. The fundamental frequency, f_0, is $0.5\ Hz$.

e. The harmonics present in this signal $x(t)$ are f_{10} and f_{20}, the 10th and 20th harmonic frequencies of f_0. This is because $(5\ Hz) = (10) * f_0$ and $(10\ Hz) = (20) * f_0$.

Appendix I: The MatLab Code

```
%------------- Problem 1 -----------------
Fk = [0 5 20];
Xk = [5 1.5*exp(1i*pi*0.25) 2.0*exp(1i*pi*0.5)];
Amp = Spectra(Fk, Xk, 'Amplitude');
Phs = Spectra(Fk, Xk, 'Phase');
clear;

%------------- Problem 3 -----------------

figure;
t3 = -1:0.001:1;
plot(t3, 5 + 3.0*cos(2*3.14159*5.0*t3+3.14159/4.0)+4.0*cos(2*3.14159*20.0*t3+3.14159/2.0));
xlabel({'Time (sec)'});
title('Time Continuous Signal');
ylabel({'Amplitude'});
clear;

%------------- Problem 4 -----------------
Fs = 100;          % Sampling frequency
T = 1/Fs;          % Sampling period
L = 1000;          % Length of signal
t = (0:L-1)*T;     % Time vector
X = 5 + 3.0*cos(2*3.14159*5.0*t+3.14159/4.0)+4.0*cos(2*3.14159*20.0*t+3.14159/2.0);
Y = fftshift(fft(X))/(length(t));
f = Fs*(-L/2:L/2-1)/L;
Phase = zeros(length(Y), 1);
Amplitude = abs(Y);
for i = 1:L
        Phase(i) = angle(Y(i));
        %
        % if Amplitude(i) <= 0.001
        %       Amplitude(i) = NaN;
        %       Phase(i) = NaN;
        % end
end
figure;
stem(f,Amplitude);
xlabel({'Frequency (Hz)'});
title('FFT Amplitude Spectrum');
ylabel({'Amplitude'});
figure;
stem(f,Phase);
xlabel({'Frequency (Hz)'});
```

```
title('FFT Phase Spectrum');
ylabel({'Phase'});
clear;

%------------- Problem 5 -----------------
figure;
Data = load('Lab3_t_xt.dat');
TimeData = Data(:,1);
AmpData = Data(:,2);
plot(TimeData, AmpData);
xlabel({'Time (sec)'});
title('Time Continuous Signal from Data file');
ylabel({'Amplitude'});

Fs = 5000;        % Sampling frequency
T = 1/Fs;         % Sampling period
t = TimeData;     % Time vector

X = AmpData;
Y = fftshift(fft(X))/(length(t));
fk = Fs/2*linspace(-1,1,length(t));
Phase = angle(Y);
Amplitude = abs(Y);

figure;
stem(fk,Amplitude);
xlabel({'Frequency (Hz)'});
title('Data Amplitude Spectrum');
ylabel({'Amplitude'});
figure;
stem(fk,Phase);
xlabel({'Frequency (Hz)'});
title('Data Phase Spectrum');
ylabel({'Phase'});
clear;
```