EEL 3135 Lab 2

Name: Brandon Davis

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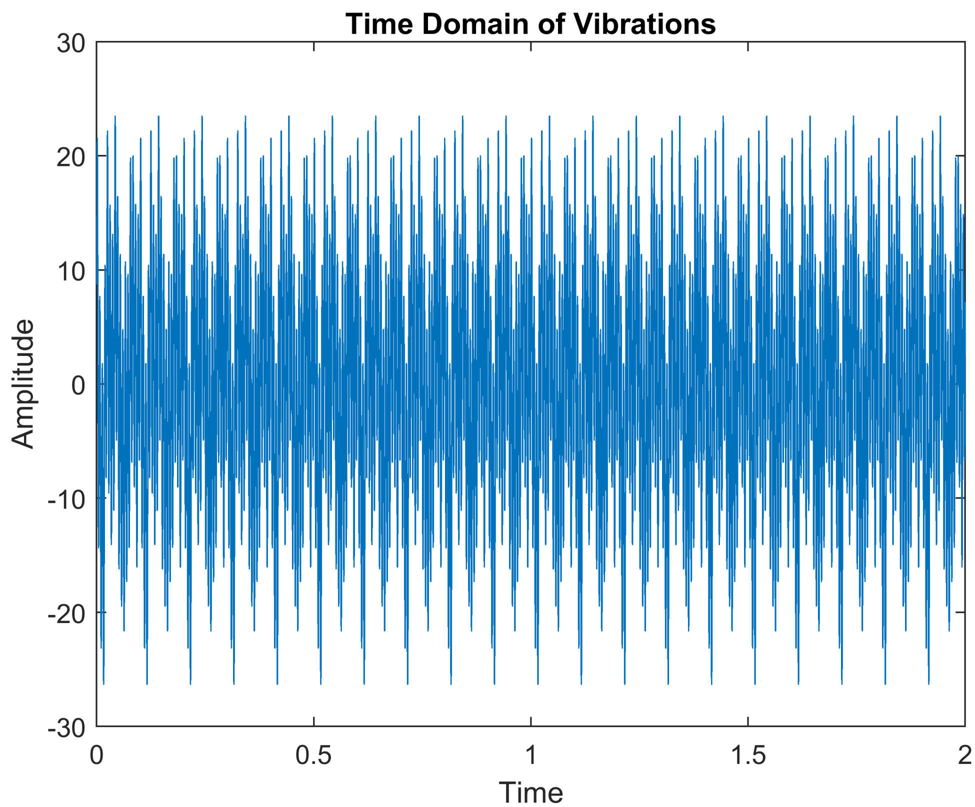
```
% Import your waveform and time data
myUFID = 45045889;
[Y_t, T_s] = BuildingTraceData(myUFID);
```

Part 1 Working within the Time Domain

```
%% Question 1
figure;
plot(T_s ,Y_t )
title('Time Domain of Vibrations')
ylabel('Amplitude')
xlabel('Time')
```



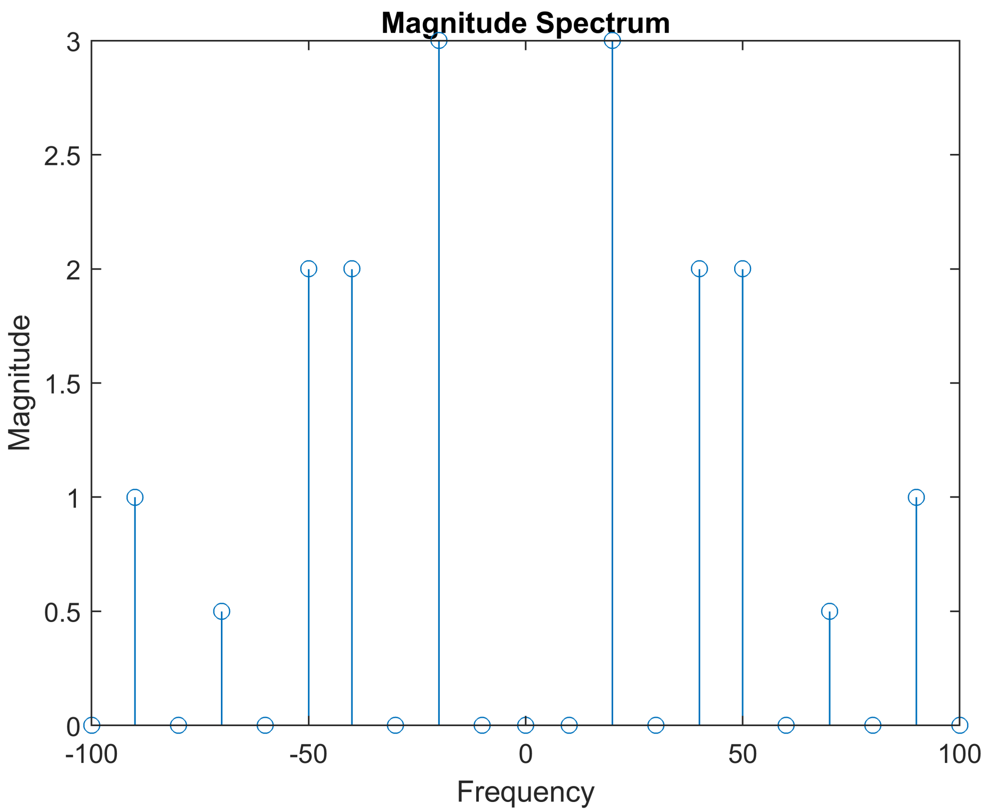

```
%% Question 2
%{
    The signal is periodic since the when zooming into the graph, the
    peaks and path of the signal seem to repeat on a constant baisis
    having a period.
%}
```

```
%% Question 3
T_0 = 0.1; % Fundamental Period

%% Question 4
f_0 = 10; % Fundamental frequency
T_0 = .1; % Fundamental Period
```

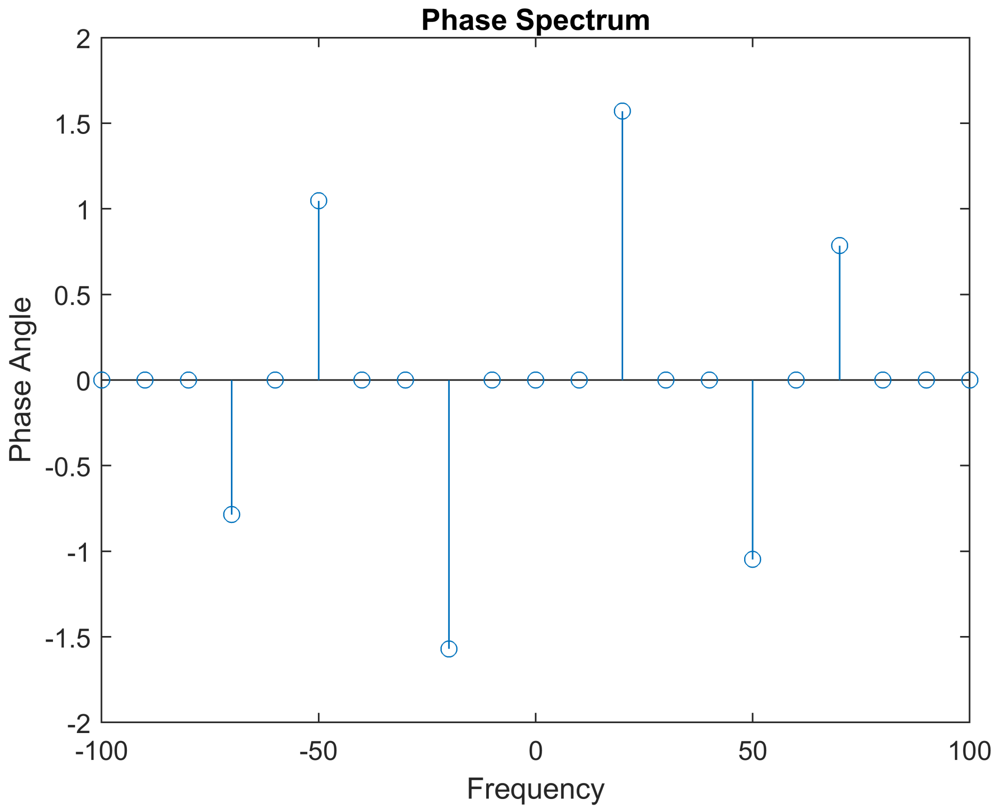
Part 2 Fourier Series (Analysis)

```
%% Question 5
K = 10;
% Find Index point within Ts for the first T_o
[~,L_T_o]=min(abs(T_0-T_s));
t_Period = T_s(1:L_T_o);
Y_period = Y_t(1, 1:(L_T_o));
%Pre-Allocation of space for Matrices  (speeds up Matlab)
Kernel_R = zeros(K,L_T_o);
Kernel_I = zeros(K,L_T_o);
% Calculation of coefficient matrix
% trapz was used as a way to approximate the integral
n=1;
for  k = -K:K
     Kernel_R(n,:) = Y_period.*cos((2*pi*k*t_Period)/T_0);
     Kernel_I(n,:) = Y_period.*sin((2*pi*k*t_Period)/T_0);
     A_R_k(n) = (1/T_0)*trapz(t_Period,Kernel_R(n,:)) ;   % Real
     A_I_k(n) = (1/T_0)*trapz(t_Period, Kernel_I(n, :)) ;   % Imaginary
     A_k(n)= A_R_k(n) - j*A_I_k(n);
     n=1+n;
end
% Because trapz approximation might cause our conjugate pairs to be
% slightly off (leading to imaginary values in the time domain),
% we can round off to 3 digits.
A_k = round(A_k,3);

%% Question 6
% For each frequency, there MUST be a negative frequency pair
% for each value's conjugate A_k so A_k and Freqs must be the same size
n = 1;
Freq = zeros(1,21);
for k = -K:K
    Freqs(1,n) = k*f_0;
    n=n+1;
end

%% Question 7
[PHI, A] = cart2pol(A_R_k, -1.*A_I_k);
A = round(A, 3);
PHI = round(PHI, 3);
figure;
stem(Freqs, A)
```

```
title('Magnitude Spectrum')
ylabel('Magnitude')
xlabel('Frequency')
```




```
%% Question 8
figure;
stem(Freqs, angle(A_k))
title('Phase Spectrum')
ylabel('Phase Angle')
xlabel('Frequency')
```



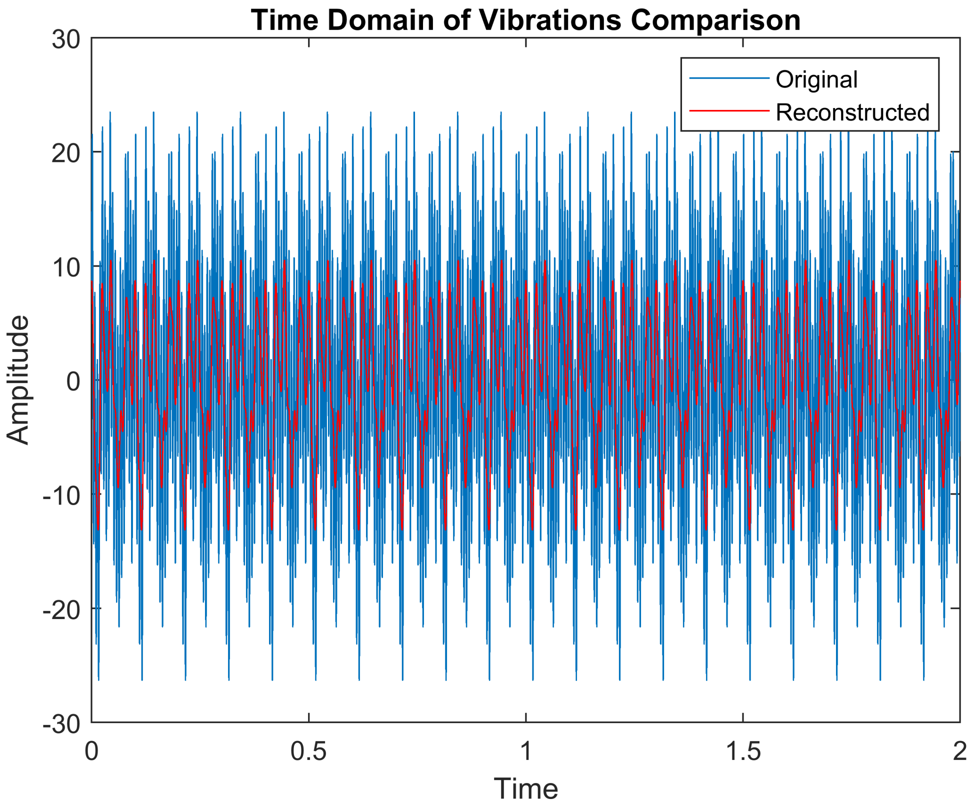

```
%% Question 9
%Determines and identifies the frequencies of the nonzero phasors
n = 1;
for k = 1:21
    if A(1,k) ~= 0
        non_zero_Freqs(1,n) = Freqs(1,k);
        n=n+1;
    end;
end;
disp(Freqs);
```

```
  Columns 1 through 19

  -100   -90   -80   -70   -60   -50   -40   -30   -20   -10     0    10    20    30    40    50    60    70    80

  Columns 20 through 21

    90   100
```

```
%% Question 10
% All nonzero harmonics are n times faster than the first harmonic. From
% the magnitude spectragram, the first harmonic's speed is 10 Hz. If n  =
% to the 5th harmonic, its speed is 50 Hz which is 5 times faster than the
% first.
```

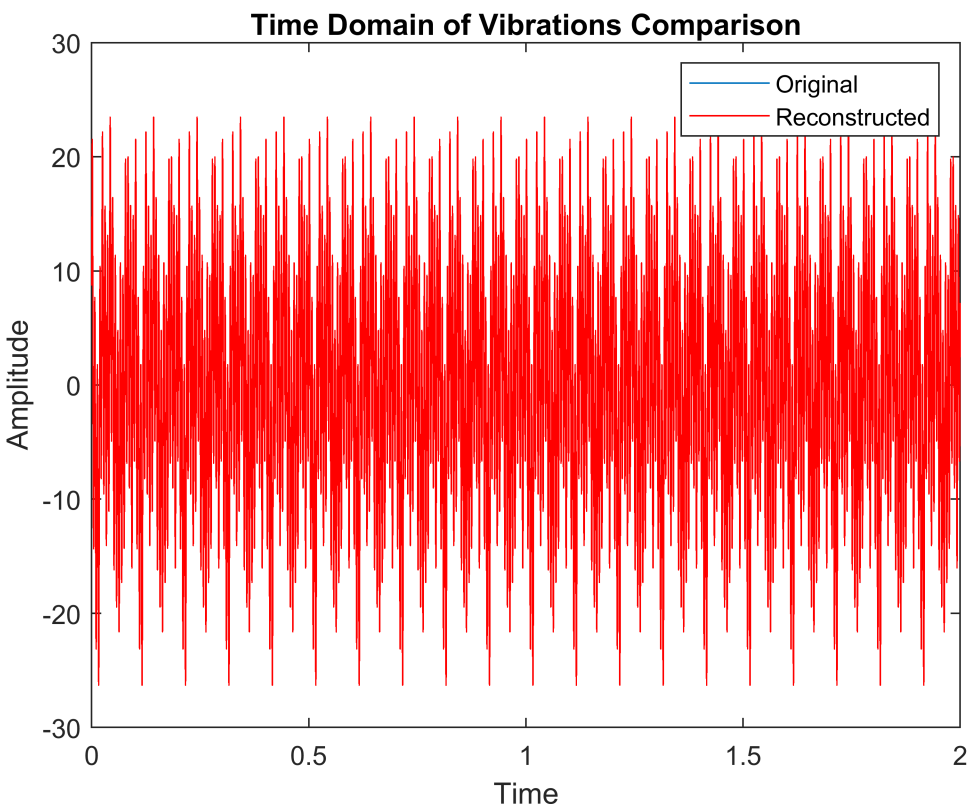
Part 3 Fourier Series (Synthesis)

```
% Question 11
% Because of rounding approximating errors in Matlab,
% it might say that your reconstructed signal is imaginary even though the
% magnitude of the imaginary componet is in the power of 10^-15.
% Something like max(imag(ReconstructedSignal)) could be used to test if
% your signal has this problem, if so, use real(ReconstructedSignal) to
% remove those small imaginary rounding errors.
% WARNING: IF max(imag(ReconstructedSignal)) RETURNS A VALUE LARGER THAN
% 10^-10,YOUR CODE IS NOT CORRECT!
n=1;
ReconstructedSignal = 0;
K = 10;
for  k = -K:K
    ReconstructedSignal = ReconstructedSignal+ A_k(n)*exp((j*2*pi*k*T_s)/T_0);
    n = n+1;
end;
ReconstructedSignal = real(ReconstructedSignal);

%% Question 12
figure;
%Blue Line
plot(T_s,Y_t)
hold on;
%Red Lines
plot(T_s,ReconstructedSignal,'r');
hold off
title('Time Domain of Vibrations Comparison')
ylabel('Amplitude')
xlabel('Time')
legend('Original','Reconstructed')
```




```
%No, I was not able to reconstruct this signal

%% Question 13
%There is a Large Error
%Improved attempt at analysis goes here
K = 20;
Kernel_R_2 = zeros(K,L_T_o);
Kernel_I_2 = zeros(K,L_T_o);
n=1;
for  k = -K:K
     Kernel_R_2(n,:) = Y_period.*cos((2*pi*k*t_Period)/T_0);
     Kernel_I_2(n,:) = Y_period.*sin((2*pi*k*t_Period)/T_0);
     A_R_k_2(n) = (1/T_0)*trapz(t_Period,Kernel_R_2(n,:)) ;   % Real
     A_I_k_2(n) = (1/T_0)*trapz(t_Period, Kernel_I_2(n, :)) ;   % Imaginary
     A_k_2(n)= A_R_k_2(n) - j*A_I_k_2(n);
     n=1+n;
end
[PHI_2, A_2] = cart2pol(A_R_k_2, -1.*A_I_k_2);
A_k_2 = round(A_k_2,3);
A_2 = round(A_2, 3);
PHI_2 = round(PHI_2, 3);
% Improved attempt at synthesis goes here
n=1;
ReconstructedSignal_2 = 0;
for  k = -K:K
    ReconstructedSignal_2 = A_k_2(n)*exp((j*2*pi*k*T_s)/T_0) + ReconstructedSignal_2;
```

```
    n = n+1;
end;
ReconstructedSignal_2 = real(ReconstructedSignal_2);
%Reconstructed Signal But better
figure;
%Blue Line
plot(T_s,Y_t)
hold on;
%Red Line
plot(T_s,ReconstructedSignal_2,'r');
hold off
title('Time Domain of Vibrations Comparison')
ylabel('Amplitude')
xlabel('Time')
legend('Original','Reconstructed')
```




```
%% Question 14
max(abs(A_k))
```

```
ans = 3
```

```
%If the maximum value of of the magnitude of the fourrier coefficeints is
%3 seen from max(abs(A_k)) and the max value on the magnitude spectrum is 3,
%the building should be safe to build since they said that any sinusoidal wave
%form over 30Hz with an amplitude greater than 8 could comprise the buildings structure.
%I was able to improve the reconstruction of the graph. The method I used was adding
```

```
%more fourier coefficents by increasing k's value to a larger number. The reason why
%it worked was because for synthesis, to get x(t), it is an infinite series;
%therefore, the more coeffiecents for the infinite series the closer it will represent
%the actual signal by adding more fourier coeffiecents.
```