LAB #05

Spectral Analysis of a random signal using MATLAB

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CSE-402L Digital Signal Processing Lab

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Section: C

“On my honor, as a student of the University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work”

Submitted to:

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Task 1

Code:

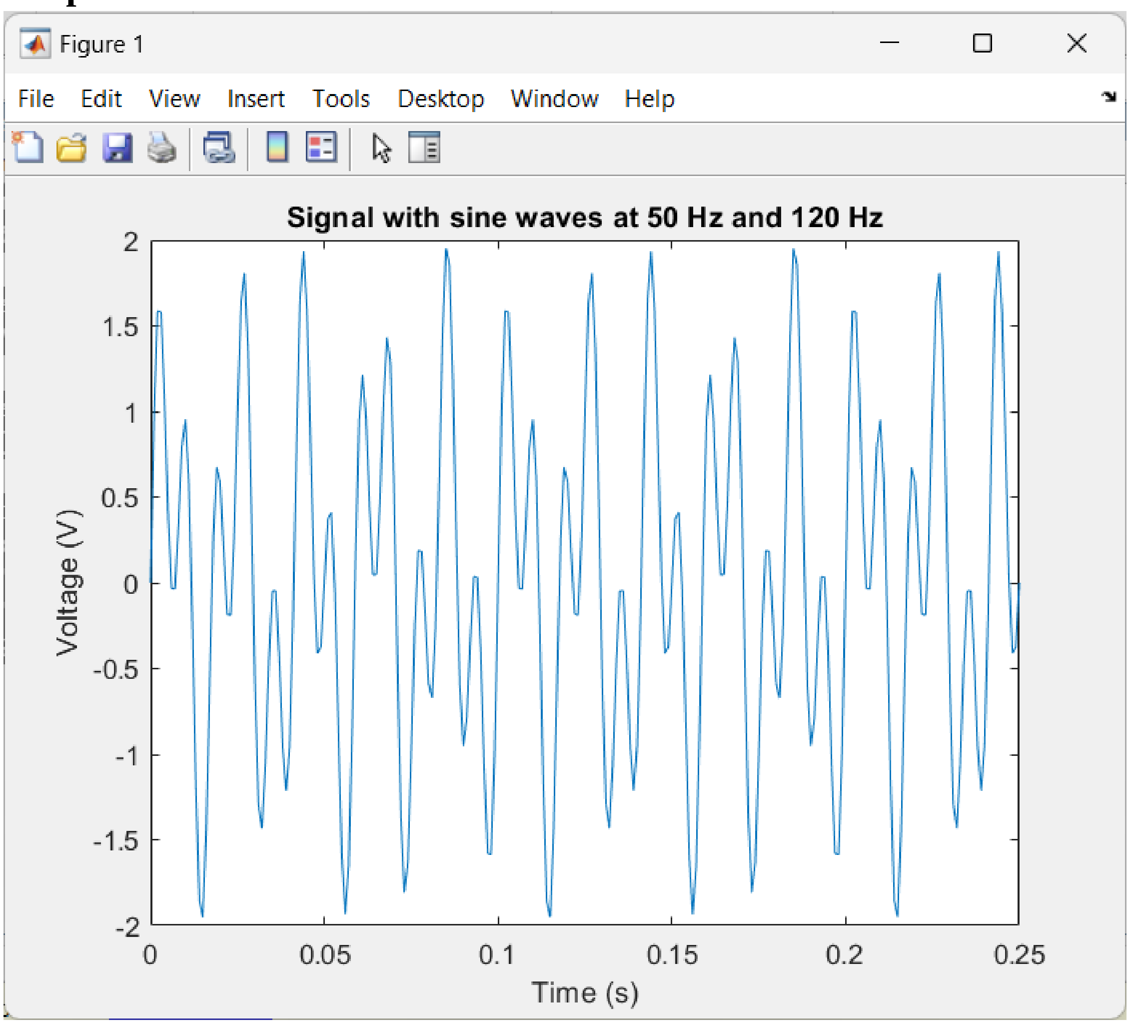
```
% Set the sampling frequency
fs = 1000; % Hz

% Create a time vector from 0 to 0.25 seconds with steps of 1 millisecond
t = 0:1/fs:0.25; % seconds

% Create a signal, x, containing sine waves at 50 Hz and 120 Hz
x = sin(2*pi*50*t) + sin(2*pi*120*t); % volts

% Plot the signal
plot(t,x)
xlabel('Time (s)')
ylabel('Voltage (V)')
title('Signal with sine waves at 50 Hz and 120 Hz')
```

Output:



Task 2

Code:

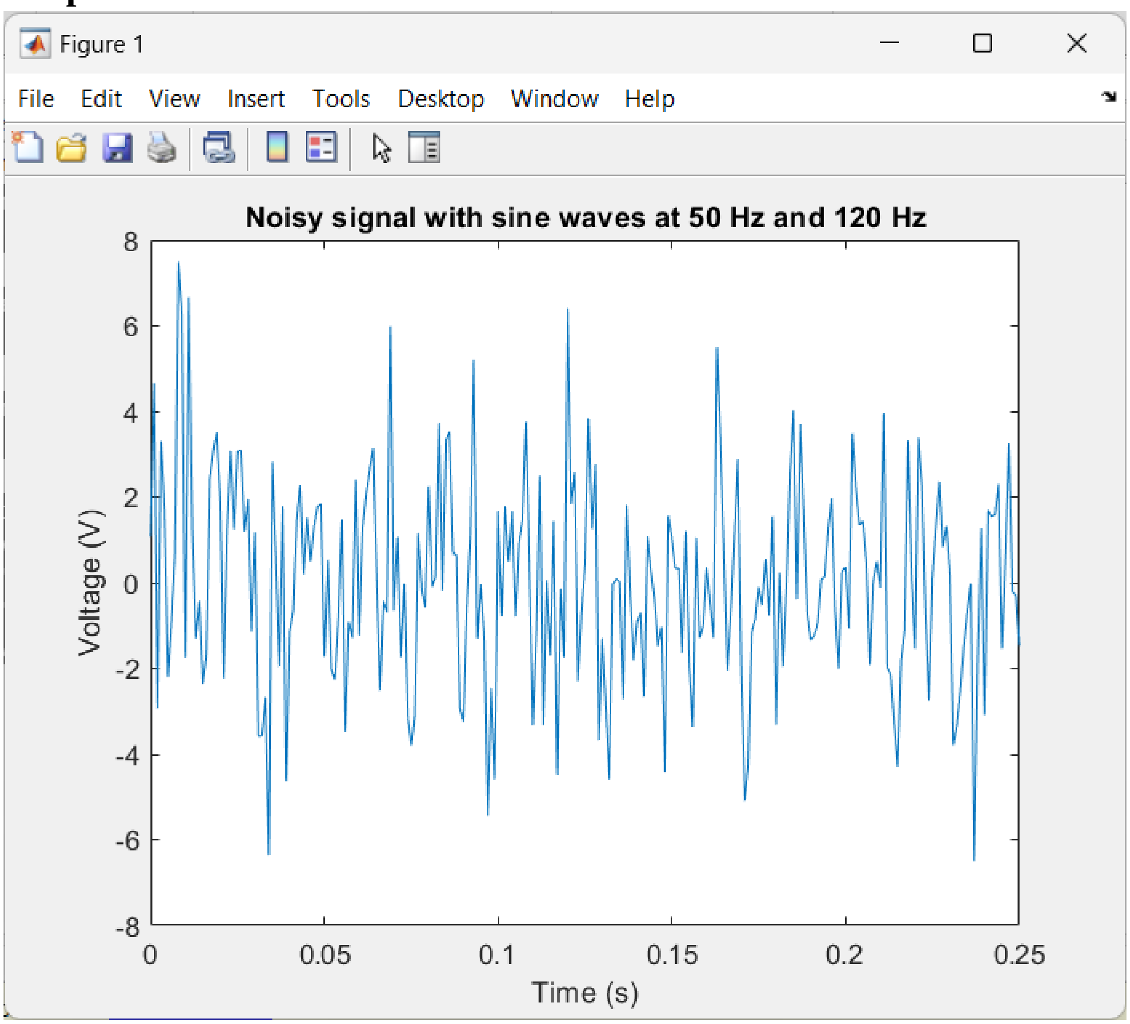
```
% Set the standard deviation of the noise
sigma = 2; % volts

% Generate a random noise vector with the same size as t
noise = sigma * randn(size(t)); % volts

% Add the noise to the signal x to get the noisy signal y
y = x + noise; % volts

% Plot the noisy signal y
plot(t,y)
xlabel('Time (s)')
ylabel('Voltage (V)')
title('Noisy signal with sine waves at 50 Hz and 120 Hz')
```

Output:



Task 3

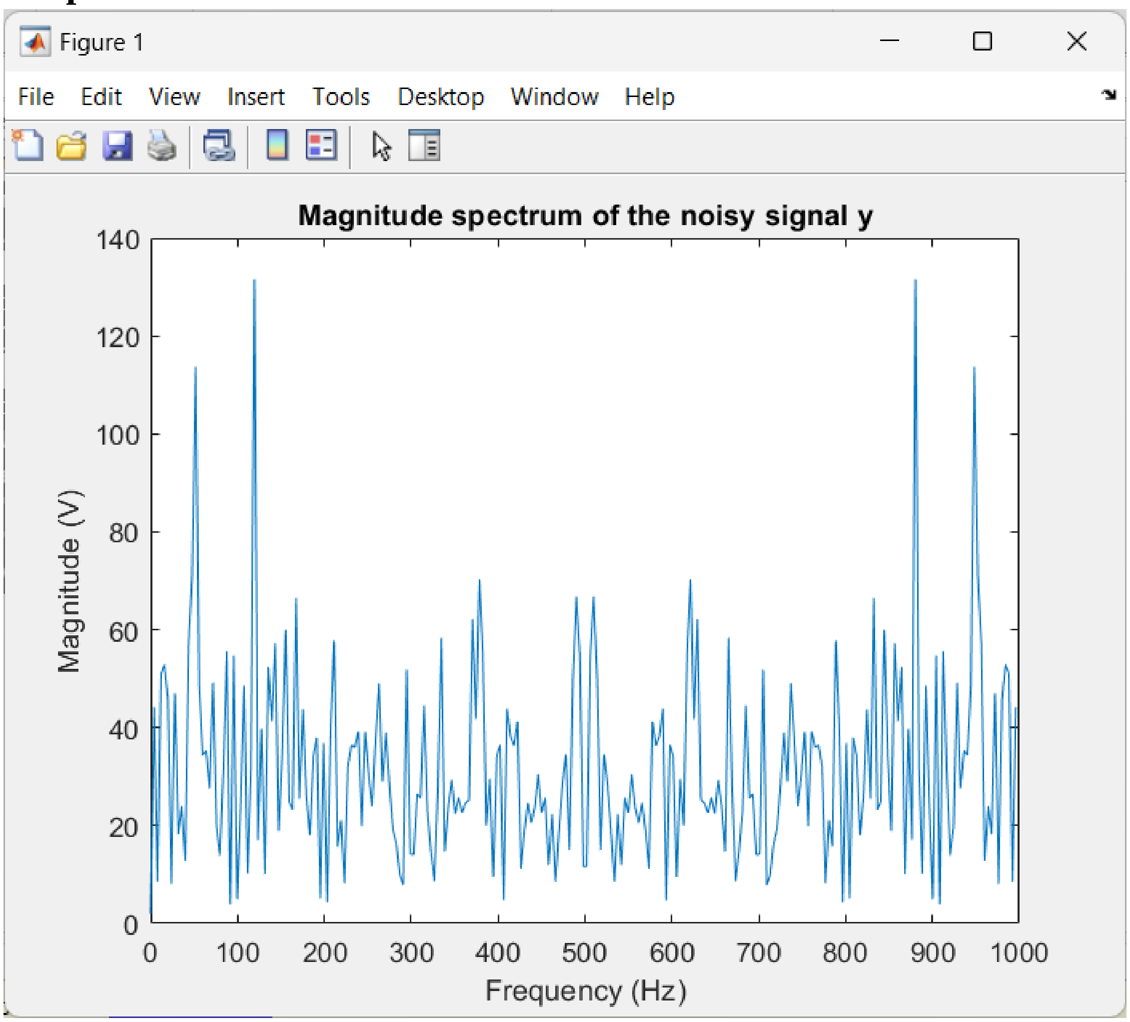
Code:

```
% Set the number of points for the DFT
N = 251; % samples

% Compute the DFT of the noisy signal y using the fft function
Y = fft(y,N); % volts

% Plot the magnitude spectrum of the DFT
f = (0:N-1) * fs / N; % frequency vector in Hz
plot(f,abs(Y))
xlabel('Frequency (Hz)')
ylabel('Magnitude (V)')
title('Magnitude spectrum of the noisy signal y')
```

Output:



Task 4

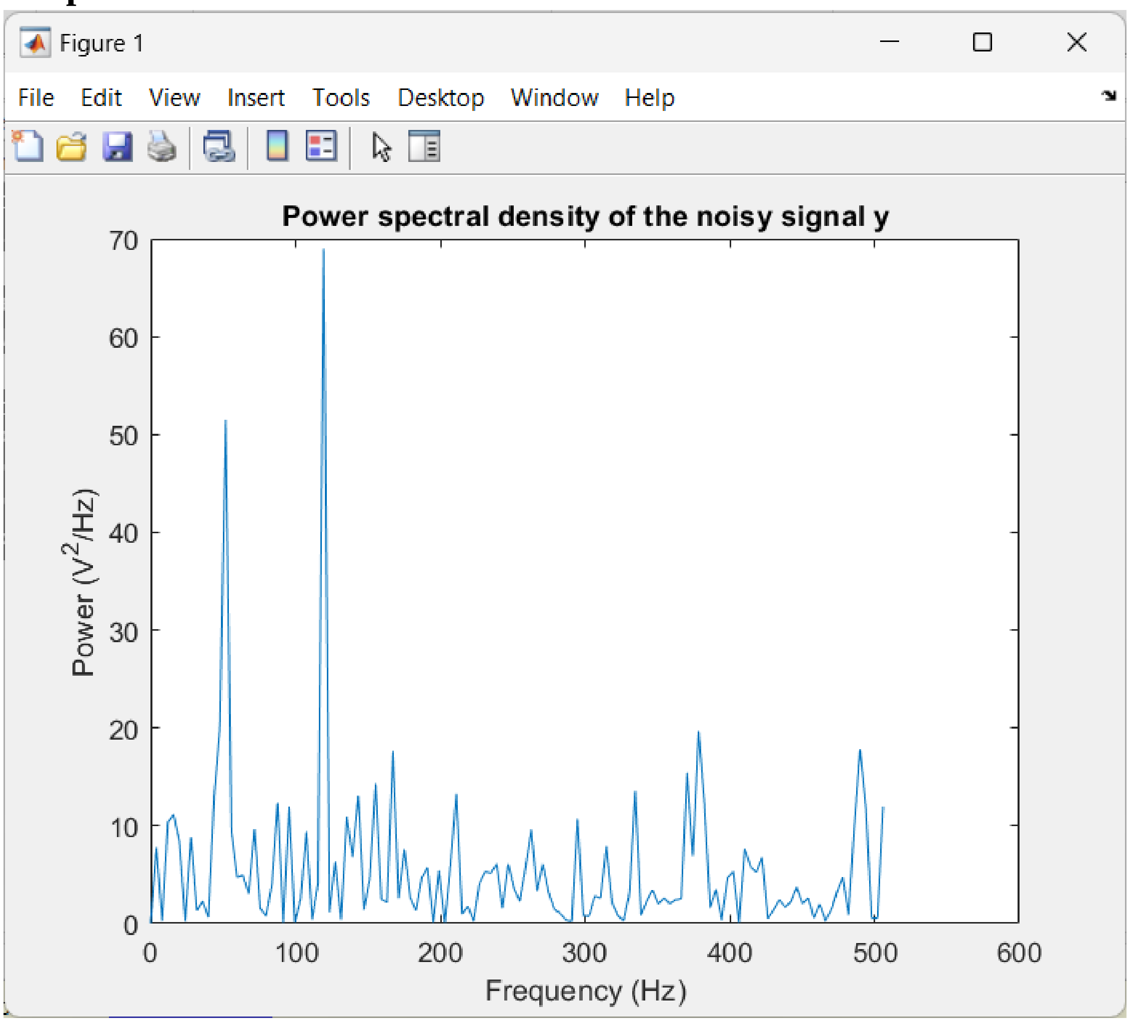
Code:

```
% Compute the PSD of the noisy signal y using the CONJ function
Pyy = Y.*conj(Y)/N; % power per frequency in V^2/Hz

% Form a frequency axis for the first 127 points
f = fs/N * (0:127); % frequency vector in Hz

% Plot the PSD of the noisy signal y
plot(f,Pyy(1:128))
xlabel('Frequency (Hz)')
ylabel('Power (V^2/Hz)')
title('Power spectral density of the noisy signal y')
```

Output:

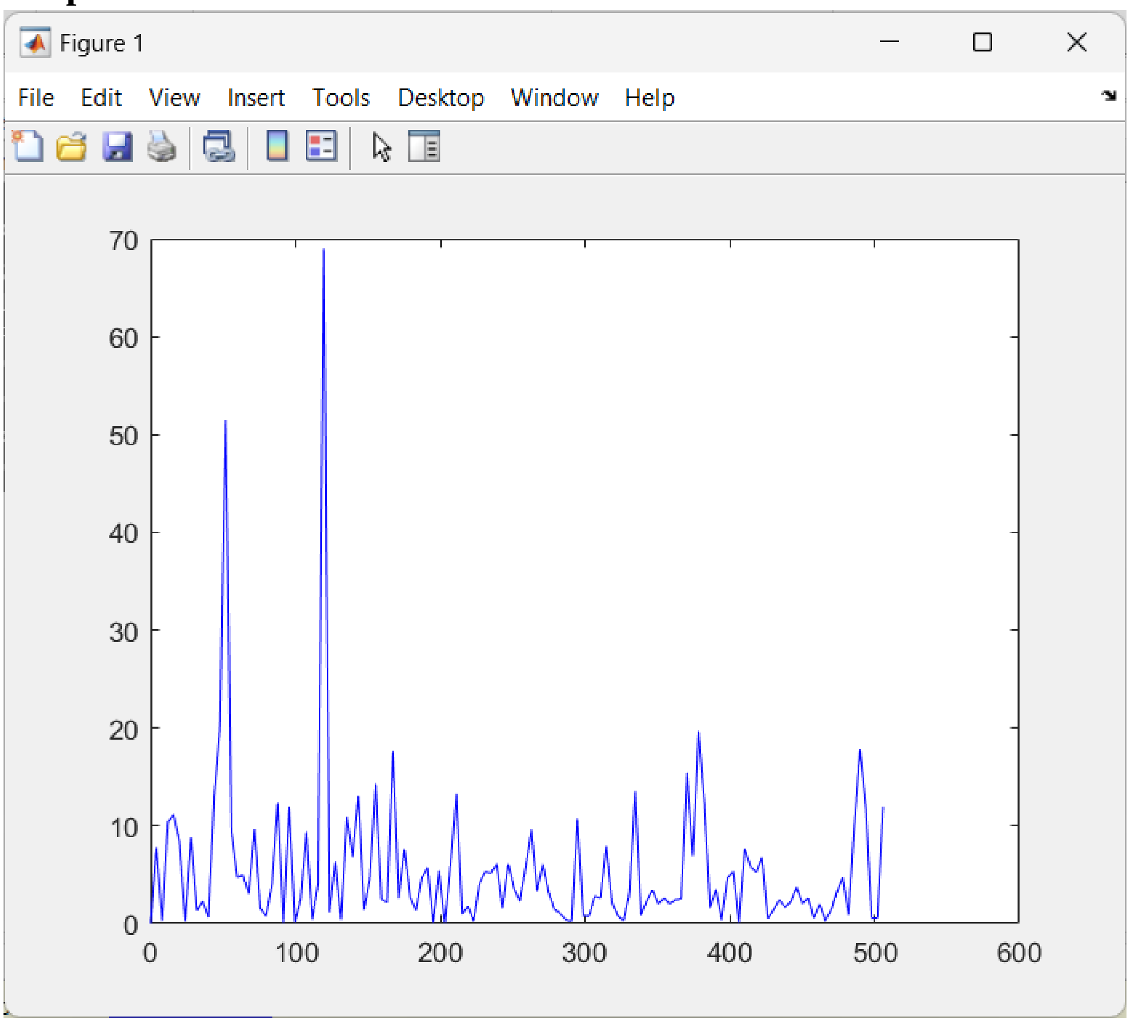


Task 5

Code:

```
figure;
plot(f,Pyy(1:128),'b'); % PSD using complex conjugate
hold on;
plot(w,10*log10(Pyy2),'r--'); % PSD using periodogram
hold off;
xlabel('Frequency (Hz)');
ylabel('Power (V^2/Hz)');
title('Power spectral density of the noisy signal y');
legend('Complex conjugate','Periodogram');
```

Output:



Task 6

Code:

```
% Set the frequency limit
fmax = 200; % Hz

% Find the index of the frequency vector that corresponds to the limit
imax = find(f <= fmax, 1, 'last');

% Plot the PSD of the noisy signal y up to 200 Hz
plot(f(1:imax),Pyy(1:imax))
xlabel('Frequency (Hz)')
ylabel('Power (V^2/Hz)')
title('Power spectral density of the noisy signal y up to 200 Hz')
```

Output: