Beth Israel Deaconess Medical Center

A teaching hospital of Harvard Medical School

WORKSHOP

Linear Analysis
Frequency Component of the Signal

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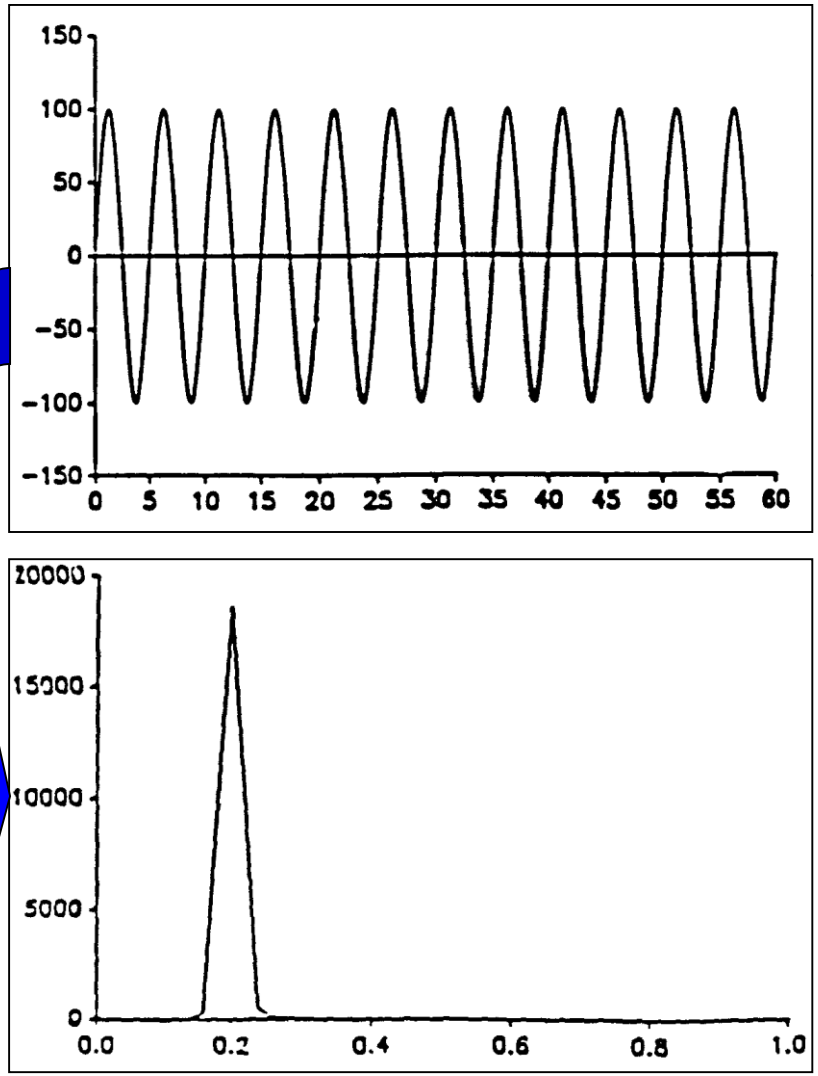
What are the Underlying Rhythms?

Fourier Transform



One rhythm

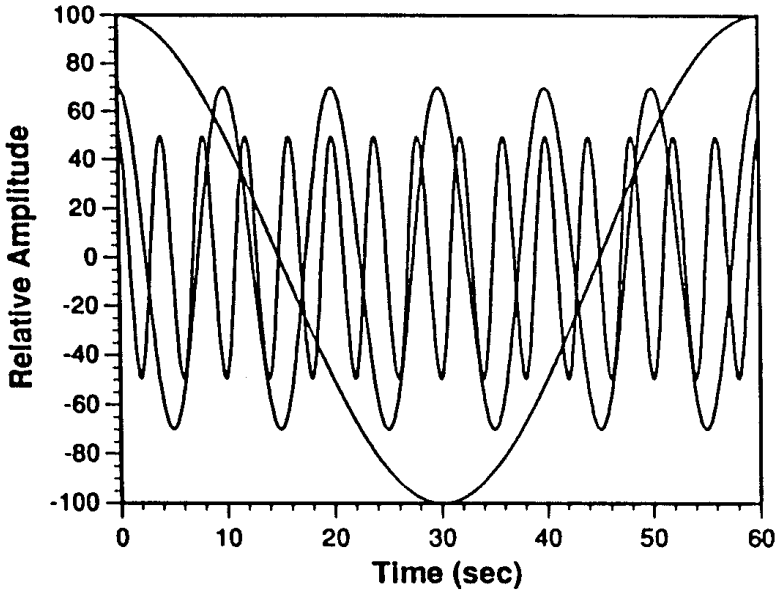
5 seconds/cycle
or
12 times/minute

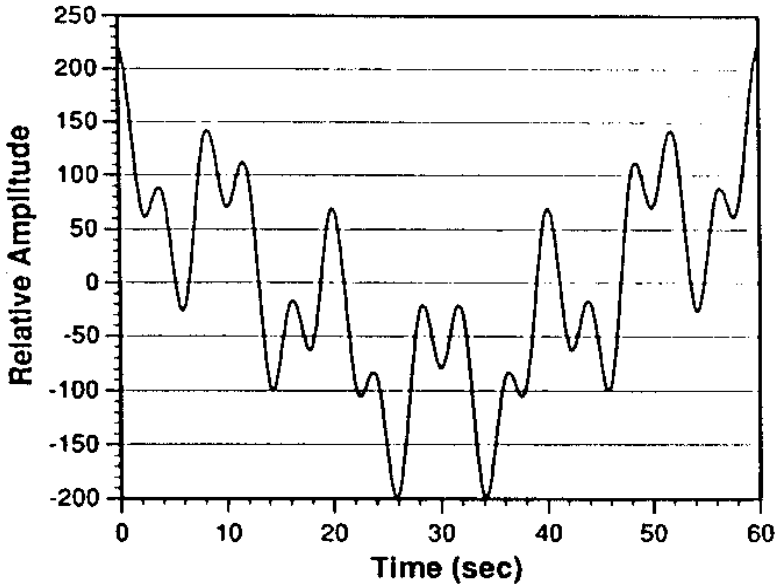
Frequency =

(1/5) cycle/second

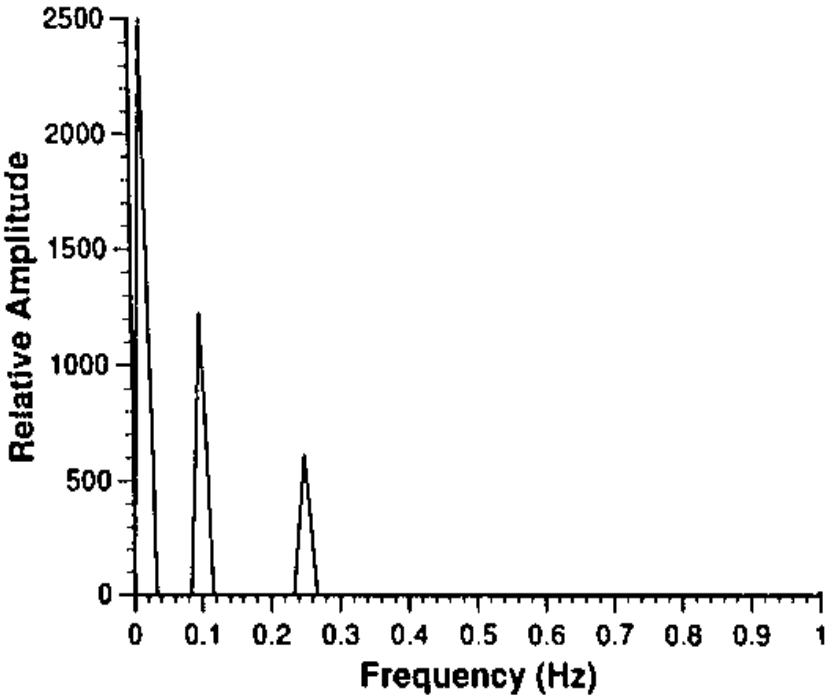
=0.2 Hz

What are the Underlying Rhythms?





What are the Underlying Rhythms?



Three Different Rhythms

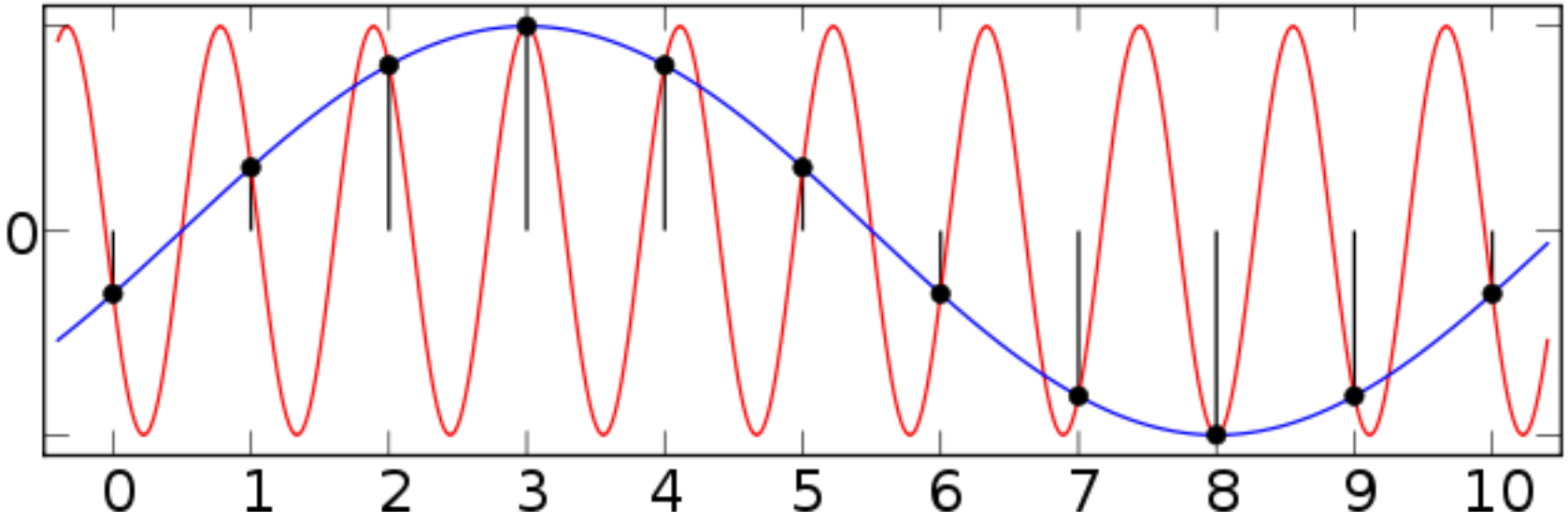
High Frequency = 0.25 Hz
(15 cycles/min)

Low Frequency = 0.1 Hz
(6 cycles/min)

Very Low Frequency = 0.016 Hz
(1 cycle/min)

Aliasing Effect

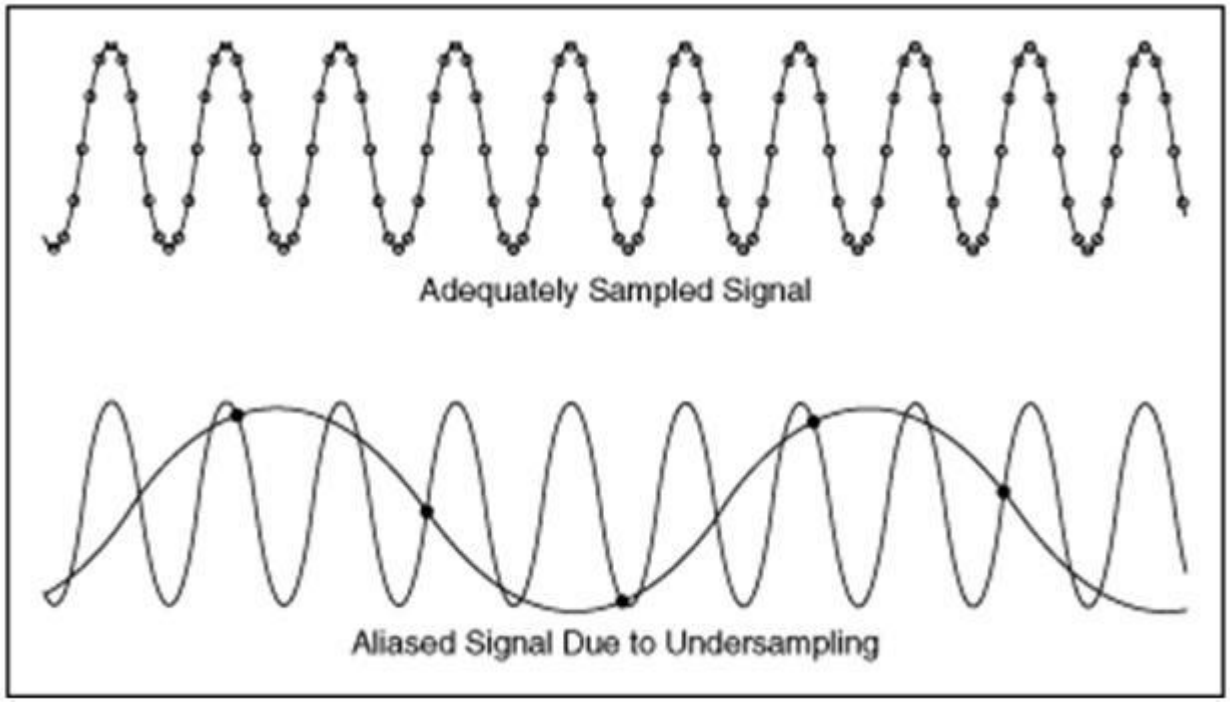
Signal Sampling



Aliasing Effect

Nyquist Criterion

The sampling rate (frequency) has to be at least twice of the highest frequency component in a given signal to capture such frequency band.



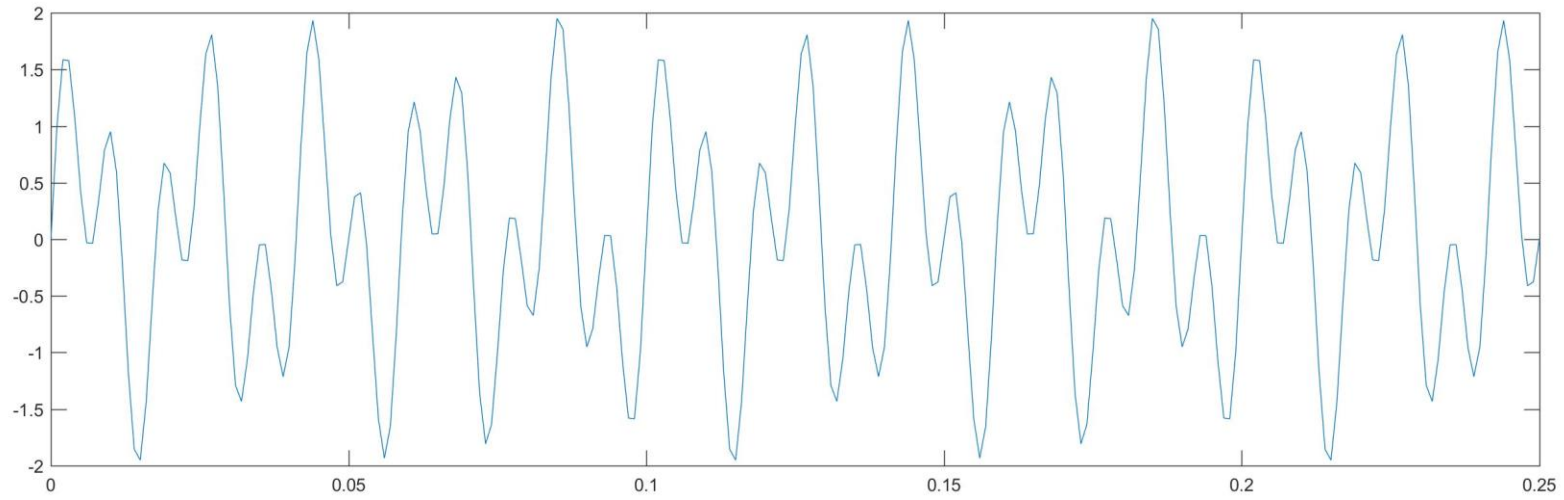
Objective

- Calculate FFT in Matlab

- Function to be learned

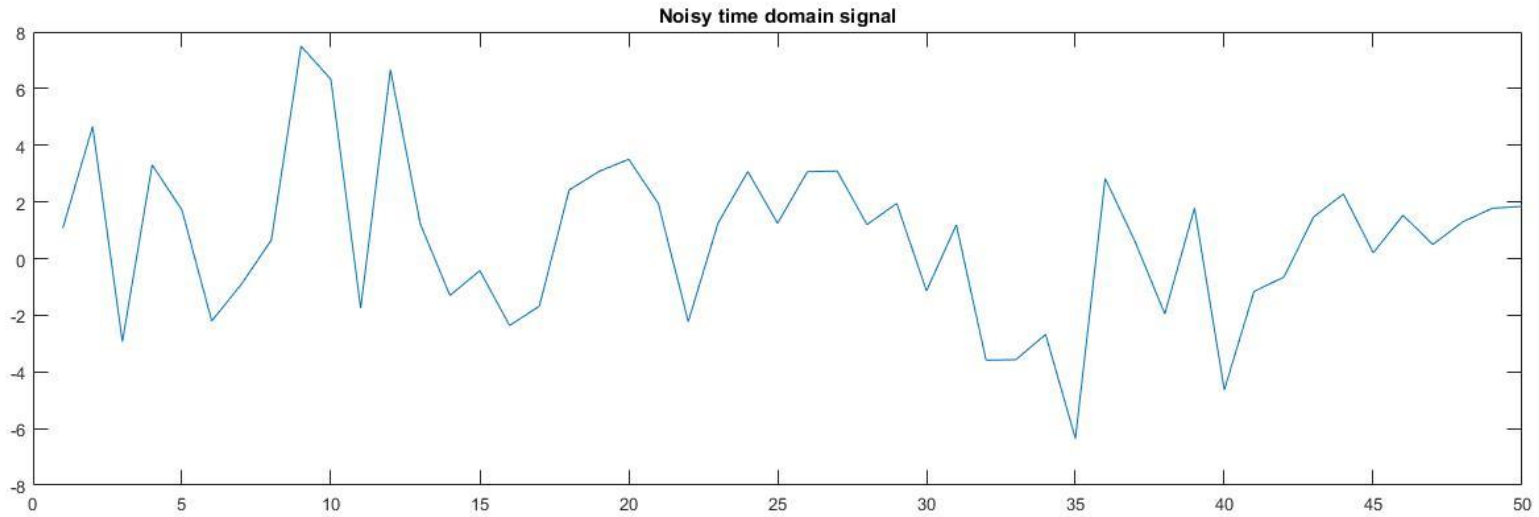
Create Artificial Time Series

- t = 0:.001:.25;
- x = sin(2*pi*50*t) + sin(2*pi*120*t);



Add Some Noise

- y = x + 2*randn(size(t));
- plot(y(1:50))
- title('Noisy time domain signal')



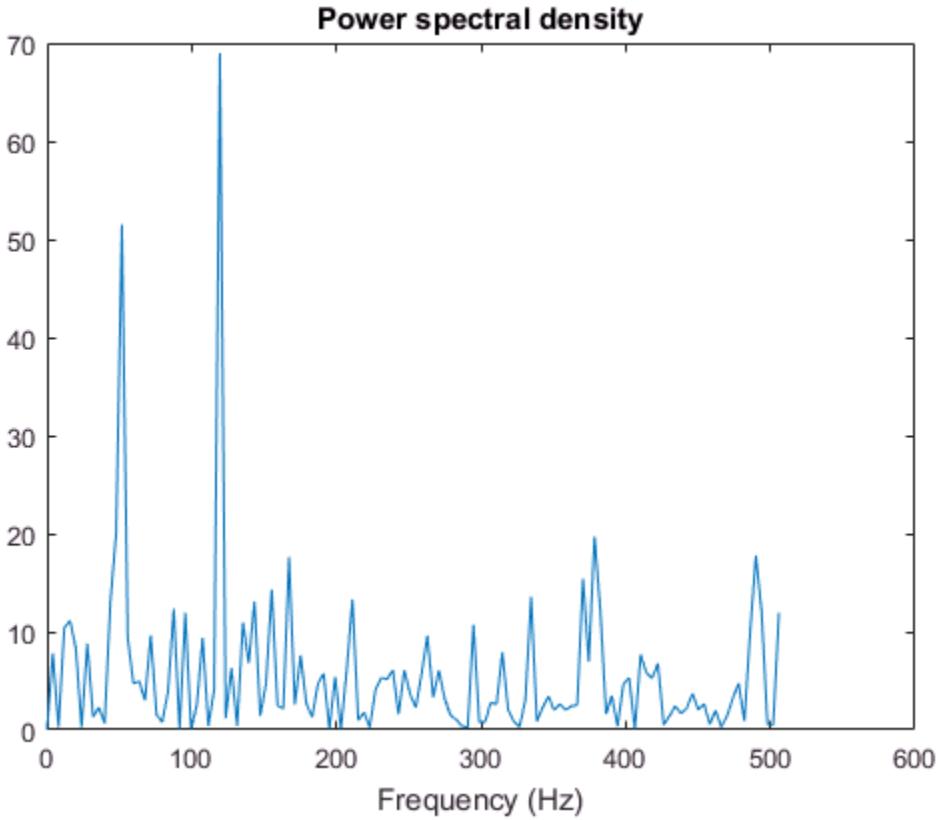
Fast Fourier Transform (FFT)

- Y = fft(y,251);

Determine Spectral Power

- Pyy = Y.*conj(Y)/251;
- f = 1000/251*(0:127);
- plot(f,Pyy(1:128))
- title('Power spectral density')
- xlabel('Frequency (Hz)')

Result of Power Spectral Density



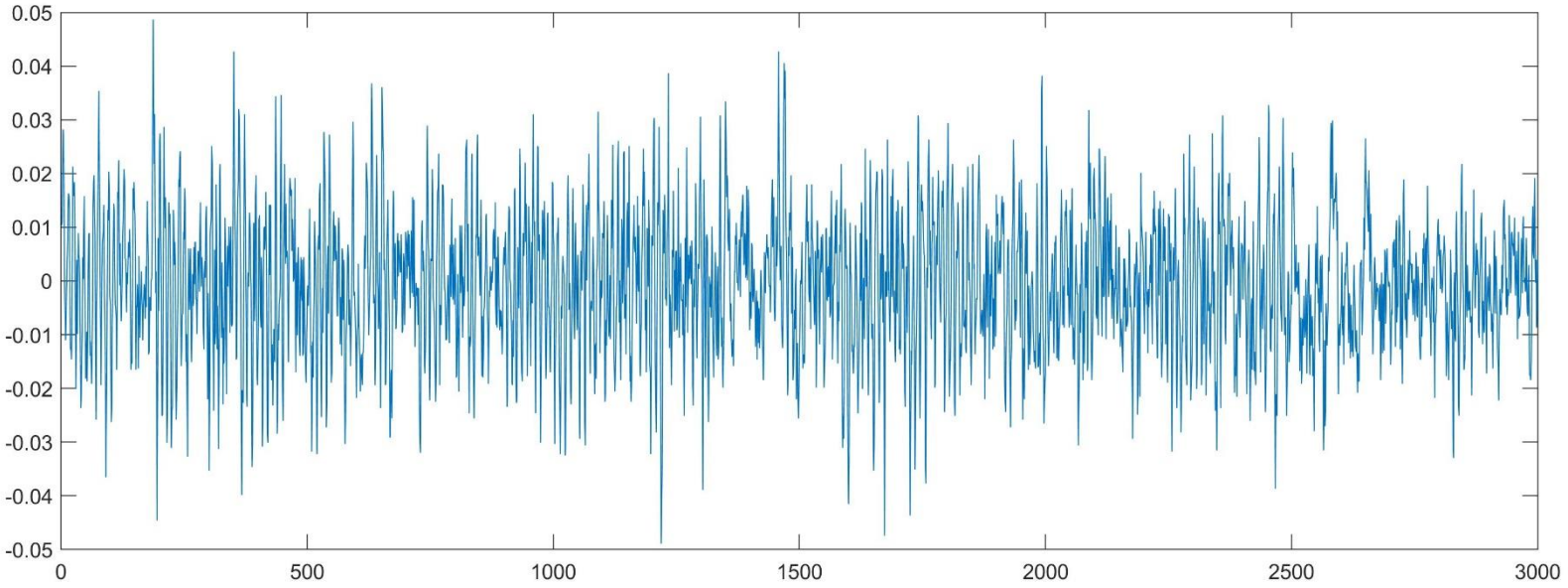
Additional Material

- How to interpolate and resample unevenly sampled time series?

- pwelch function

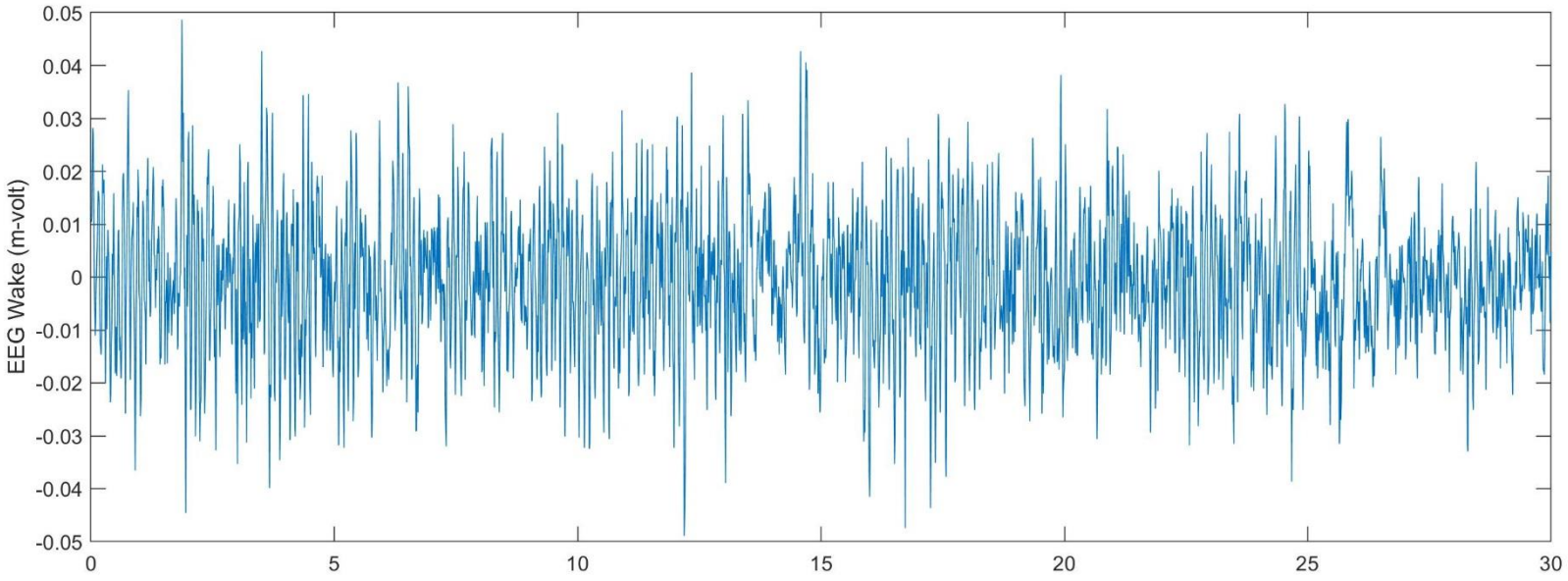
Load EEG Time Series

- eeg_wake = load('EEG_Wake.txt');
- plot(eeg_wake);



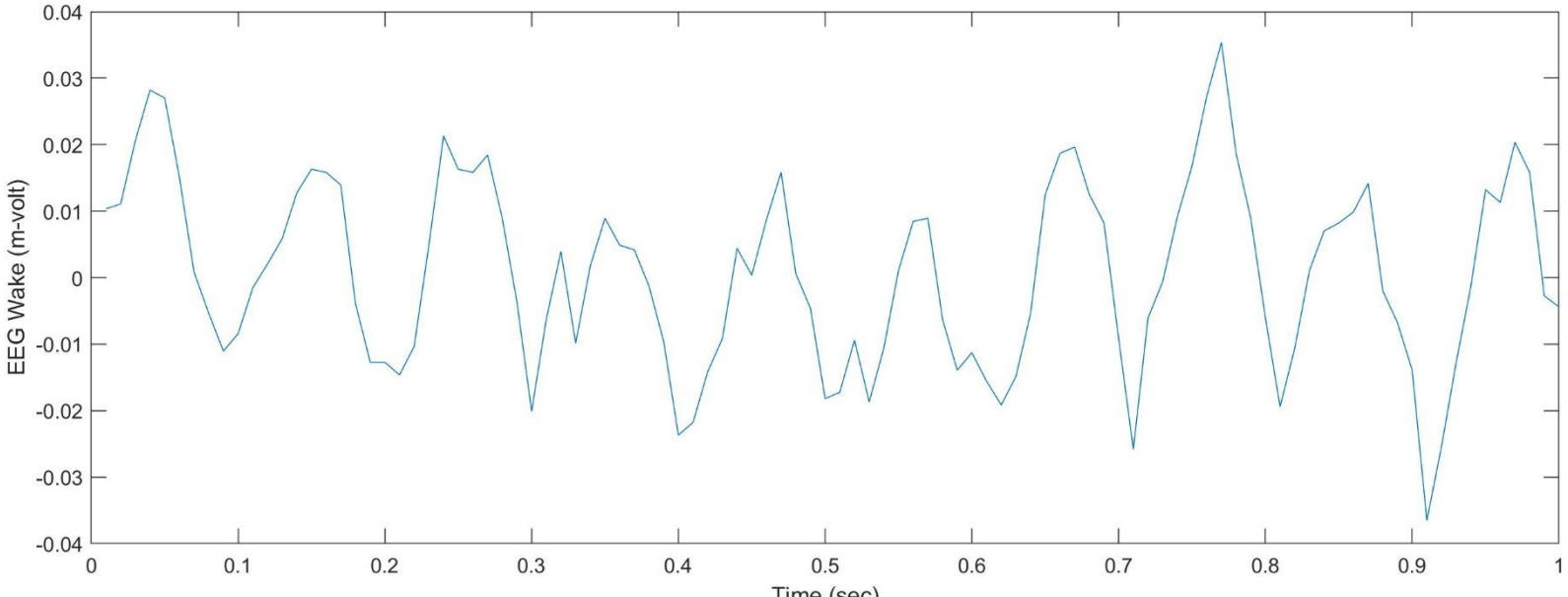
Plot EEG Time Series

- t=1/100:1/100:30;
- plot(t,eeg_wake);
- xlabel('Time (sec)');
- ylabel('EEG Wake (m-volt)');



Zoom into the Time Series

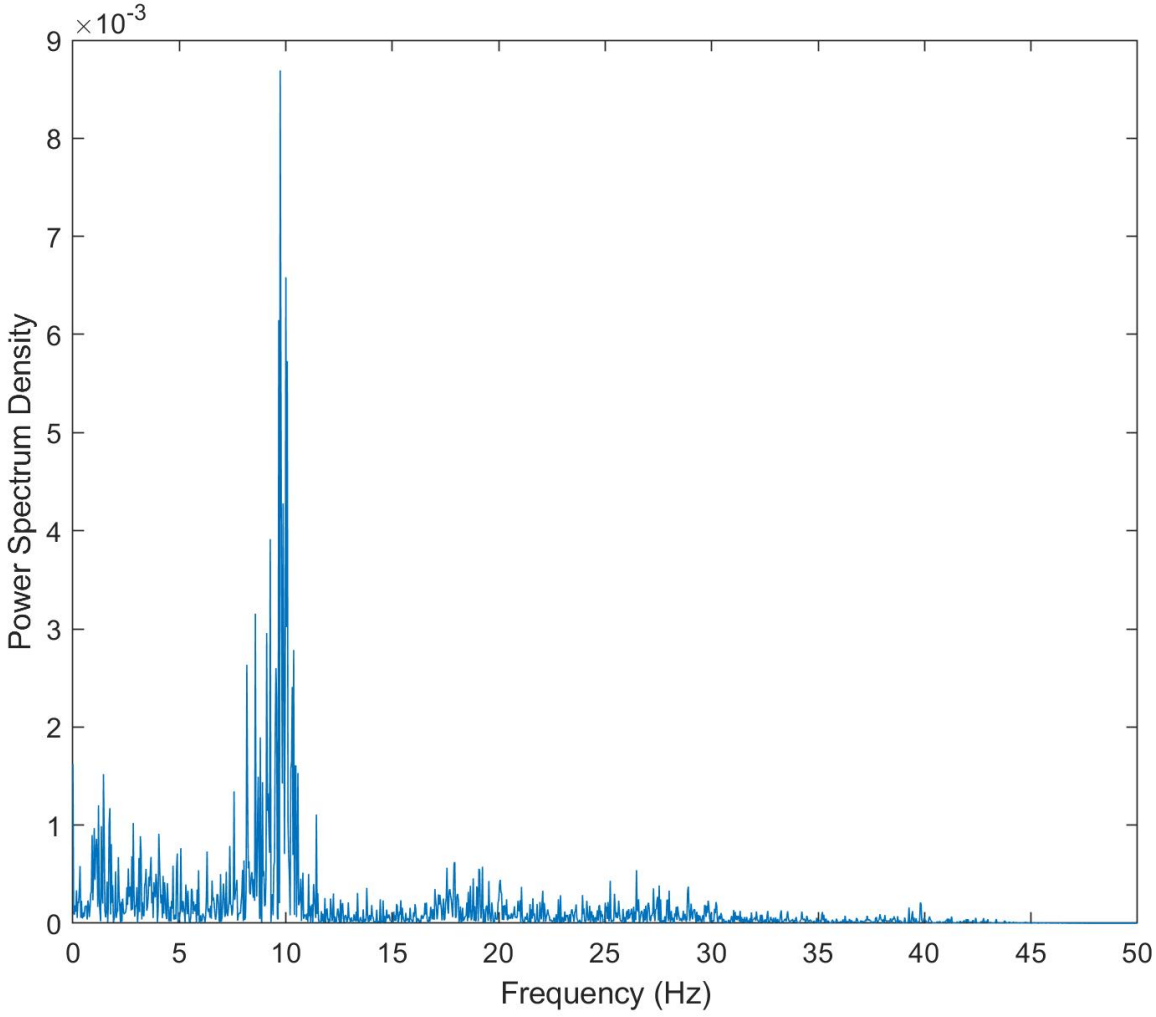
- t=1/100:1/100:1;
- plot(t,eeg_wake(1:100));
- xlabel('Time (sec)');
- ylabel('EEG Wake (m-volt)');



Fast Fourier Transform (FFT)

- Y = fft(eeg_wake,3000);

Determine Spectral Power

- Pyy = Y.*conj(Y)/3000;
- f = 100/3000*(0:1499);
- plot(f,Pyy(1:1500))
- title('Power spectral density')
- xlabel('Frequency (Hz)')

Result of Power Spectral Density