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BME 413

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Programming Assignment 1

**Question 1:**

1. MATLAB Code to plot sine, cosine, and square waves:

f = 4; %4 Hz frequency

fs = 1000; %sampling frequency

N = 1000; %num sampling points

t = (0:N-1)/fs; %time vector

sine = sin(2\*pi\*f\*t);

sq = square(2\*pi\*f\*t);

cosine = cos(2\*pi\*f\*t);

figure;

plot(sine, 'b'); hold on;

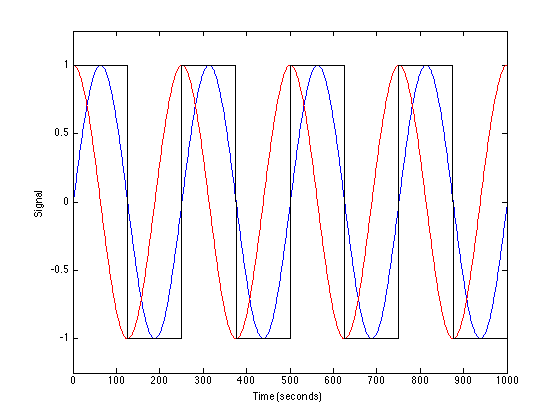
plot(cosine, 'r'); hold on;

plot(sq,'k')

xlabel('Time (seconds)')

ylabel('Signal')

ylim([-1.25 1.25])



1. Calculating signal correlations in MATLAB:

r\_sin = mean(sine.\*sq);

% = 0.6366

r\_cos = mean(cosine.\*sq);

% = 0.0080

By Hand:

**Question 2:**

1. Sampling frequency fs = number of samples / time interval

load dataforEEG.mat

N = length(eeg); %num samples

interval = 16; %16 sec signal

fs = N/interval; %sampling frequency

t = (1:length(eeg))/fs;

1. Cross-Correlation:

rmax = (1:20);

for i=1:20

x = sin(2\*pi\*i\*t);

r = xcorr(eeg,x);

rmax(i) = max(r);

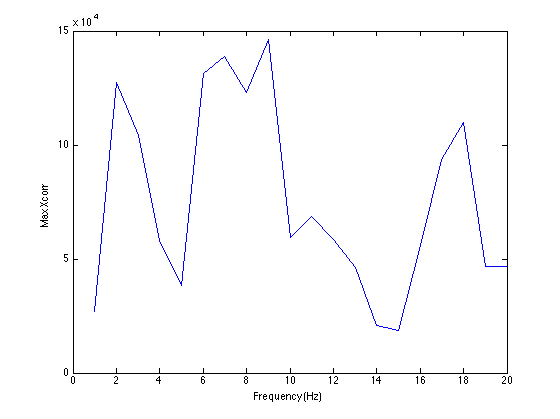
end

figure;

plot(rmax)

xlabel('Frequency (Hz)')

ylabel('Max Xcorr')



1. Looking at the above plot of the maximum value of the cross-correlation at each frequency, there is a peak, the highest peak, within the 7-12 Hz range. This is the alpha wave and indicates that there is maximal correlation with the sinusoidal reference signal within this range of frequencies.

**Question 3:**

1. Plotting Magnitude and Phase Spectrum of Fourier Transform

N = length(resp); %num samples

fs = N / 125; %sampling frequency for 125s interval

f = (1:N)\*fs/N; %frequency vector

X = fft(resp); %complex fourier transform

%only plot spectrum up to 2Hz

index = round(2\*(N/fs));

%plot magnitude

subplot(2,1,1);

plot(f(1:index-1),abs(X(2:index)),'k');

xlabel('Frequency (Hz)');

ylabel('Magnitude');

%unwrap smooths out discontinuities

phase = unwrap(angle(X));

%plot phase

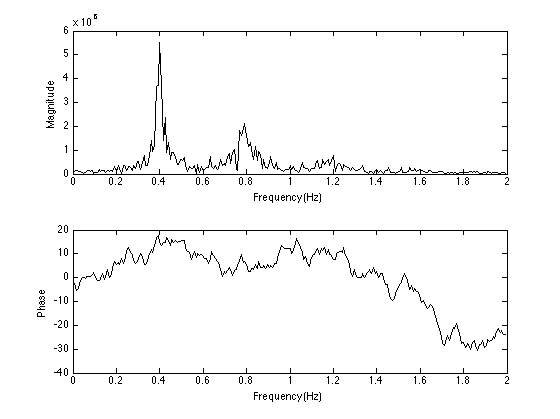
subplot(2,1,2);

plot(f(1:index-1),phase(2:index),'k');

xlabel('Frequency (Hz)');

ylabel('Phase');

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1. To find the breaths per minute, first find the breathing frequency based on the argmax of the frequency magnitude spectrum. The time it takes to make one breath is 1 divided by this frequency, which is 2.5 seconds. To obtain the number of breaths per min, calculate how many 2.5 second breaths can be made within a 60s interval: 60/2.5 = 24 breaths per minute.

[peak, n\_peak] = max(abs(X(2:index)));

max\_freq = f(n\_peak); %breathing frequency

max\_time = 1/max\_freq;

breaths\_per\_minute = 60 / max\_time;

% = 24 breaths per minute