ABSTRACT

Data Analysis and Extraction for: Data set p300

Zunera Zahid

1. Extract caridac time series signal from the data. show the plot

In order to extract cardiac time series signal from data following steps were used :

1. Loading data set into workspace, Squeezing the Signal
2. Saving the reduced data
3. Method 1: Using bandpass filter function with frequency 0.8 1.2
4. Designing 2nd order filter
5. Plotting square Signal
6. Repeat steps 1-5 for each data set train/test
7. Repeat steps 1-5 for both subjects A and B

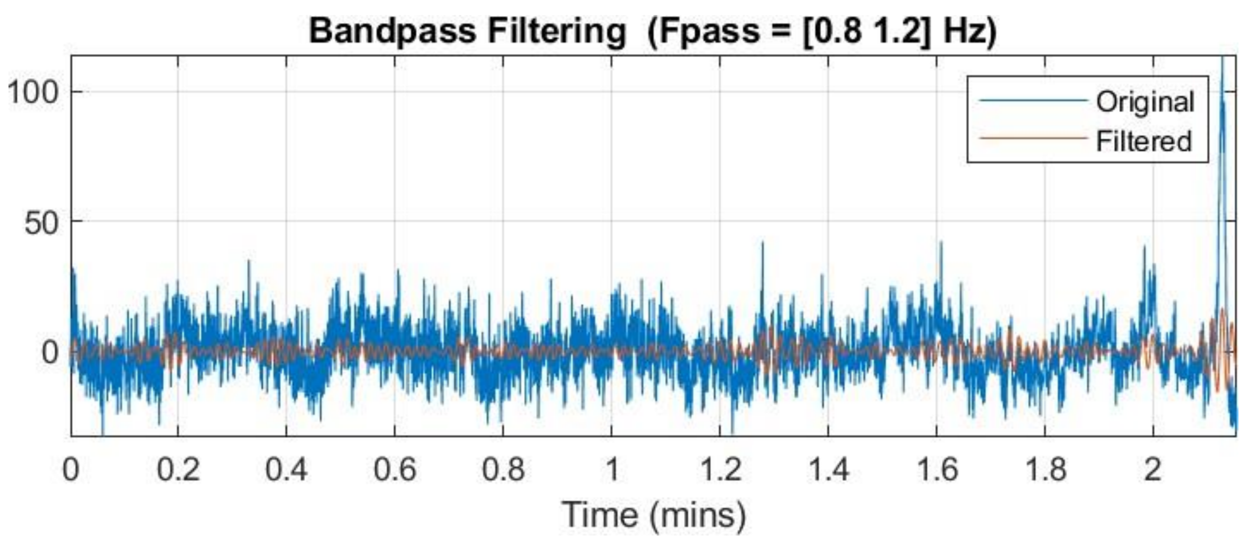
Matlab Commands Subject A:

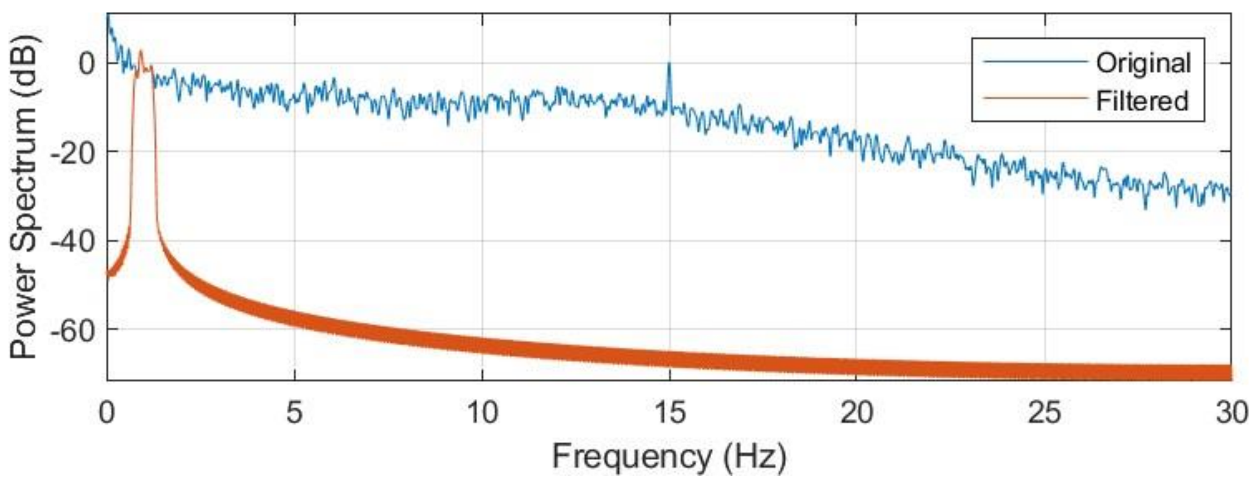
```
load('Subject_A_Train.mat') % Loading data set A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_P5 = squeeze(Signal(1,39:end,1))
figure(1)
bandpass(singleStimulus_P5,[0.8 1.2],fs)

%with normalized frequency
Wp = [1.2   20]/Fn;                                   % Passband Frequency (Normalised)
Ws = [0.8   21]/Fn;                                   % Stopband Frequency (Normalised)
Rp =    1;                                            % Passband Ripple (dB)
Rs = 150;                                             % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                       % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                            % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                          % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);   % Filter Signal
```

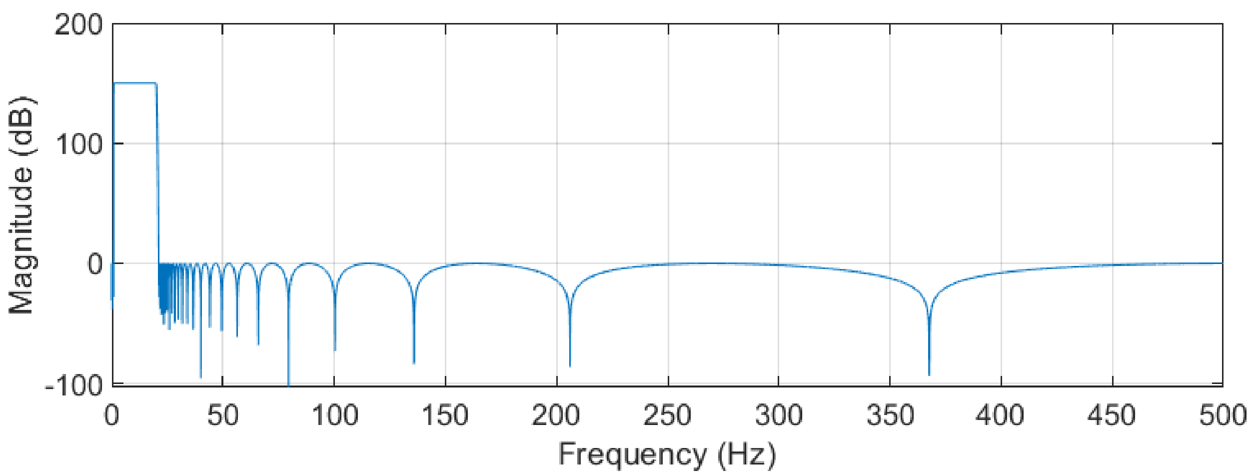
Matlab Commands Subject B:

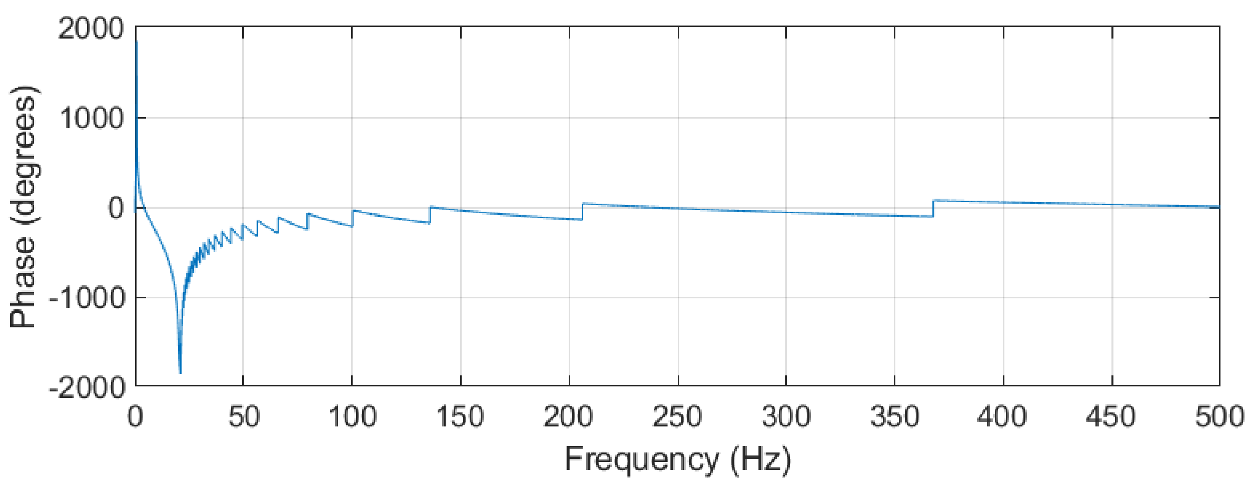
```
load('Subject_B_Train.mat') % Loading data set B
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_P5 = squeeze(Signal(1,39:end,1))
figure(1)
bandpass(singleStimulus_P5,[0.8 1.2],fs)

Fs = 1000;                                              % Setting the frequency to 60 Hz
Fn = Fs/2;                                             % Setting value for Nyquist

%with normalized frequency
Wp = [1.2   20]/Fn;                                    % Passband Frequency (Normalised)
Ws = [0.8   21]/Fn;                                    % Stopband Frequency (Normalised)
Rp =   1;                                              % Passband Ripple (dB)
Rs = 150;                                              % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                        % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                             % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                           % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                 % Filter Bode Plot
% filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);    % Filter Signal
```

Plots Subject A :




Original
Filtered
Power Spectrum (dB)
Frequency (Hz)


Magnitude (dB)
Frequency (Hz)


Phase (degrees)
Frequency (Hz)

2. Extract Respiratory time series data. Show the plot.

In order to extract respiratory time series signal from data following steps were used :

1. Loading data set into workspace, Squeezing the Signal
2. Saving the reduced data
3. Method 1: Using bandpass filter function with frequency 0.3 0.6
4. Designing 2nd order filter
5. Plotting square Signal
6. Repeat steps 1-5 for each data set train/test
7. Repeat steps 1-5 for both subjects A and B

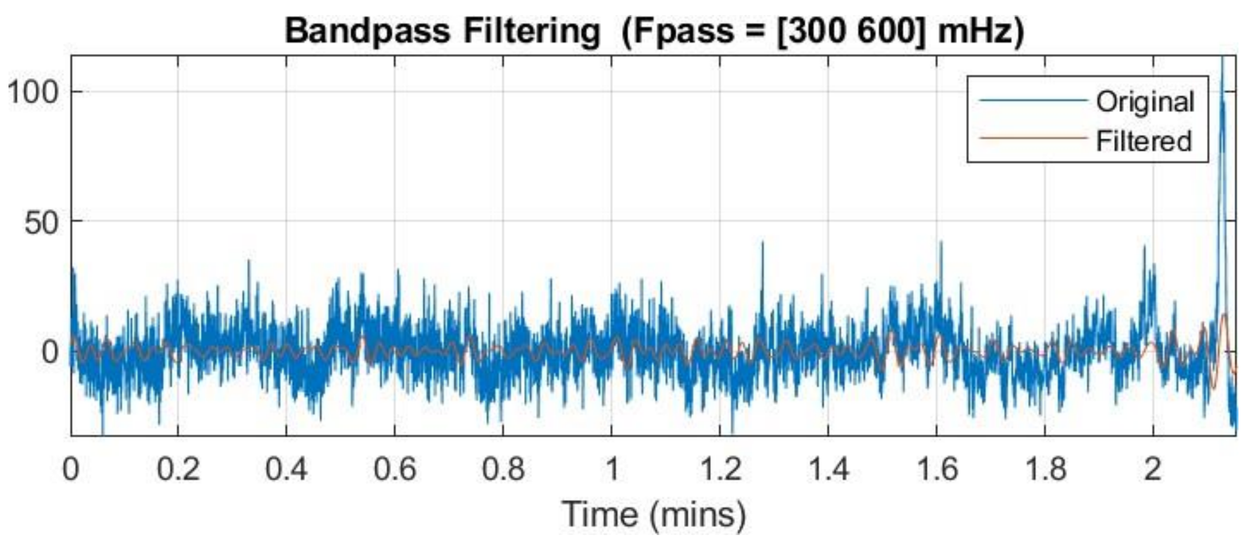
Matlab Commands Subject A:

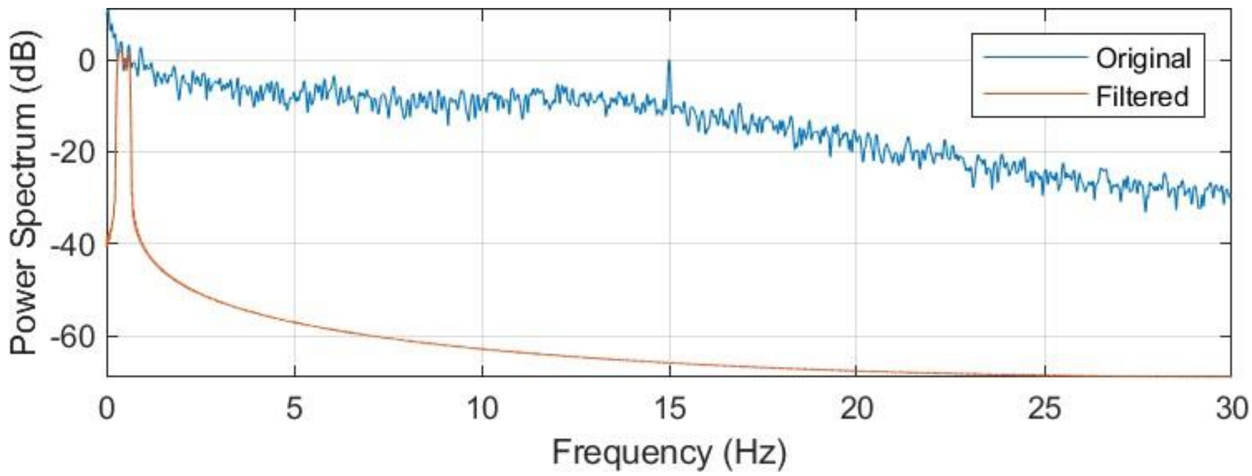
```
load('Subject_A_Train.mat') % Loading data set A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_P5 = squeeze(Signal(1,39:end,1))
figure(1)
bandpass(singleStimulus_P5,[0.3 0.6],fs)

%with normalized frequency
Wp = [0.3   20]/Fn;                             % Passband Frequency (Normalised)
Ws = [0.6   21]/Fn;                             % Stopband Frequency (Normalised)
Rp =   1;                                       % Passband Ripple (dB)
Rs = 150;                                       % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                 % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                      % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                    % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                          % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);    % Filter Signal
```

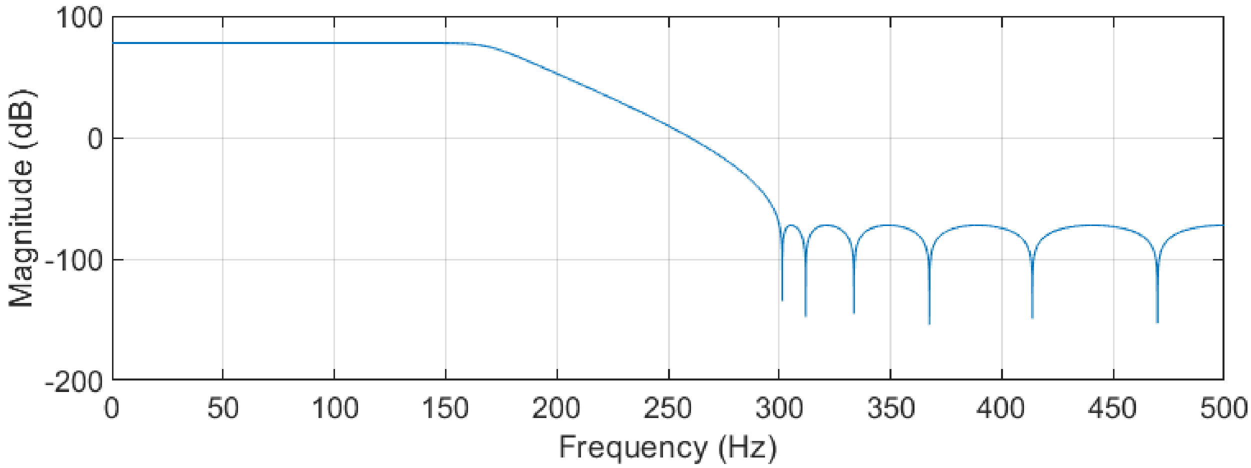
Matlab Commands Subject B:

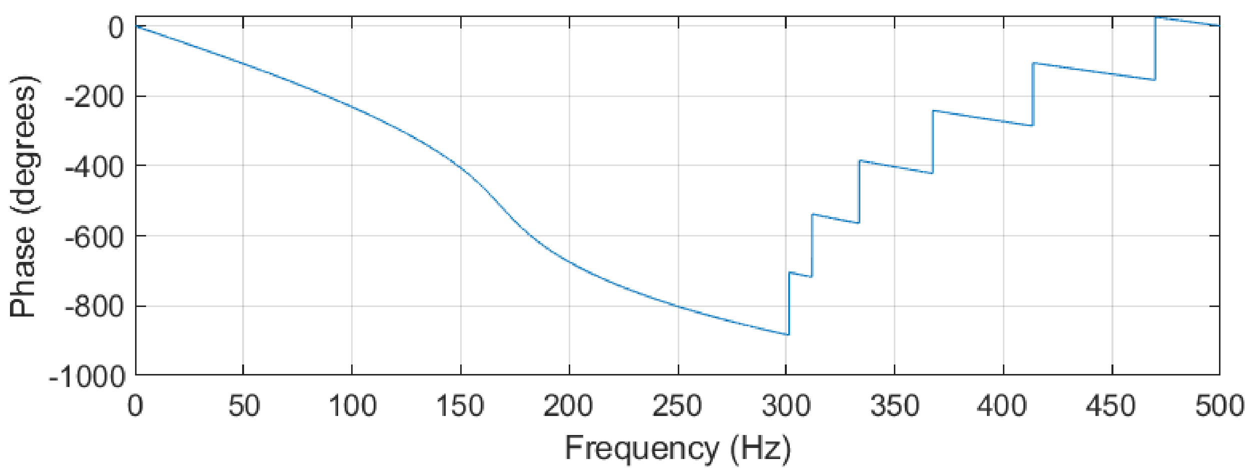
```
load('Subject_B_Train.mat') % Loading data set B
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_P5 = squeeze(Signal(1,39:end,1))
figure(1)
bandpass(singleStimulus_P5,[0.3 0.6],fs)

Fs = 1000;                                              % Setting the frequency to 60 Hz
Fn = Fs/2;                                             % Setting value for Nyquist

%with normalized frequency
Wp = [0.3   20]/Fn;                                    % Passband Frequency (Normalised)
Ws = [0.6   21]/Fn;                                    % Stopband Frequency (Normalised)
Rp =   1;                                              % Passband Ripple (dB)
Rs = 150;                                              % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                        % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                             % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                           % Convert To Second-Order-Section
For Stability
figure(3)
freqz(sosbp, 2^16, Fs)                                 % Filter Bode Plot
% filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);    % Filter Signal
```

Plots Subject A :




Power Spectrum (dB)
0
-20
-40
-60
0
5
10
15
20
25
30
Frequency (Hz)
Original
Filtered


Magnitude (dB)
100
0
-100
-200
0
50
100
150
200
250
300
350
400
450
500
Frequency (Hz)

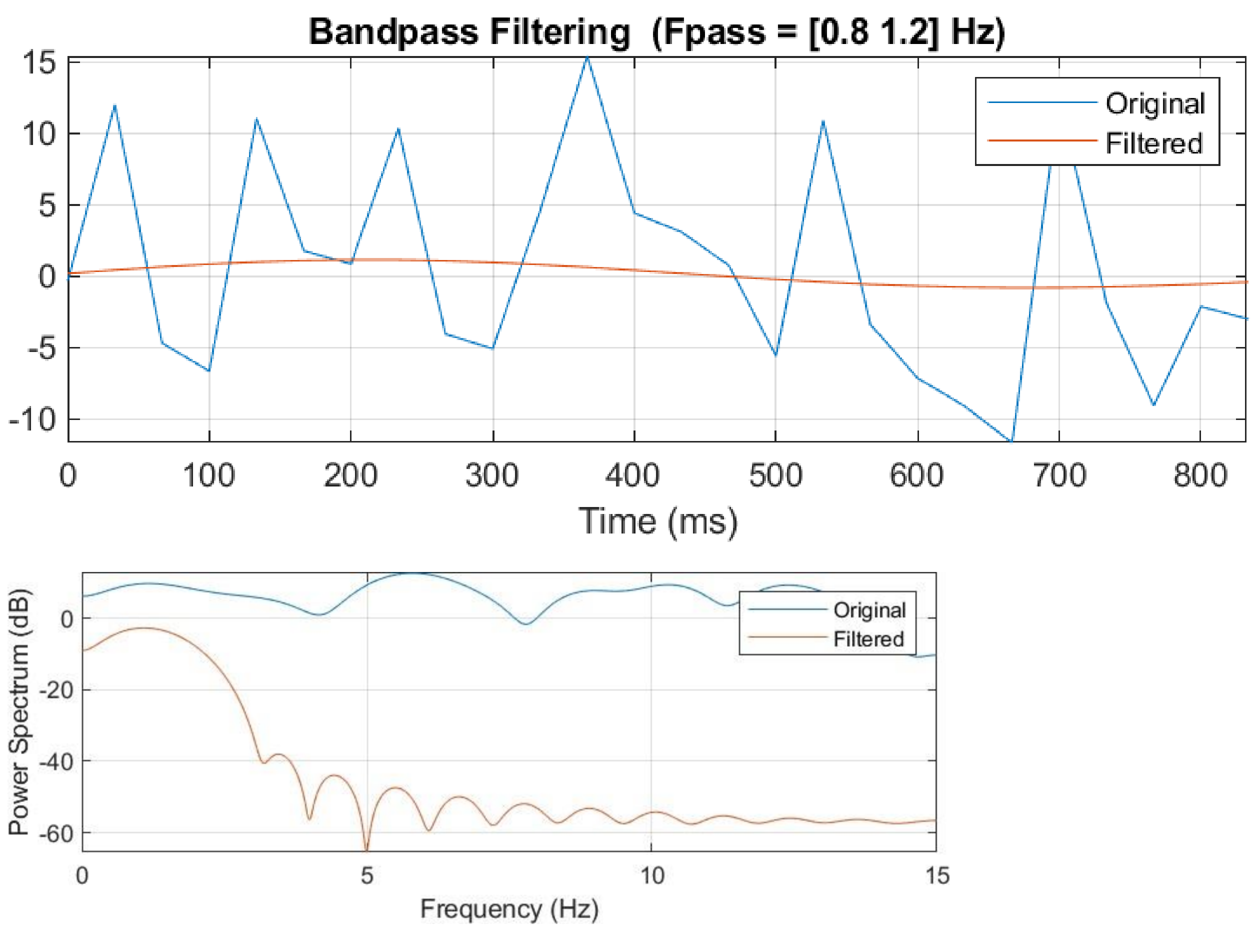

Phase (degrees)
0
-200
-400
-600
-800
-1000
0
50
100
150
200
250
300
350
400
450
500
Frequency (Hz)

3. Filter the signals and find the different bands corresponding to the mentioned tasks.

Matlab Commands :

```
load('Subject_A_Train.mat') % Loading data set A
fs= 60; % Setting the frequency to 60 Hz
% points from Subject A, channel 5, trial 3 48,49,53,54
singleStimulus_Train_A_P5 = squeeze(Signal(1,48,39:end,1))
singleStimulus_Train_A_P3 = squeeze(Signal(1,49,39:end,1))
singleStimulus_Train_A_P4 = squeeze(Signal(1,53,39:end,1))
singleStimulus_Train_A_P6 = squeeze(Signal(1,54,39:end,1))
N=length(singleStimulus_Train_A_P5); % Get length
t=(0:N-1)/fs; % Generating time vector
singleStimulus_Train_A_parietal_avg=(singleStimulus_Train_A_P5+single
Stimulus_Train_A_P3+singleStimulus_Train_A_P4+singleStimulus_Train_A_
P6)/4
figure(2)
bandpass(singleStimulus_Train_A_parietal_avg,[0.8 1.2],fs/2)
```

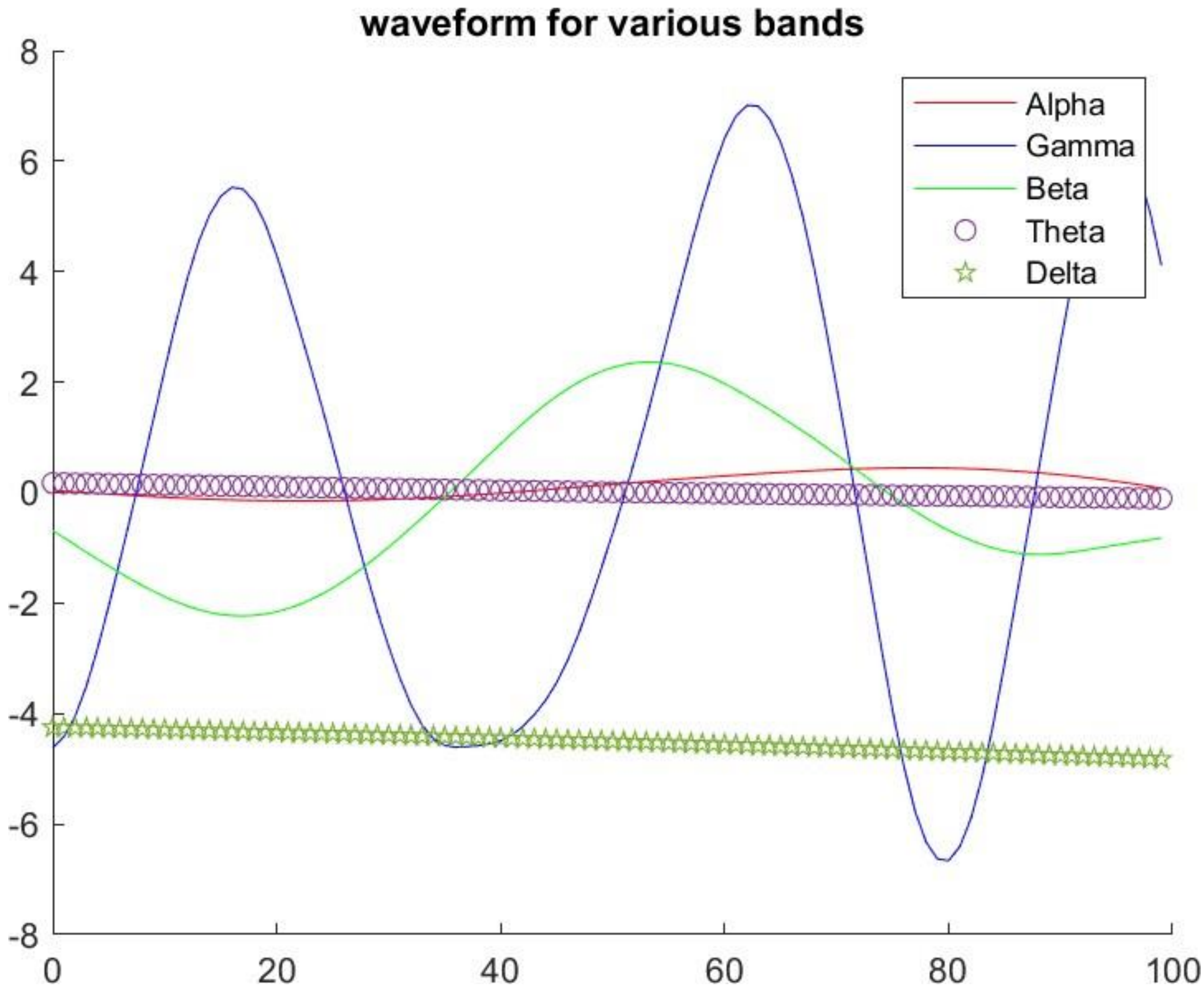
Plots



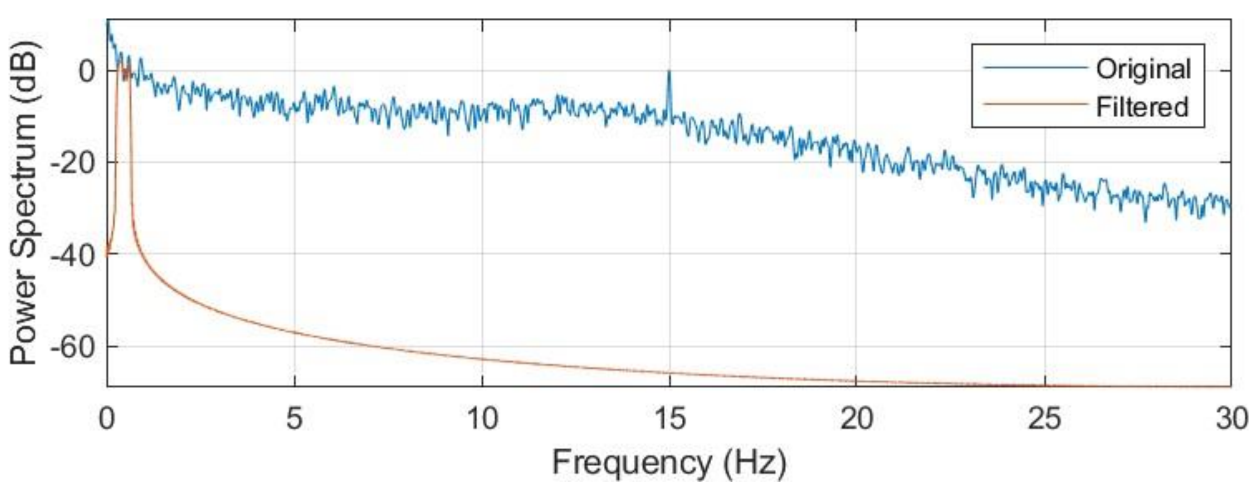
4. Extimate the power spectrum of the and lable the compoenets corresponding to activitiies.

Matlab Commands : Power spectrum made in part 1, Coefficients code and plot

```
load('Subject_A_Train.mat') % Loading data set A
column2 = Signal;
out = reshape(column2(1:100), [], 1)
S=out;
waveletFunction = 'db8';
[ZZ,LE] = wavedec(S,8,waveletFunction);
%%Coffiecient Vectors
cofD1 = detcoef(ZZ,LE,1);                    %NOISE
cofD2 = detcoef(ZZ,LE,2);                    %NOISE
cofD3 = detcoef(ZZ,LE,3);                    %NOISE
cofD4 = detcoef(ZZ,LE,4);                    %NOISE
cofD5 = detcoef(ZZ,LE,5);                    %gamma
cofD6 = detcoef(ZZ,LE,6);                    %beta
cofD7 = detcoef(ZZ,LE,7);                    %alpha
cofD8 = detcoef(ZZ,LE,8);                    %theta
cofA8 = appcoef(ZZ,LE,waveletFunction,8);    %delta
% Vectors
D1 = wrcoef('d',ZZ,LE,waveletFunction,1); %noise
D2 = wrcoef('d',ZZ,LE,waveletFunction,2); %noise
D3 = wrcoef('d',ZZ,LE,waveletFunction,3); %npise
D4 = wrcoef('d',ZZ,LE,waveletFunction,4); %noise
Gamma = wrcoef('d',ZZ,LE,waveletFunction,5); %gamma
Beta = wrcoef('d',ZZ,LE,waveletFunction,6); %beta
Alpha = wrcoef('d',ZZ,LE,waveletFunction,7); %alpha
Theta = wrcoef('d',ZZ,LE,waveletFunction,8); %theta
Delta = wrcoef('a',ZZ,LE,waveletFunction,8); %delta
ts=1;
t=0:ts:99;
hold on
plot(t,Alpha,'r','DisplayName','Alpha')
plot(t,Gamma,'b','DisplayName','Gamma')
plot(t,Beta,'g','DisplayName','Beta')
plot(t,Theta,'o','DisplayName','Theta')
plot(t,Delta,'p','DisplayName','Delta')
title('waveform for various bands')
legend
```


waveform for various bands
Alpha
Gamma
Beta
Theta
Delta
8
6
4
2
0
-2
-4
-6
-8
0
20
40
60
80
100

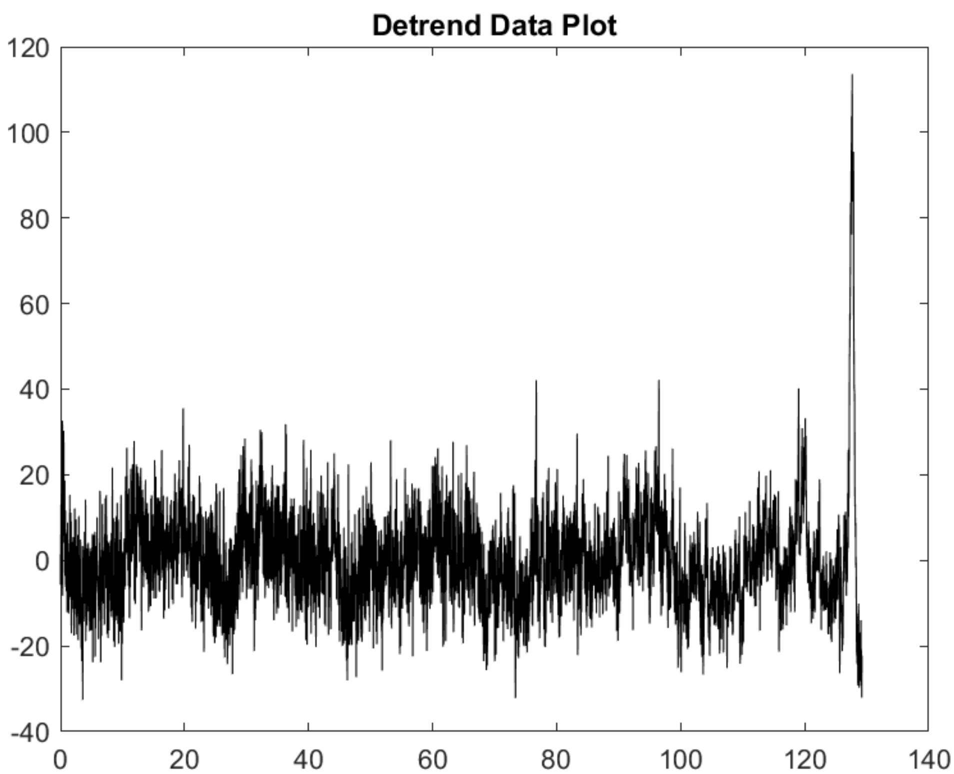
Plots


Power Spectrum (dB)
0
-20
-40
-60
Original
Filtered
0
5
10
15
20
25
30
Frequency (Hz)

5. Detend the signal

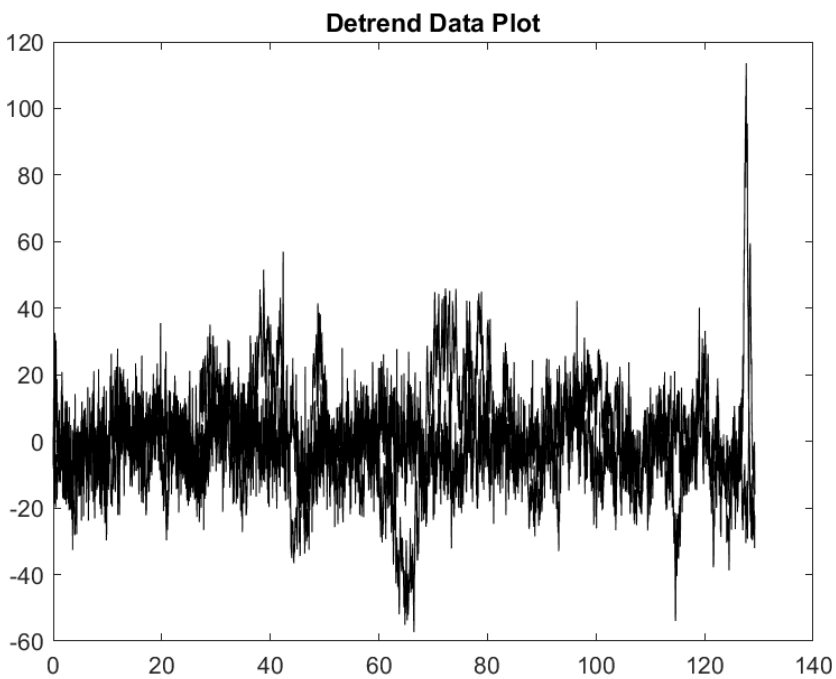
P300 Subject A

```
load('Subject_A_Train.mat') % Loading data set A
%  points from Subject A, channel 5, trial 3 48,49,53,54
singleStimulus_P5 = squeeze(Signal(1,39:end,1))
detrend_sdata = detrend(singleStimulus_P5);
trend = singleStimulus_P5 - detrend_sdata;
mean(detrend_sdata)
frequency_s=60; % Setting the frequency to 60 Hz
N=length(singleStimulus_P5); % Get length of average per 5 trails
t=(0:N-1)/frequency_s; % Generating time vector
plot(t,detrend_sdata,'k');
title('Detrend Data Plot');
```



P300 Subject B

```
load('Subject_B_Train.mat') % Loading data set B
%  points from Subject A, channel 5, trial 3 48,49,53,54
singleStimulus_P5 = squeeze(Signal(1,39:end,1))
detrend_sdata = detrend(singleStimulus_P5);
trend = singleStimulus_P5 - detrend_sdata;
mean(detrend_sdata)
frequency_s=60; % Setting the frequency to 60 Hz
N=length(singleStimulus_P5); % Get length of average per 5 trails
t=(0:N-1)/frequency_s; % Generating time vector
plot(t,detrend_sdata,'k');
title('Detrend Data Plot');
```

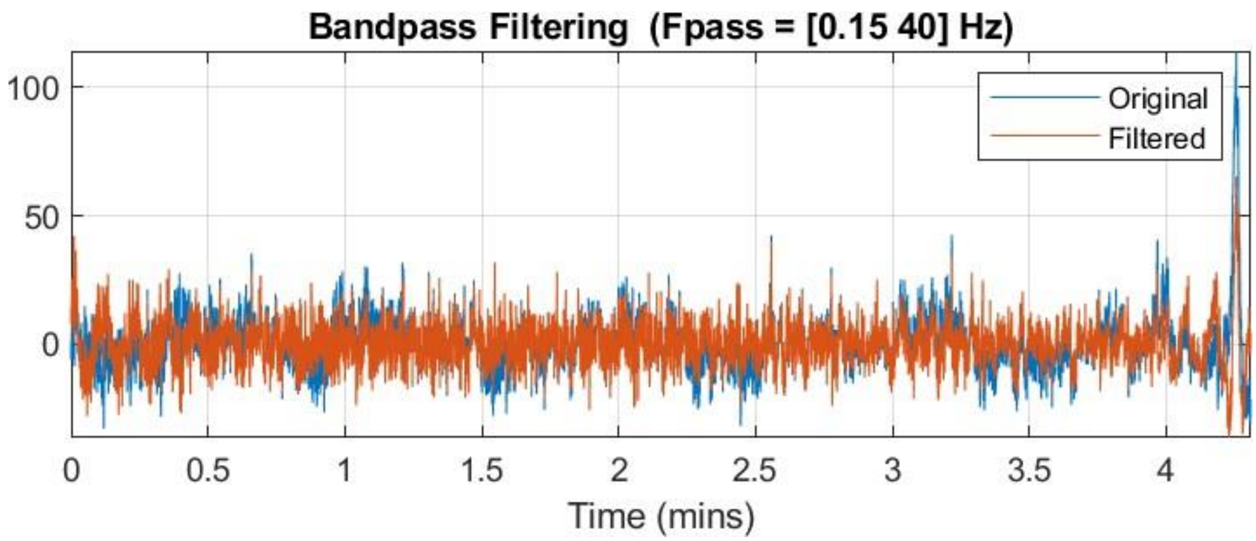


6. Extract P300 or ERP from the signals based on the type of task.

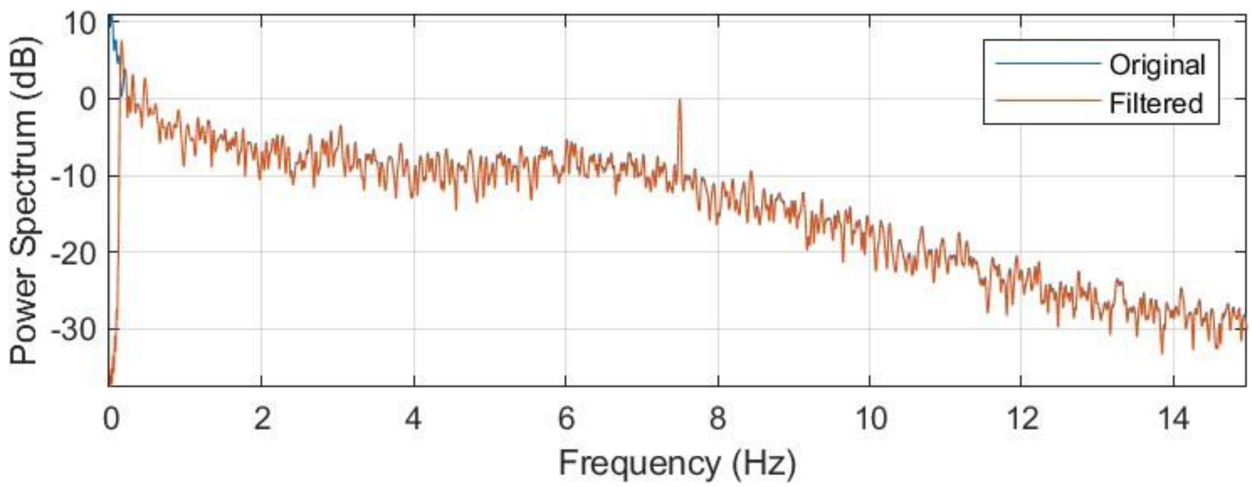
P300 Subject A

```
load('Subject_A_Train.mat') % Loading data set A
fs= 60; % Setting the frequency to 60 Hz
% points from Subject A, channel 5, trial 3 48,49,53,54
singleStimulus_P5 = squeeze(Signal(1,39:end,1))
singleStimulus_Train_A_P5 = squeeze(Signal(1,48,39:end,1))
singleStimulus_Train_A_P3 = squeeze(Signal(1,49,39:end,1))
singleStimulus_Train_A_P4 = squeeze(Signal(1,53,39:end,1))
singleStimulus_Train_A_P6 = squeeze(Signal(1,54,39:end,1))
N=length(singleStimulus_Train_A_P5); % Get length
t=(0:N-1)/fs; % Generating time vector
singleStimulus_Train_A_parietal_avg=(singleStimulus_Train_A_P5+singleStimulus_T
rain_A_P3+singleStimulus_Train_A_P4+singleStimulus_Train_A_P6)/4
figure(1)
bandpass(singleStimulus_P5,[0.15 40],fs/2)
figure(2)
bandpass(singleStimulus_Train_A_parietal_avg,[0.15 40],fs/2)
figure(3)
Y=fft(singleStimulus_P5)

Fs = 1000;              % Sampling frequency
T = 1/Fs;               % Sampling period
t = (0:N-1)*T;          % Time vector
P2 = abs(Y/N);
P1 = P2(1:N/2+1);
P1(2:end-1) = 2*P1(2:end-1);

f = Fs*(0:(N/2))/N;
plot(f,P1)
title('Single-Sided Amplitude Spectrum of Signal(t)')
xlabel('f (Hz)')
ylabel('|P1(f)|')
```

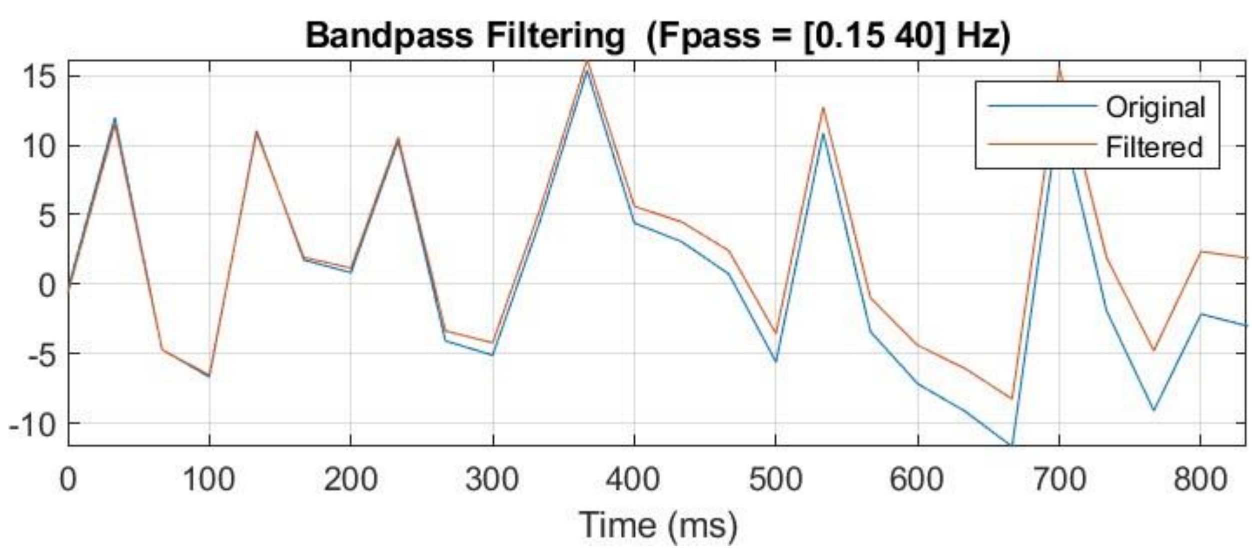
Plots



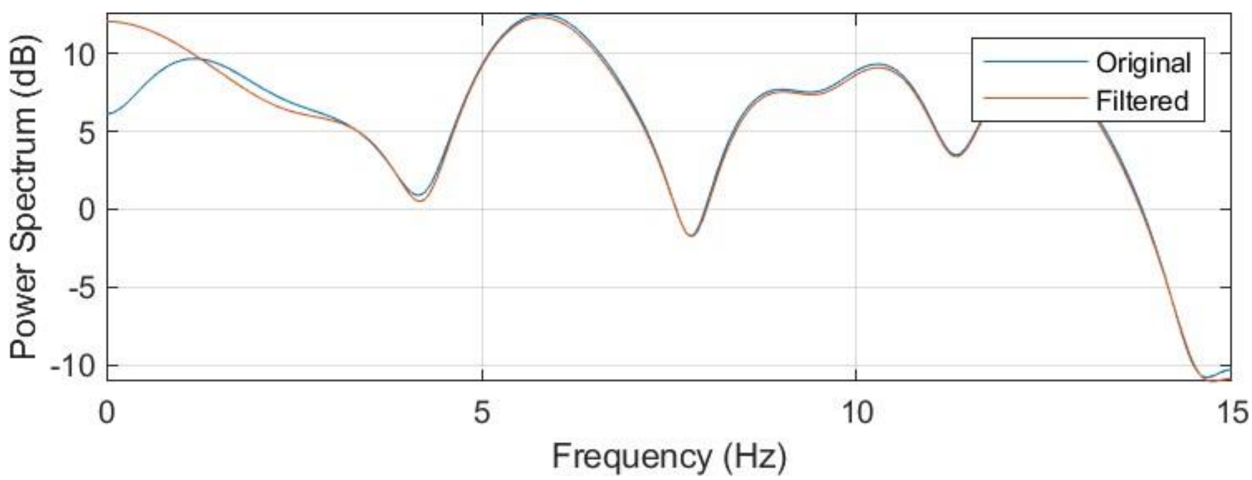
Bandpass Filtering (Fpass = [0.15 40] Hz)
Original
Filtered
100
50
0
0
0.5
1
1.5
2
2.5
3
3.5
4
Time (mins)

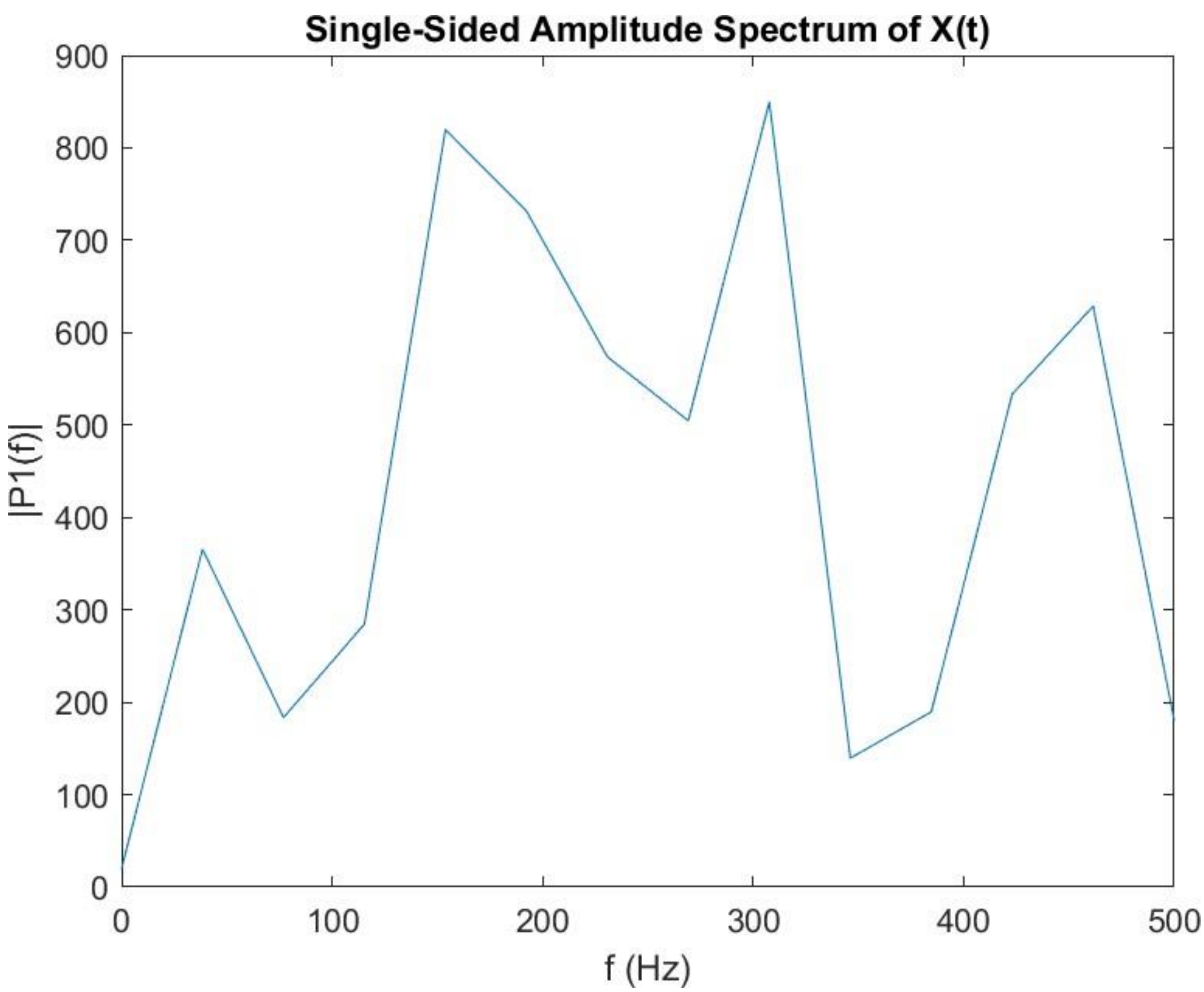


Original
Filtered
10
0
-10
-20
-30
Power Spectrum (dB)
0
2
4
6
8
10
12
14
Frequency (Hz)



Bandpass Filtering (Fpass = [0.15 40] Hz)
Original
Filtered
15
10
5
0
-5
-10
0
100
200
300
400
500
600
700
800
Time (ms)


Power Spectrum (dB)
Frequency (Hz)
Original
Filtered
10
5
0
-5
-10
0
5
10
15


Single-Sided Amplitude Spectrum of X(t)
|P1(f)|
f (Hz)
900
800
700
600
500
400
300
200
100
0
0
100
200
300
400
500

ASSIGNMENT 3

PART 2

Bio Robotics

ABSTRACT

Data Analysis and Extraction for: Data set p3a

Zunera Zahid

00000359368

1. Extract caridac time series signal from the data. show the plot

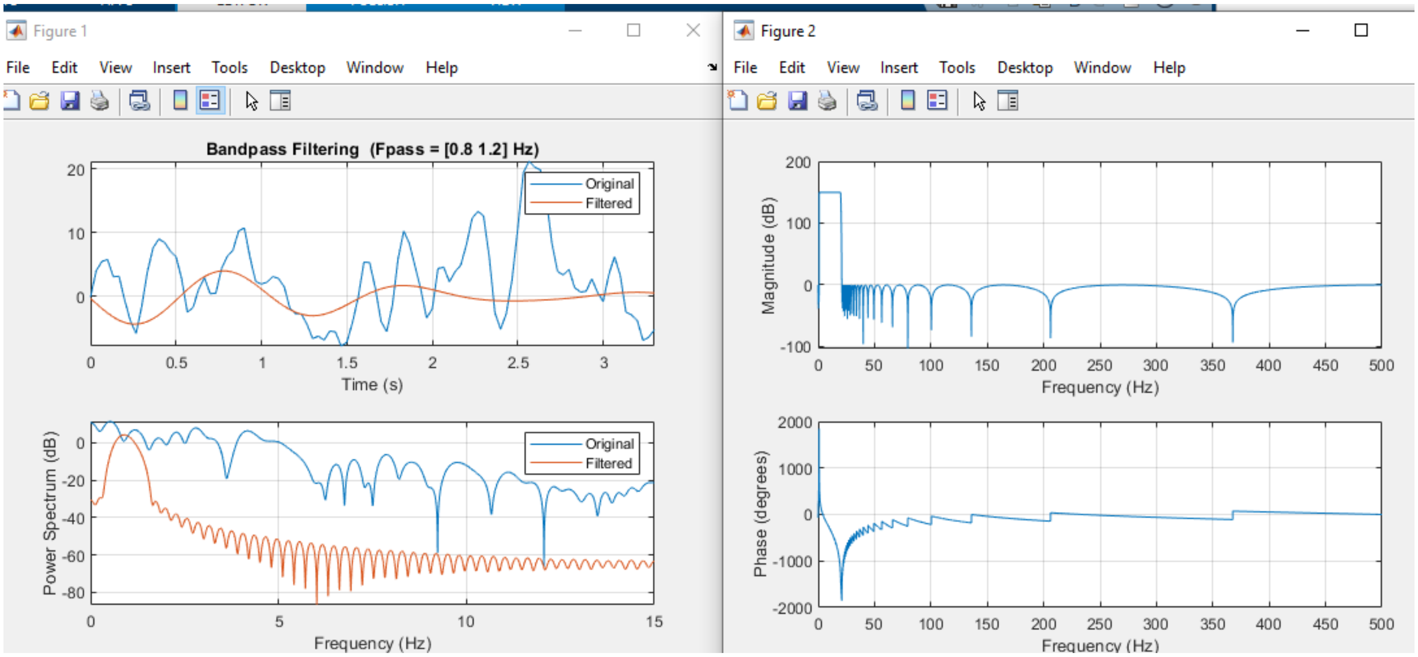
In order to extract cardiac time series signal from data following steps were used :

8. Loading data set into workspace, Squeezing the Signal
9. Saving the reduced data
10. Method 1: Using bandpass filter function with frequency 0.8 1.2
11. Designing 2nd order filter
12. Plotting square Signal
13. Repeat steps 1-5 for each data set train/test
14. Repeat steps 1-5 for both subjects A and B and C

Matlab Commands Subject A:

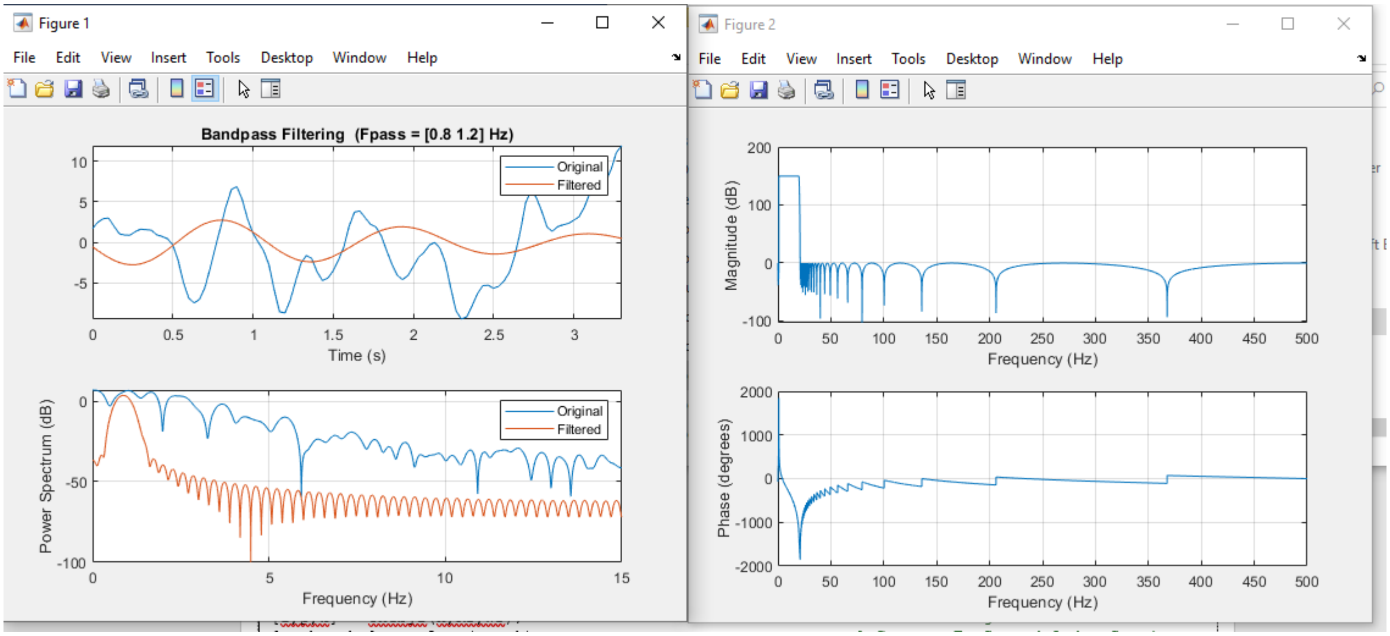
```
load('k3b.mat') % Loading data 3a Subject A
column2 = s;
out = reshape(column2(1:100), [], 1)
N=length(out); % Get length
frequency_s=1000; % Setting the frequency to 60 Hz
t=(0:N-1)/frequency_s; % Generating time vector
means5 = mean(out, 2)
figure(1)
bandpass(means5,[0.8 1.2],fs/2)
hold on
Fs = 1000;                                    % Setting the frequency to 60 Hz
Fn = Fs/2;                                   % Setting value for Nyquist
Frequency (Hz)
Wp  =  [1.2  20]/Fn;                         % Passband Frequency (Normalised)
Ws  =  [0.8  21]/Fn;                         % Stopband Frequency (Normalised)
Rp =  1;                                     % Passband Ripple (dB)
Rs = 150;                                    % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);              % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                   % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                 % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                       % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);    % Filter Signal
```

Plots Subject A:



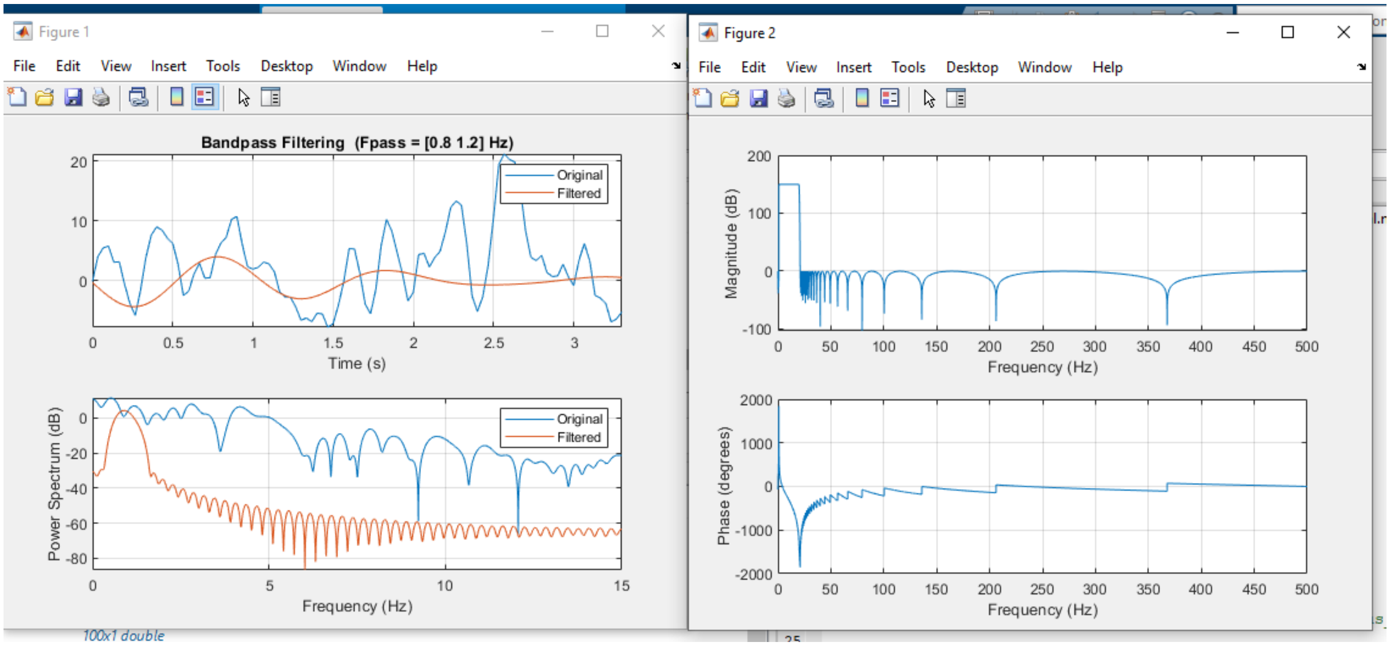
Matlab Commands Subject B:

```
load('k6b.mat') % for Subject B and comment rest of data files

load('k3b.mat') % Loading data 3a Subject A
column2 = s;
out = reshape(column2(1:100), [], 1)
N=length(out); % Get length
frequency_s=1000; % Setting the frequency to 60 Hz
t=(0:N-1)/frequency_s; % Generating time vector
means5 = mean(out, 2)
figure(1)
bandpass(means5,[0.8 1.2],fs/2)
hold on
Fs = 1000;                                                  % Setting the frequency to 60 Hz
Fn = Fs/2;                                                 % Setting value for Nyquist
Frequency (Hz)
Wp  =  [1.2  20]/Fn;                                       % Passband Frequency (Normalised)
Ws  =  [0.8  21]/Fn;                                       % Stopband Frequency (Normalised)
Rp =  1;                                                   % Passband Ripple (dB)
Rs = 150;                                                  % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                            % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                                 % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                               % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                     % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);    % Filter Signal
```



Matlab Commands Subject C:

```matlab
load('l1b.mat') % for Subject B and comment rest of data files

load('k3b.mat') % Loading data 3a Subject A
column2 = s;
out = reshape(column2(1:100), [], 1)
N=length(out); % Get length
frequency_s=1000; % Setting the frequency to 60 Hz
t=(0:N-1)/frequency_s; % Generating time vector
means5 = mean(out, 2)
figure(1)
bandpass(means5,[0.8 1.2],fs/2)
hold on
Fs = 1000;                                                  % Setting the frequency to 60 Hz
Fn = Fs/2;                                                 % Setting value for Nyquist
Frequency (Hz)
Wp  =  [1.2  20]/Fn;                                       % Passband Frequency (Normalised)
Ws  =  [0.8  21]/Fn;                                       % Stopband Frequency (Normalised)
Rp =  1;                                                   % Passband Ripple (dB)
Rs = 150;                                                  % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                            % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                                 % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                               % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                     % Filter Bode Plot
%filtered signal = filtfilt(sosbp, gbp, singleStimulus P5);    % Filter Signal
```



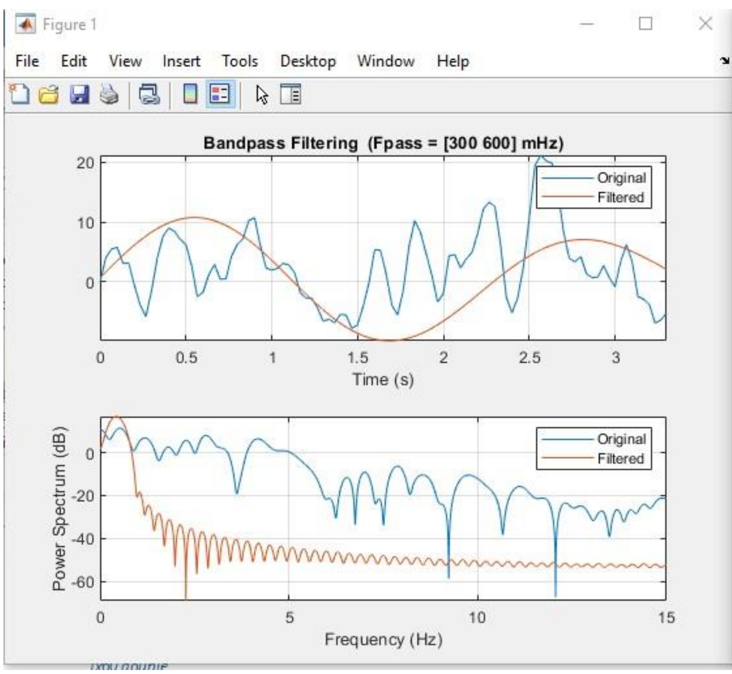
2. Extract Respiratory time series data. Show the plot.

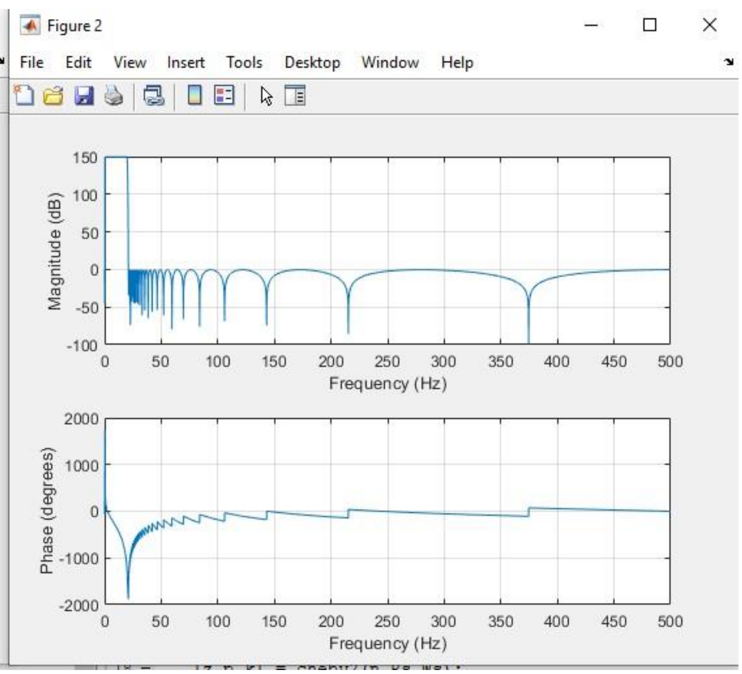
In order to extract respiratory time series signal from data following steps were used :

8. Loading data set into workspace, Squeezing the Signal
9. Saving the reduced data
10. Method 1: Using bandpass filter function with frequency 0.3 0.6
11. Designing 2nd order filter
12. Plotting square Signal
13. Repeat steps 1-5 for each data set train/test
14. Repeat steps 1-5 for both subjects A and B

Matlab Commands Subject A:

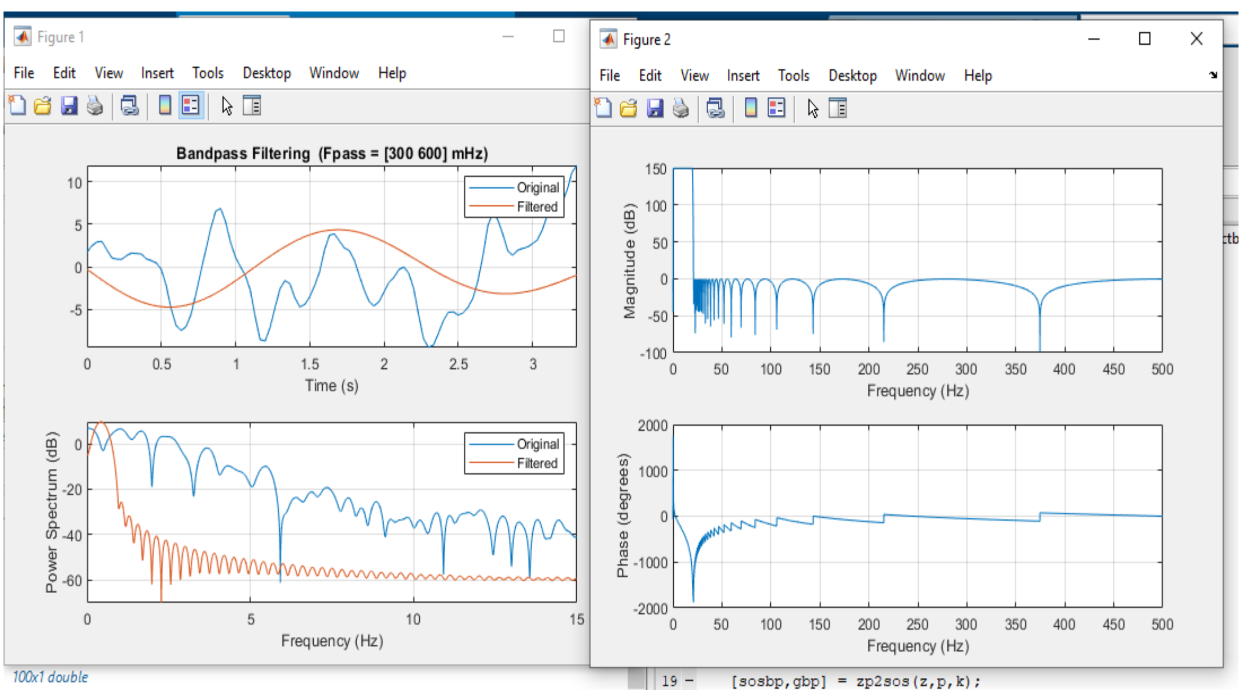
```
load('k3b.mat') % Loading data 3a Subject A
column2 = s;
out = reshape(column2(1:100), [], 1)
N=length(out); % Get length
frequency_s=1000; % Setting the frequency to 60 Hz
t=(0:N-1)/frequency_s; % Generating time vector
means5 = mean(out, 2)
figure(1)
bandpass(means5,[0.3 0.6],fs/2)
hold on
Fs = 1000;                                                  % Setting the frequency to 60 Hz
Fn = Fs/2;                                                  % Setting value for Nyquist
Frequency (Hz)
Wp = [0.6   20]/Fn;                                         % Passband Frequency (Normalised)
Ws = [0.3   21]/Fn;                                         % Stopband Frequency (Normalised)
Rp =   1;                                                   % Passband Ripple (dB)
Rs = 150;                                                   % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                             % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                                  % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                                % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                      % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);    % Filter Signal
```





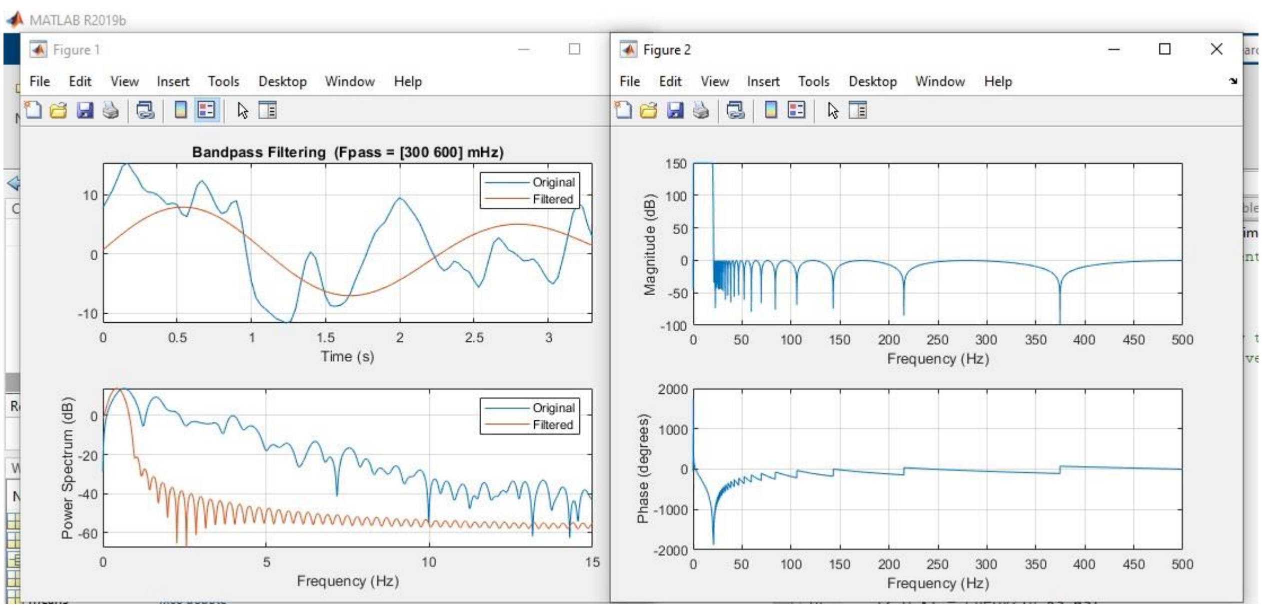
Matlab Commands Subject B:

```
load('k6b.mat') % Loading data 3a Subject A
column2 = s;
out = reshape(column2(1:100), [], 1)
N=length(out); % Get length
frequency_s=1000; % Setting the frequency to 60 Hz
t=(0:N-1)/frequency_s; % Generating time vector
means5 = mean(out, 2)
figure(1)
bandpass(means5,[0.3 0.6],fs/2)
hold on
Fs = 1000;                                                          % Setting the frequency to 60 Hz
Fn = Fs/2;                                                         % Setting value for Nyquist
Frequency (Hz)
Wp = [0.6   20]/Fn;                                                % Passband Frequency (Normalised)
Ws = [0.3   21]/Fn;                                                % Stopband Frequency (Normalised)
Rp =   1;                                                          % Passband Ripple (dB)
Rs = 150;                                                          % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                                    % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                                         % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                                       % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                             % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);          % Filter Signal
```



Matlab Commands Subject C:

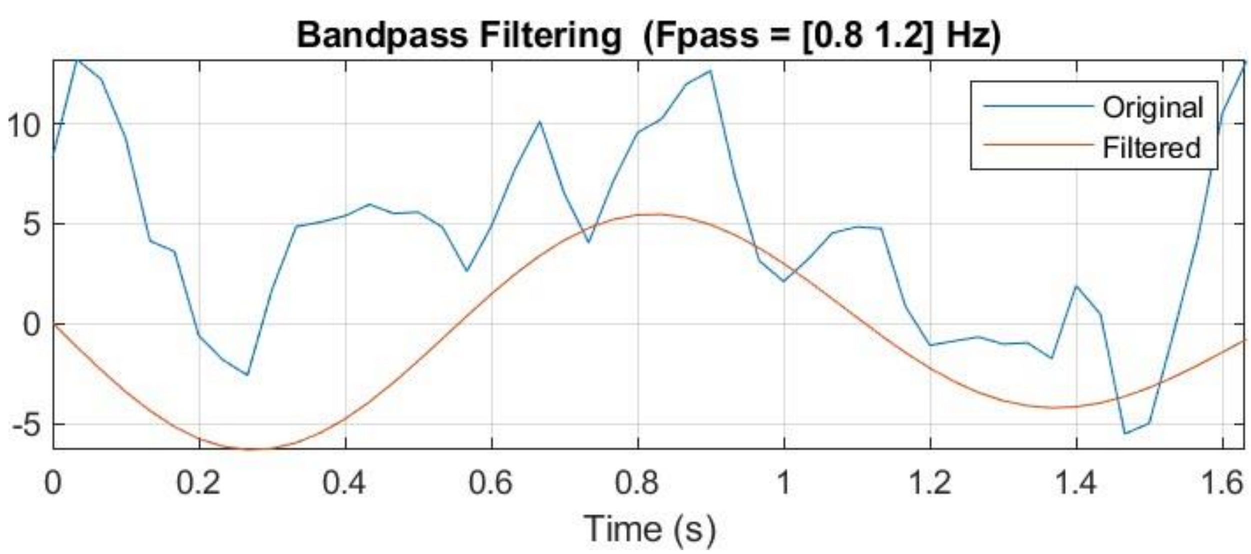
```
load('l1b.mat') % Loading data 3a Subject A
column2 = s;
out = reshape(column2(1:100), [], 1)
N=length(out); % Get length
frequency_s=1000; % Setting the frequency to 60 Hz
t=(0:N-1)/frequency_s; % Generating time vector
means5 = mean(out, 2)
figure(1)
bandpass(means5,[0.3 0.6],fs/2)
hold on
Fs = 1000;                                                    % Setting the frequency to 60 Hz
Fn = Fs/2;                                                   % Setting value for Nyquist
Frequency (Hz)
Wp = [0.6   20]/Fn;                                          % Passband Frequency (Normalised)
Ws = [0.3   21]/Fn;                                          % Stopband Frequency (Normalised)
Rp =   1;                                                    % Passband Ripple (dB)
Rs = 150;                                                    % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                              % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                                   % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                                 % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                       % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);     % Filter Signal
```

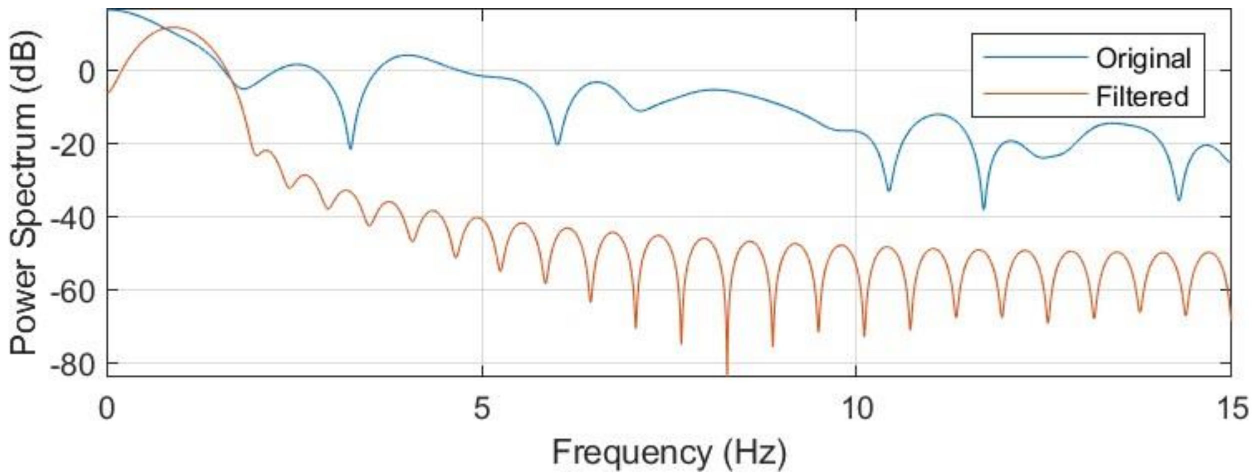


3. Filter the signals and find the different bands corresponding to the mentioned tasks.

Matlab Commands and Plots for Subject A :

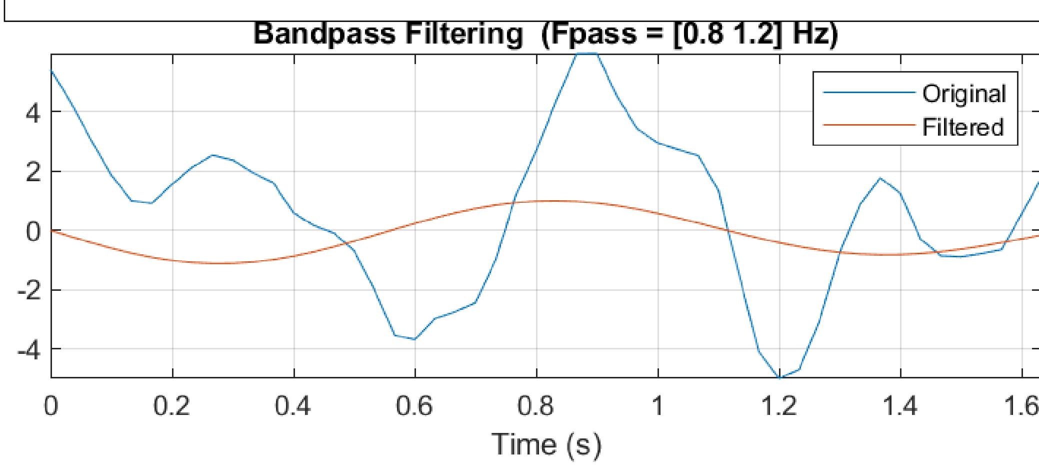
```
load('k3b.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

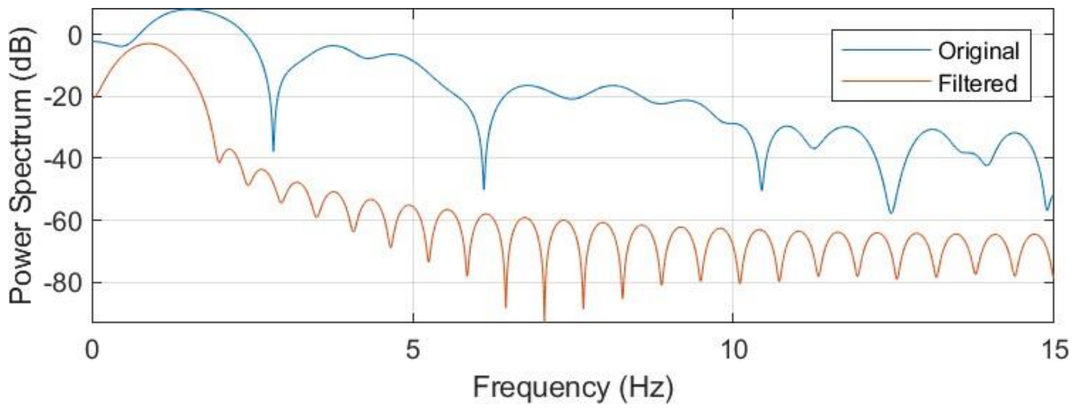




Matlab Commands and Plots for Subject B :

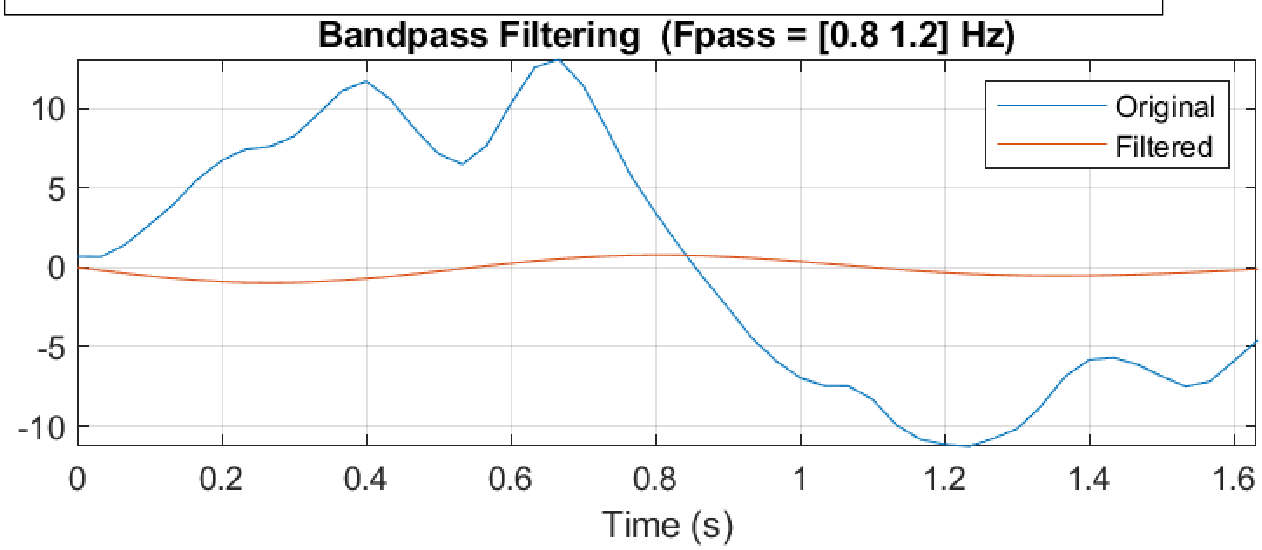
```
load('k6b.mat') % Loading data 3a Subject B
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

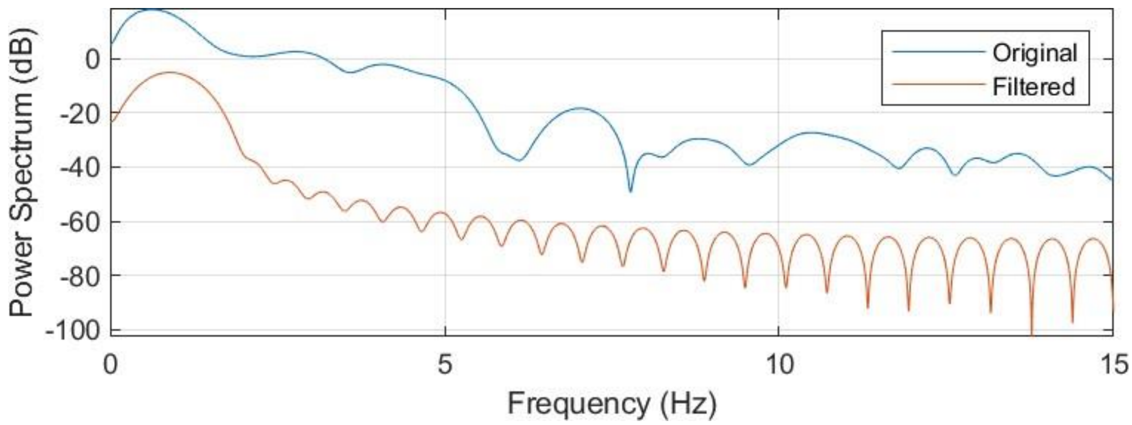




Matlab Commands and Plots for Subject C :

```
load('l1b.mat') % Loading data 3a Subject B
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

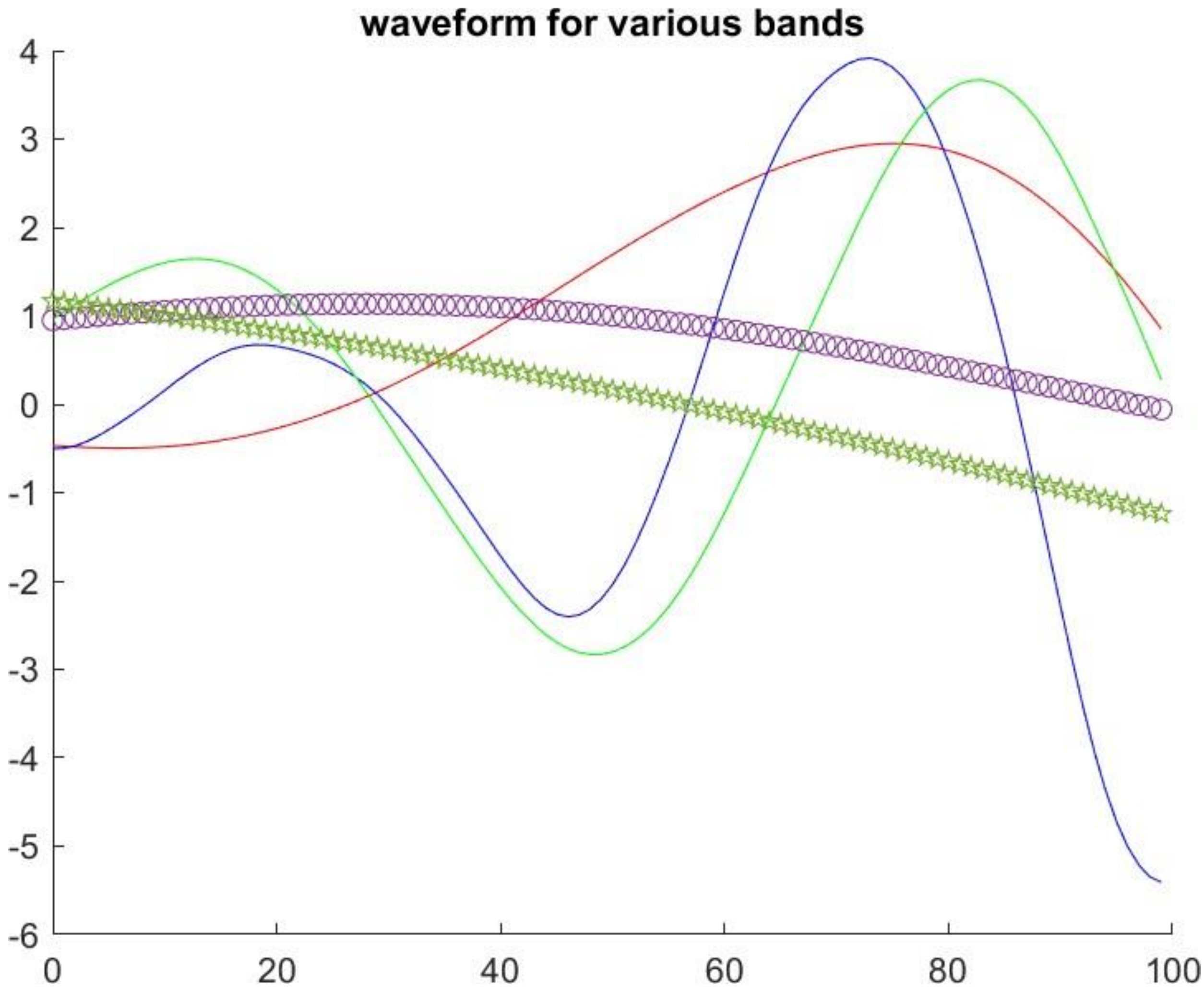




4. Extimate the power spectrum of the and lable the compoenets corresponding to activitiies.

Matlab Commands : Power spectrum made in part 1, Coefficients code and plot

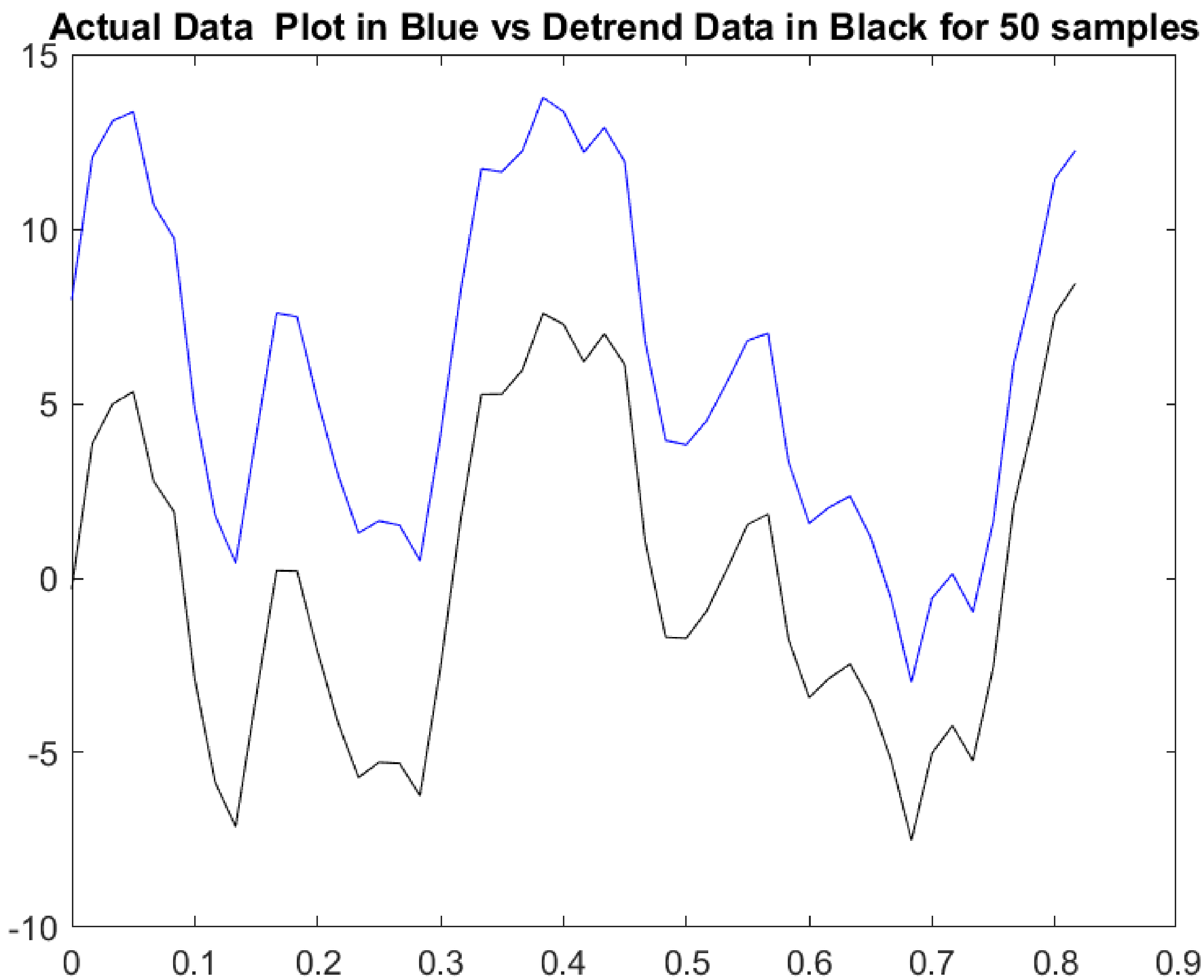
```
load('k3b.mat') % Loading data 3a Subject A
column2 = s;
out = reshape(column2(1:100), [], 1)
S=out;
waveletFunction = 'db8';
[ZZ,LE] = wavedec(S,8,waveletFunction);
%%Coffiecient Vectors
cofD1 = detcoef(ZZ,LE,1);                    %NOISE
cofD2 = detcoef(ZZ,LE,2);                    %NOISE
cofD3 = detcoef(ZZ,LE,3);                    %NOISE
cofD4 = detcoef(ZZ,LE,4);                    %NOISE
cofD5 = detcoef(ZZ,LE,5);                    %gamma
cofD6 = detcoef(ZZ,LE,6);                    %beta
cofD7 = detcoef(ZZ,LE,7);                    %alpha
cofD8 = detcoef(ZZ,LE,8);                    %theta
cofA8 = appcoef(ZZ,LE,waveletFunction,8);    %delta
% Vectors
D1 = wrcoef('d',ZZ,LE,waveletFunction,1); %noise
D2 = wrcoef('d',ZZ,LE,waveletFunction,2); %noise
D3 = wrcoef('d',ZZ,LE,waveletFunction,3); %npise
D4 = wrcoef('d',ZZ,LE,waveletFunction,4); %noise
Gamma = wrcoef('d',ZZ,LE,waveletFunction,5); %gamma
Beta = wrcoef('d',ZZ,LE,waveletFunction,6); %beta
Alpha = wrcoef('d',ZZ,LE,waveletFunction,7); %alpha
Theta = wrcoef('d',ZZ,LE,waveletFunction,8); %theta
Delta = wrcoef('a',ZZ,LE,waveletFunction,8); %delta
ts=1;
t=0:ts:99;
hold on
plot(t,Alpha,'r','DisplayName','Alpha')
plot(t,Gamma,'b','DisplayName','Gamma')
plot(t,Beta,'g','DisplayName','Beta')
plot(t,Theta,'o','DisplayName','Theta')
plot(t,Delta,'p','DisplayName','Delta')
title('waveform for various bands')
```



5. Detend the signal

Subject A

```
load('k3b.mat') % Loading data set A
% points from Subject A, 50
singleStimulus_P5 = squeeze(s(1:50,end))
detrend_sdata = detrend(singleStimulus_P5);
trend = singleStimulus_P5 - detrend_sdata;
mean(detrend_sdata)
frequency_s=60; % Setting the frequency to 60 Hz
N=length(singleStimulus_P5); % Get length of average per 5 trails
t=(0:N-1)/frequency_s; % Generating time vector
plot(t,detrend_sdata,'k');
hold on
plot(t,singleStimulus_P5,'b');
```



Subject B

```
load('k6b.mat') % Loading data set B
% points from Subject b 50
singleStimulus_P5 = squeeze(s(1:50,end))
detrend_sdata = detrend(singleStimulus_P5);
trend = singleStimulus_P5 - detrend_sdata;
mean(detrend_sdata)
frequency_s=60; % Setting the frequency to 60 Hz
N=length(singleStimulus_P5); % Get length of average per 5 trails
t=(0:N-1)/frequency_s; % Generating time vector
plot(t,detrend_sdata,'k');
hold on
plot(t,singleStimulus_P5,'b');
```

Subject C

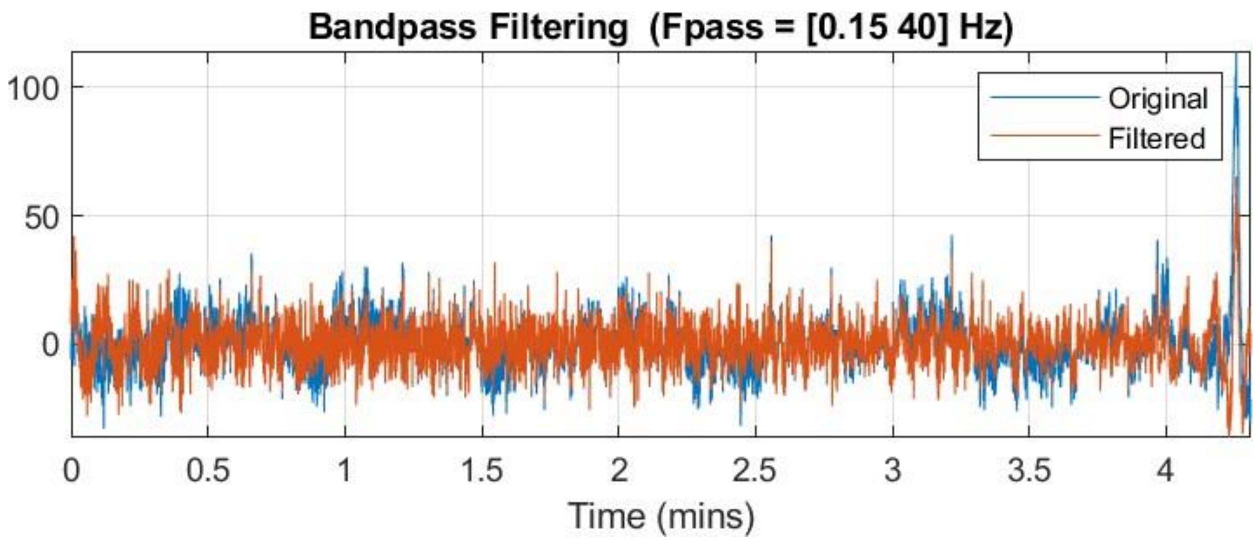
```
load(l1b.mat') % Loading data set c
% points from Subject C 50
singleStimulus_P5 = squeeze(s(1:50,end))
detrend_sdata = detrend(singleStimulus_P5);
trend = singleStimulus_P5 - detrend_sdata;
mean(detrend_sdata)
frequency_s=60; % Setting the frequency to 60 Hz
N=length(singleStimulus_P5); % Get length of average per 5 trails
t=(0:N-1)/frequency_s; % Generating time vector
plot(t,detrend_sdata,'k');
hold on
plot(t,singleStimulus_P5,'b');
```

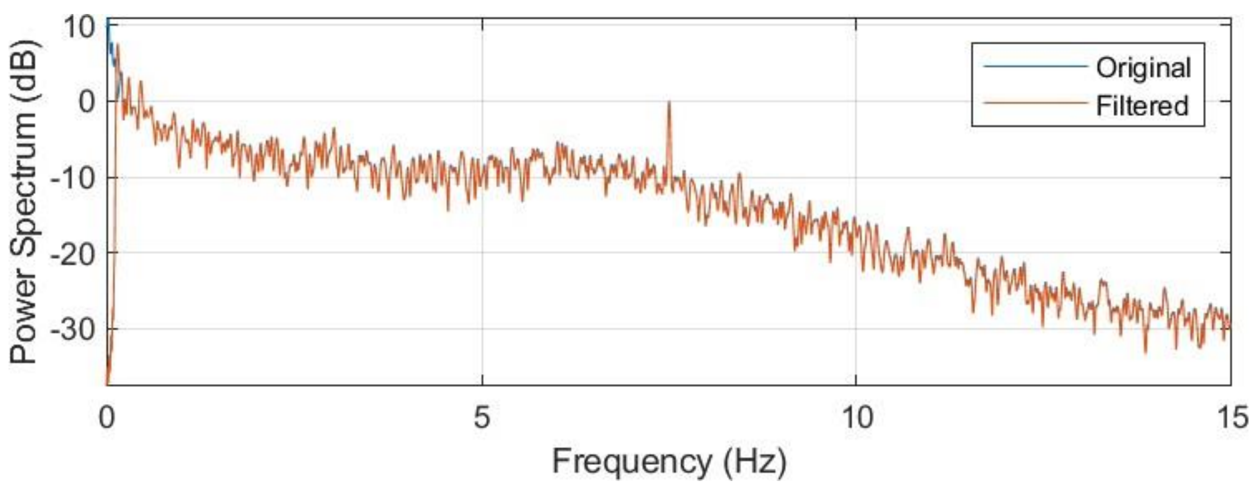
6. Extract P300 or ERP from the signals based on the type of task.

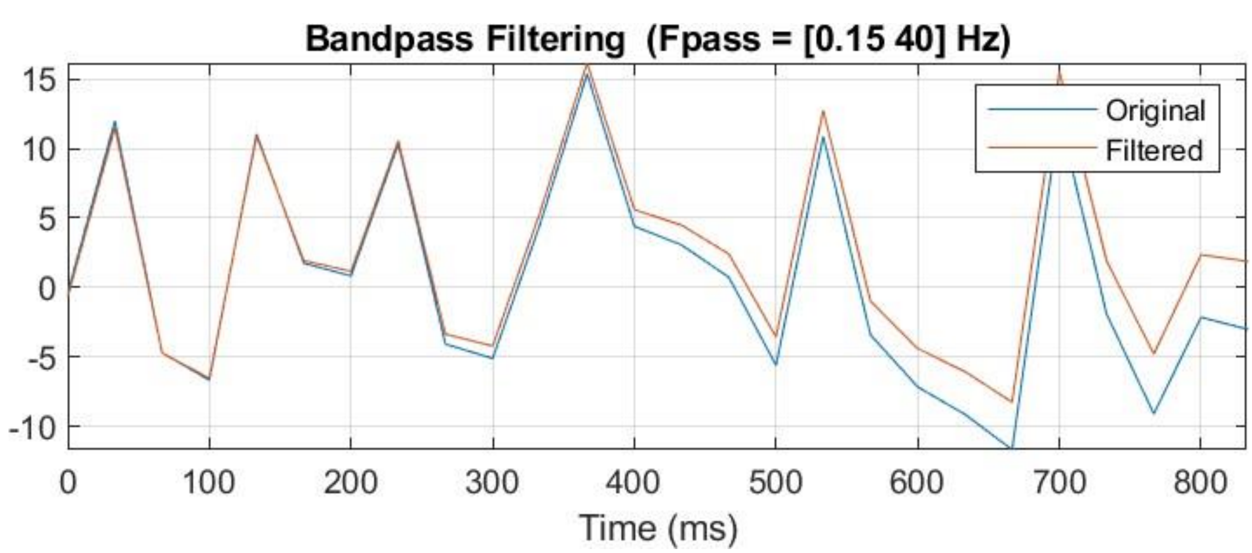
Subject A

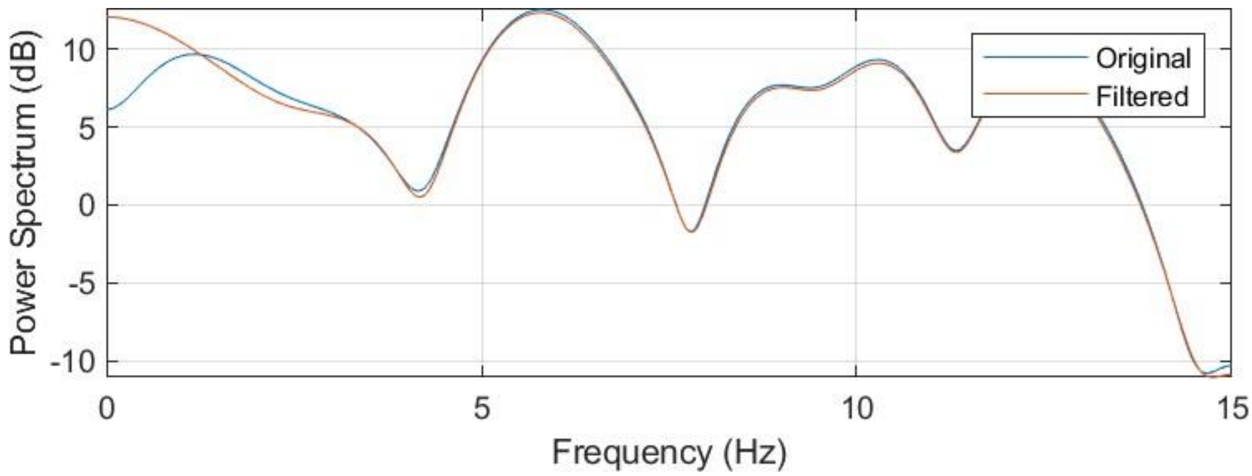
```
load('k3b.mat') % Loading data set A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singleStimulus_C3+singleSt
imulus_C4+singleStimulus_C5+singleStimulus_C6+singleStimulus_C7+singleStimulus_C8+singleSt
imulus_C9+singleStimulus_C10+singleStimulus_C11+singleStimulus_C12)/12
t=(0:N-1)/fs; % Generating time vector
figure(1)
bandpass(singleStimulus_P5,[0.15 40],fs/2)
figure(2)
bandpass(singleStimulus_Train_A_parietal_avg,[0.15 40],fs/2)
figure(3)
Y=fft(singleStimulus_P5)
Fs = 1000;            % Sampling frequency
T = 1/Fs;             % Sampling period
t = (0:N-1)*T;        % Time vector
P2 = abs(Y/N);
P1 = P2(1:N/2+1);
P1(2:end-1) = 2*P1(2:end-1);
f = Fs*(0:(N/2))/N;
plot(f,P1)
title('Single-Sided Amplitude Spectrum of Signal(t)')
xlabel('f (Hz)')
ylabel('|P1(f)|')
```

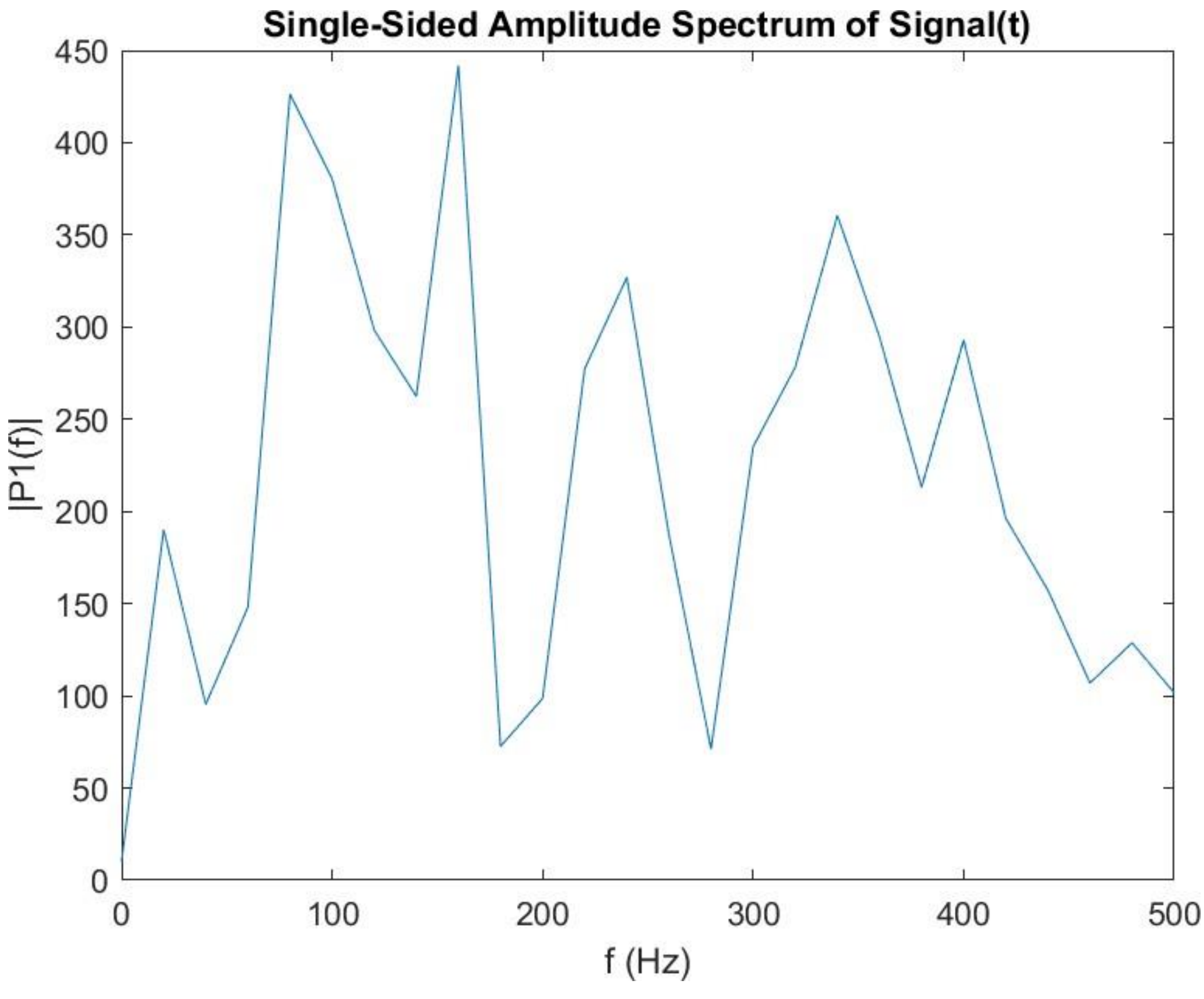
Plots


Bandpass Filtering (Fpass = [0.15 40] Hz)
Original
Filtered
100
50
0
0
0.5
1
1.5
2
2.5
3
3.5
4
Time (mins)


Original
Filtered
Power Spectrum (dB)
10
0
-10
-20
-30
0
5
10
15
Frequency (Hz)


Bandpass Filtering (Fpass = [0.15 40] Hz)
Original
Filtered
15
10
5
0
-5
-10
0
100
200
300
400
500
600
700
800
Time (ms)


Original
Filtered
Power Spectrum (dB)
Frequency (Hz)
10
5
0
-5
-10
0
5
10
15


Single-Sided Amplitude Spectrum of Signal(t)
|P1(f)|
f (Hz)
450
400
350
300
250
200
150
100
50
0
0
100
200
300
400
500

ASSIGNMENT 3

PART 3

Bio Robotics

ABSTRACT

Data Analysis and Extraction for: Data set p3a

Zunera Zahid

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1. Extract caridac time series signal from the data. show the plot

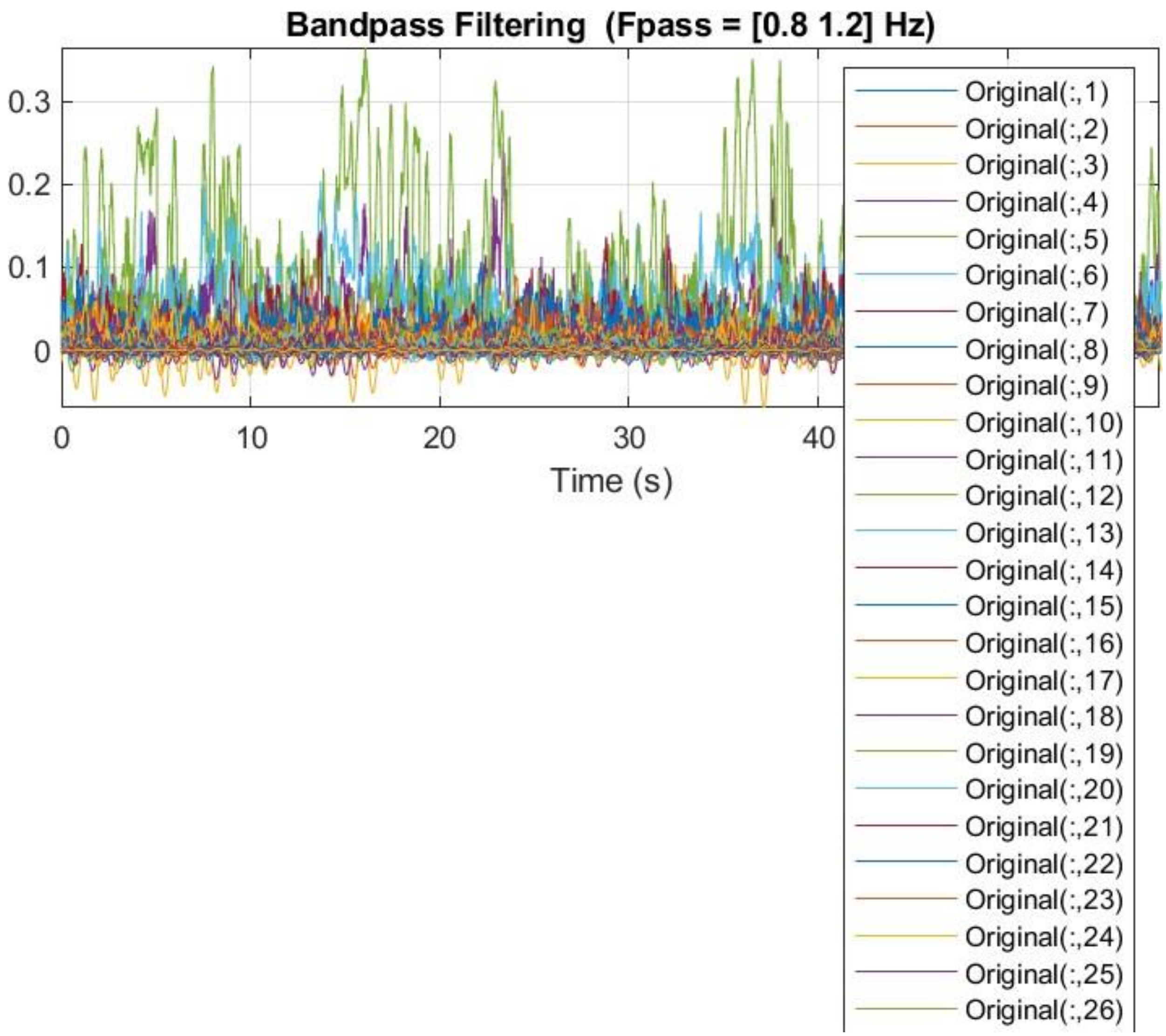
In order to extract cardiac time series signal from data following steps were used :

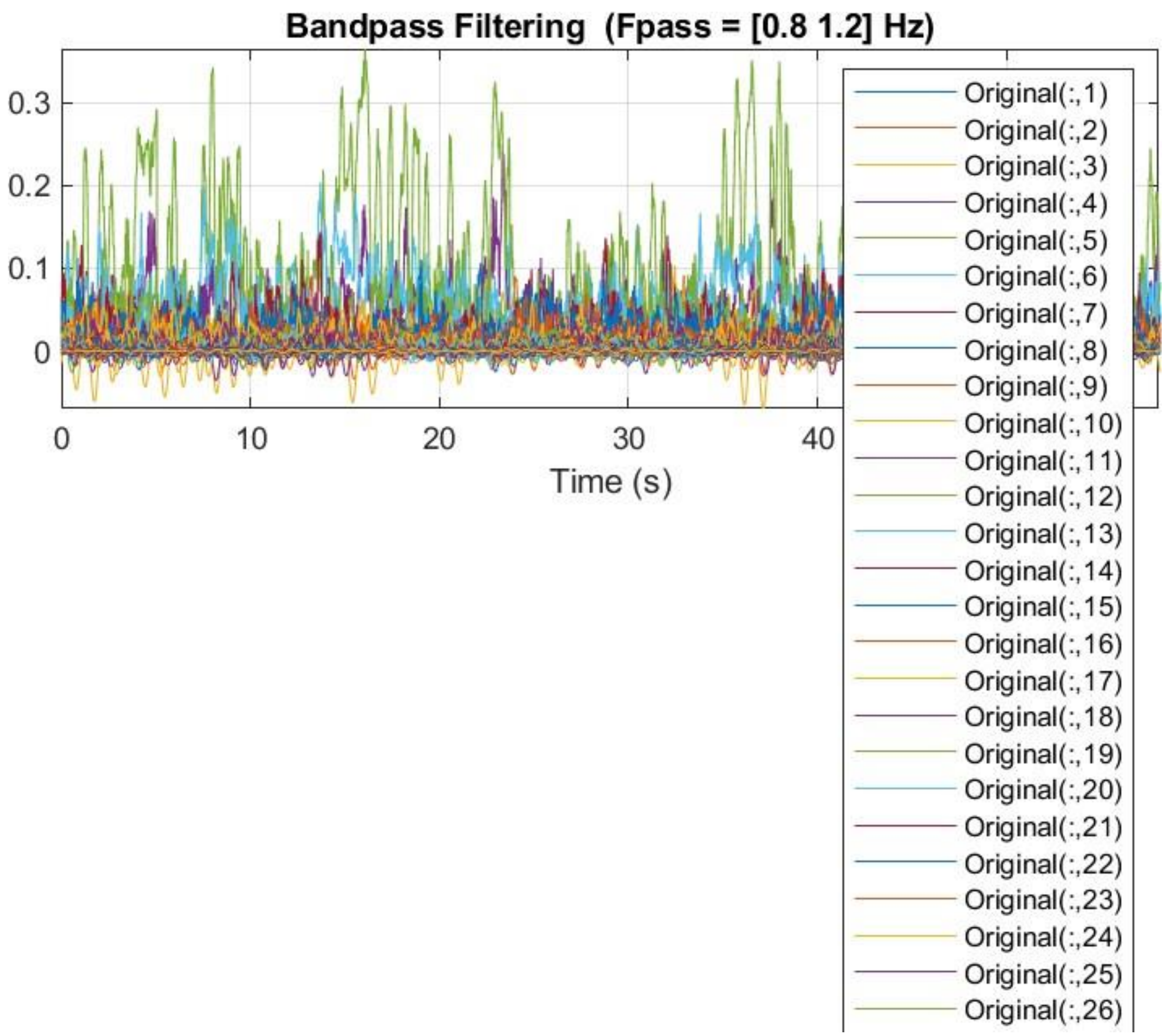
15. Loading data set into workspace, Squeezing the Signal
16. Saving the reduced data
17. Method 1: Using bandpass filter function with frequency 0.8 1.2
18. Designing 2nd order filter
19. Plotting square Signal
20. Repeat steps 1-5 for each data set train/test
21. Repeat steps 1-5 for both subjects A and B and C

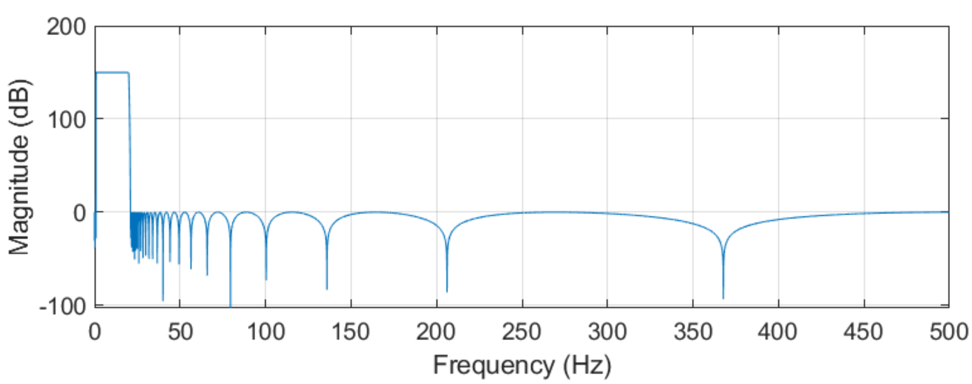
Matlab Commands Subject A without average:

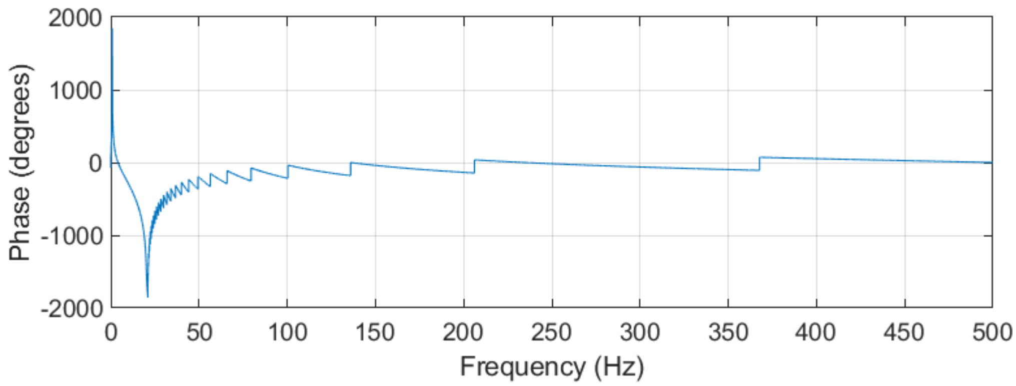
```
load('train_subject1_psd01.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus =  squeeze(X)
figure(1)
bandpass(singleStimulus,[0.8 1.2],fs)

Fs = 1000;                                                    % Setting the frequency to 60 Hz
Fn = Fs/2;                                                   % Setting value for Nyquist
Frequency (Hz)
Wp  =  [1.2   20]/Fn;                                        % Passband Frequency (Normalised)
Ws  =  [0.8   21]/Fn;                                        % Stopband Frequency (Normalised)
Rp =   1;                                                    % Passband Ripple (dB)
Rs = 150;                                                    % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                              % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                                   % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                                 % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                       % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);     % Filter Signal
```

Plots Subject A:



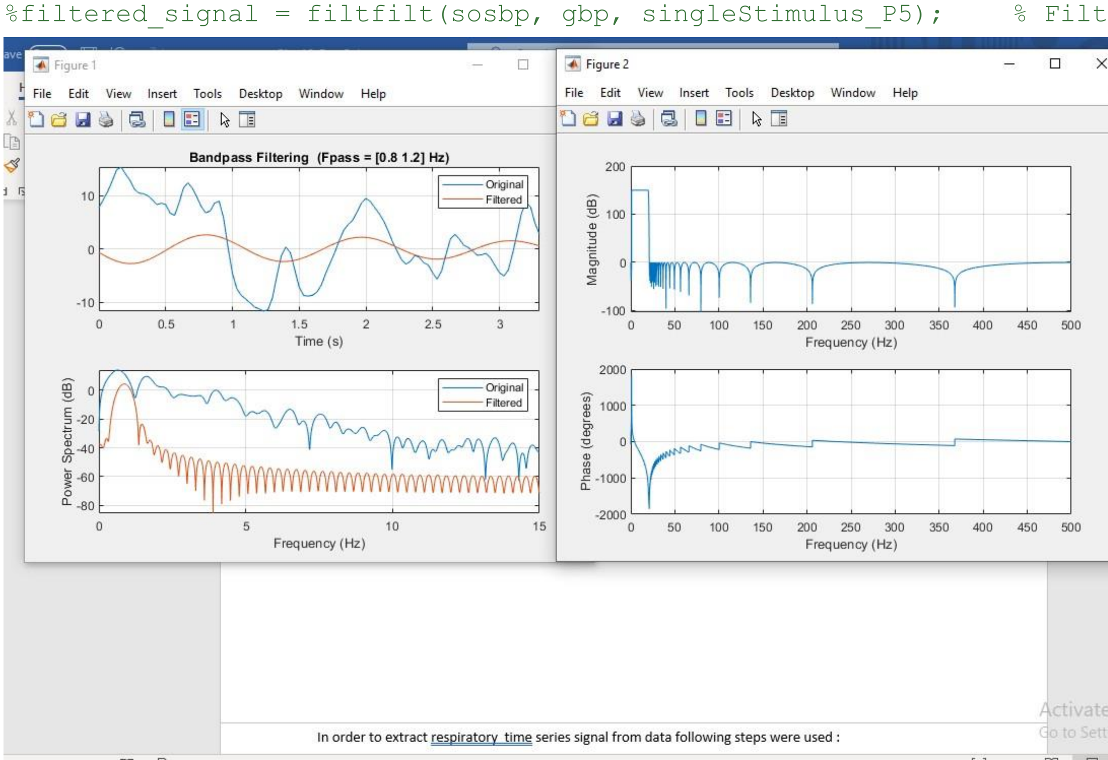

Bandpass Filtering (Fpass = [0.8 1.2] Hz)
0.3
0.2
0.1
0
0
10
20
30
40
Time (s)
Original(:,1)
Original(:,2)
Original(:,3)
Original(:,4)
Original(:,5)
Original(:,6)
Original(:,7)
Original(:,8)
Original(:,9)
Original(:,10)
Original(:,11)
Original(:,12)
Original(:,13)
Original(:,14)
Original(:,15)
Original(:,16)
Original(:,17)
Original(:,18)
Original(:,19)
Original(:,20)
Original(:,21)
Original(:,22)
Original(:,23)
Original(:,24)
Original(:,25)
Original(:,26)


200
100
0
-100
Magnitude (dB)
0
50
100
150
200
250
300
350
400
450
500
Frequency (Hz)



Matlab Commands Subject A with average:

```
load('train_subject1_psd01.mat') % Loading data 5 Subject 1
column2 = s;
out = reshape(column2(1:100), [], 1)
N=length(out); % Get length
frequency_s=1000; % Setting the frequency to 60 Hz
t=(0:N-1)/frequency_s; % Generating time vector
means5 = mean(out, 2)
figure(1)
bandpass(means5,[0.8 1.2],fs/2)
hold on
Fs = 1000;                                                  % Setting the frequency to 60 Hz
Fn = Fs/2;                                                 % Setting value for Nyquist
Frequency (Hz)
Wp = [1.2   20]/Fn;                                        % Passband Frequency (Normalised)
Ws = [0.8   21]/Fn;                                        % Stopband Frequency (Normalised)
Rp =   1;                                                  % Passband Ripple (dB)
Rs = 150;                                                  % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                            % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                                 % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                               % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                     % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);    % Filter Signal
```

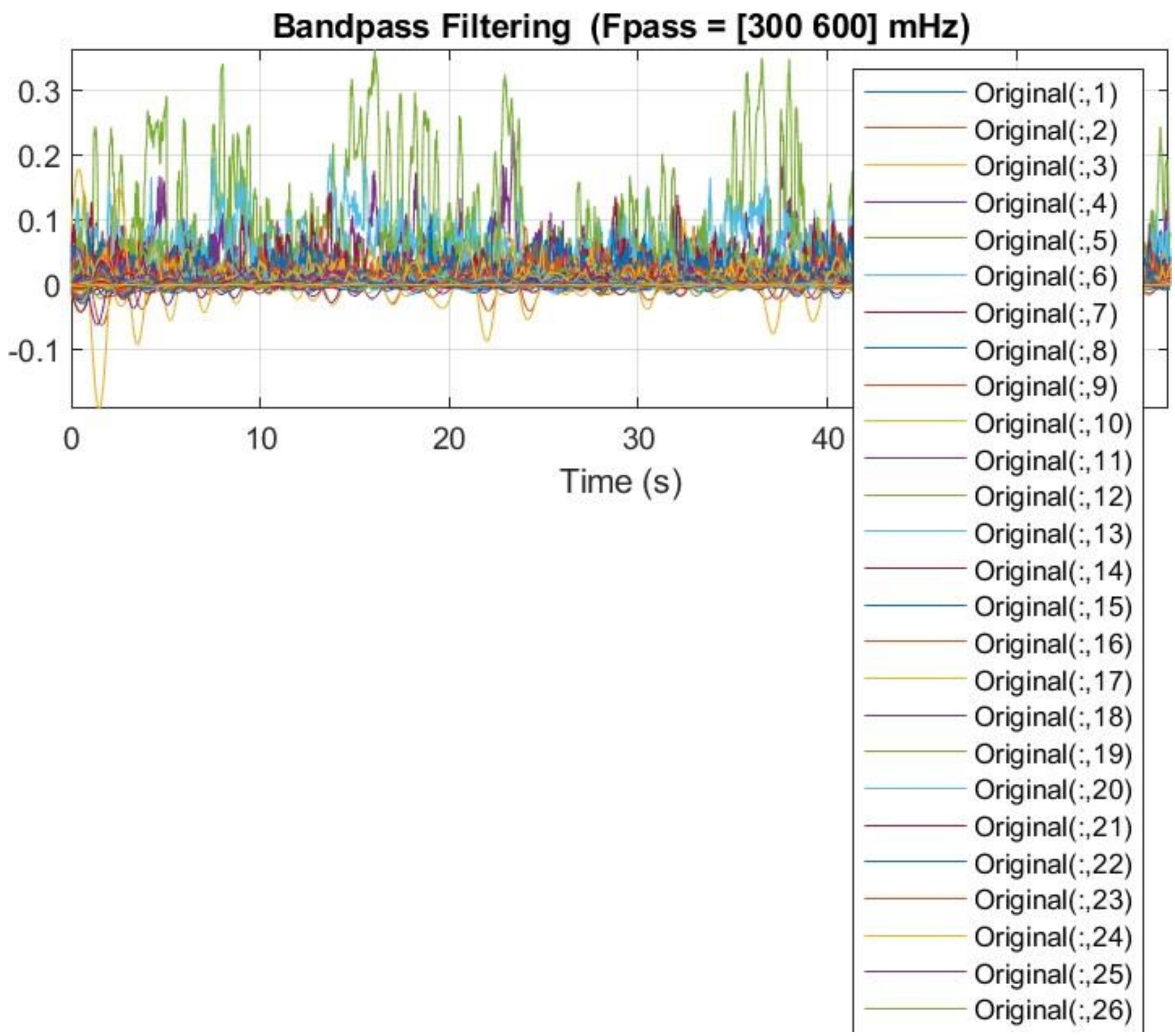


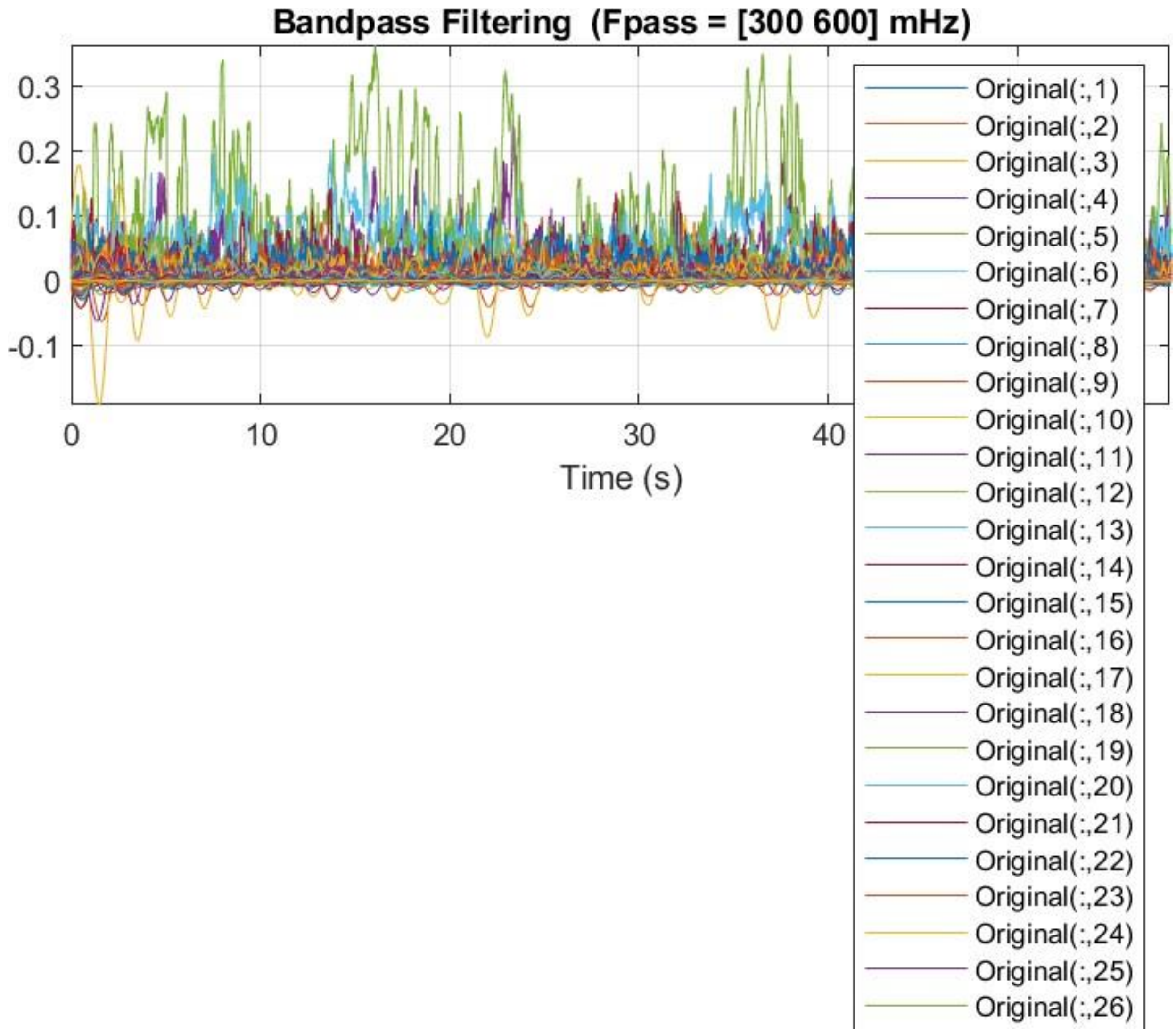
2. Extract Respiratory time series data. Show the plot.

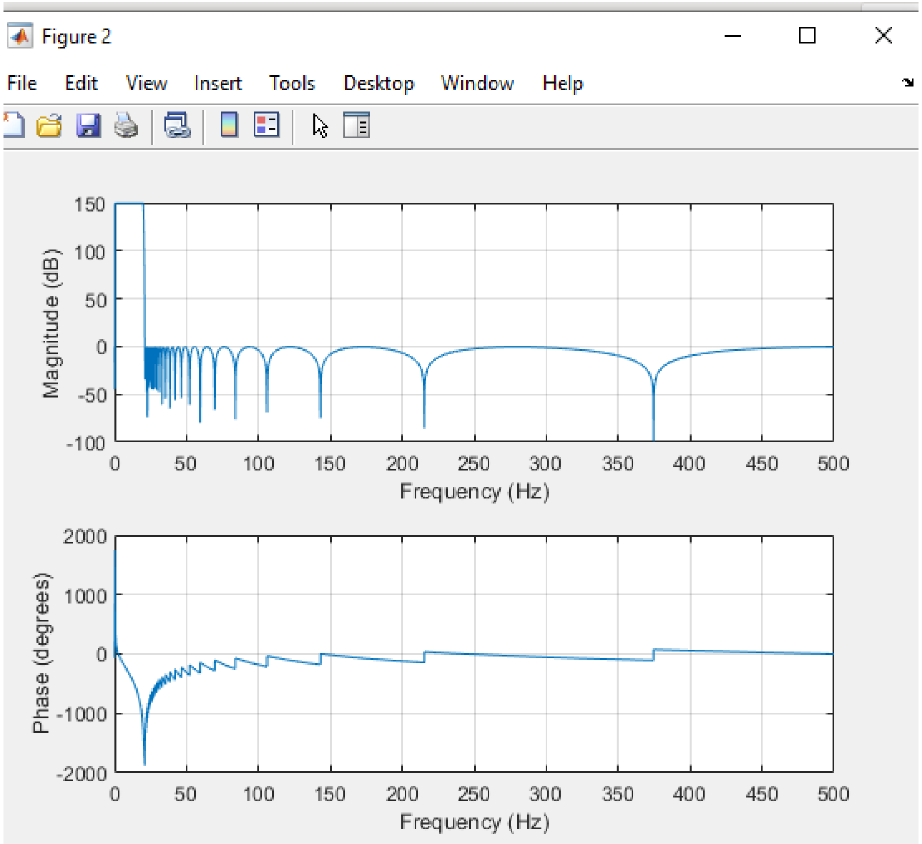
15. Loading data set into workspace, Squeezing the Signal
16. Second method was taking data average
17. Saving the reduced data
18. Method 1: Using bandpass filter function with frequency 0.3 0.6
19. Designing 2nd order filter
20. Plotting square Signal
21. Repeat steps 1-5 for each data set train/test
22. Repeat steps 1-5 for both subjects A and B

Matlab Commands Subject A without avarage:

```
load('train_subject1_psd01.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus =  squeeze(X)
figure(1)
bandpass(singleStimulus,[0.3 0.6],fs)

Fs = 1000;                                                % Setting the frequency to 60 Hz
Fn = Fs/2;                                               % Setting value for Nyquist
Frequency (Hz)
Wp  =  [0.6  20]/Fn;                                     % Passband Frequency (Normalised)
Ws  =  [0.3  21]/Fn;                                     % Stopband Frequency (Normalised)
Rp =  1;                                                 % Passband Ripple (dB)
Rs = 150;                                                % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                          % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                               % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                             % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                   % Filter Bode Plot
%filtered_signal = filtfilt(sosbp, gbp, singleStimulus_P5);    % Filter Signal
```

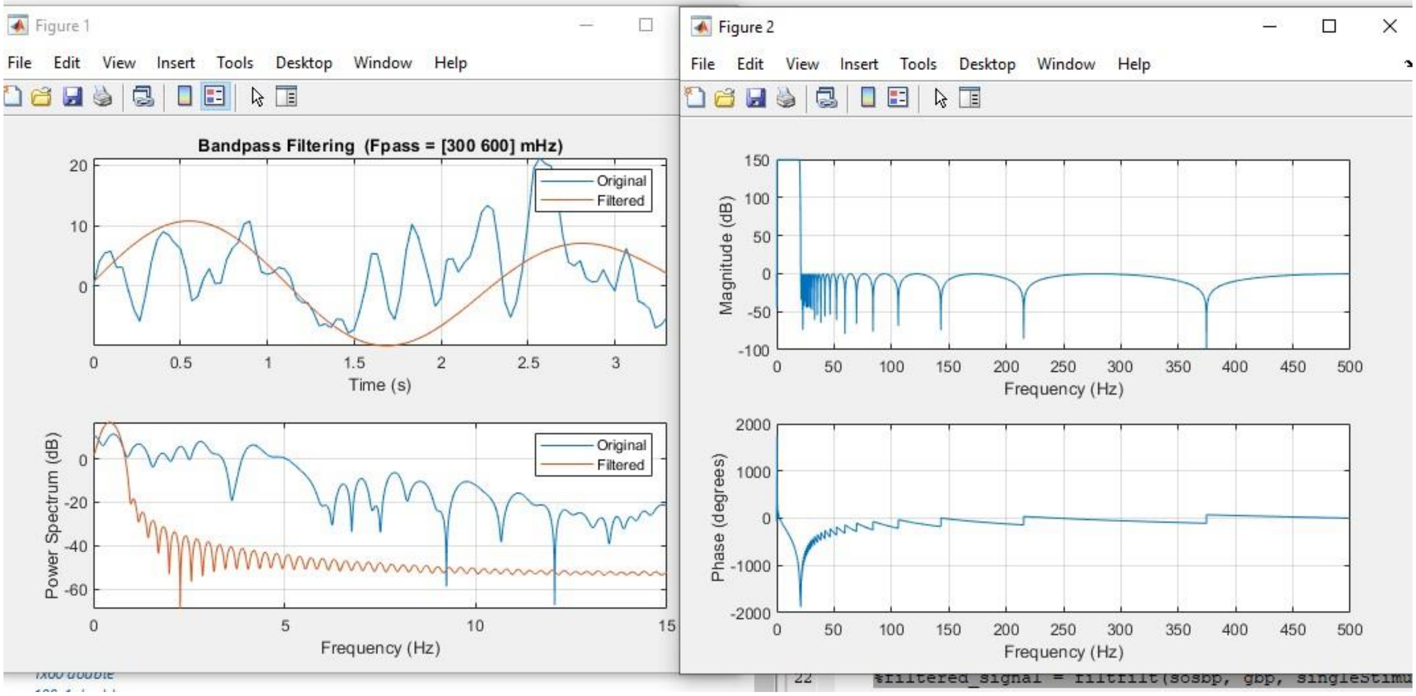

Bandpass Filtering (Fpass = [300 600] mHz)
0.3
0.2
0.1
0
-0.1
0
10
20
30
40
Time (s)
Original(:,1)
Original(:,2)
Original(:,3)
Original(:,4)
Original(:,5)
Original(:,6)
Original(:,7)
Original(:,8)
Original(:,9)
Original(:,10)
Original(:,11)
Original(:,12)
Original(:,13)
Original(:,14)
Original(:,15)
Original(:,16)
Original(:,17)
Original(:,18)
Original(:,19)
Original(:,20)
Original(:,21)
Original(:,22)
Original(:,23)
Original(:,24)
Original(:,25)
Original(:,26)


Bandpass Filtering (Fpass = [300 600] mHz)
0.3
0.2
0.1
0
-0.1
0
10
20
30
40
Time (s)
Original(:,1)
Original(:,2)
Original(:,3)
Original(:,4)
Original(:,5)
Original(:,6)
Original(:,7)
Original(:,8)
Original(:,9)
Original(:,10)
Original(:,11)
Original(:,12)
Original(:,13)
Original(:,14)
Original(:,15)
Original(:,16)
Original(:,17)
Original(:,18)
Original(:,19)
Original(:,20)
Original(:,21)
Original(:,22)
Original(:,23)
Original(:,24)
Original(:,25)
Original(:,26)



Matlab Commands Subject A with average:

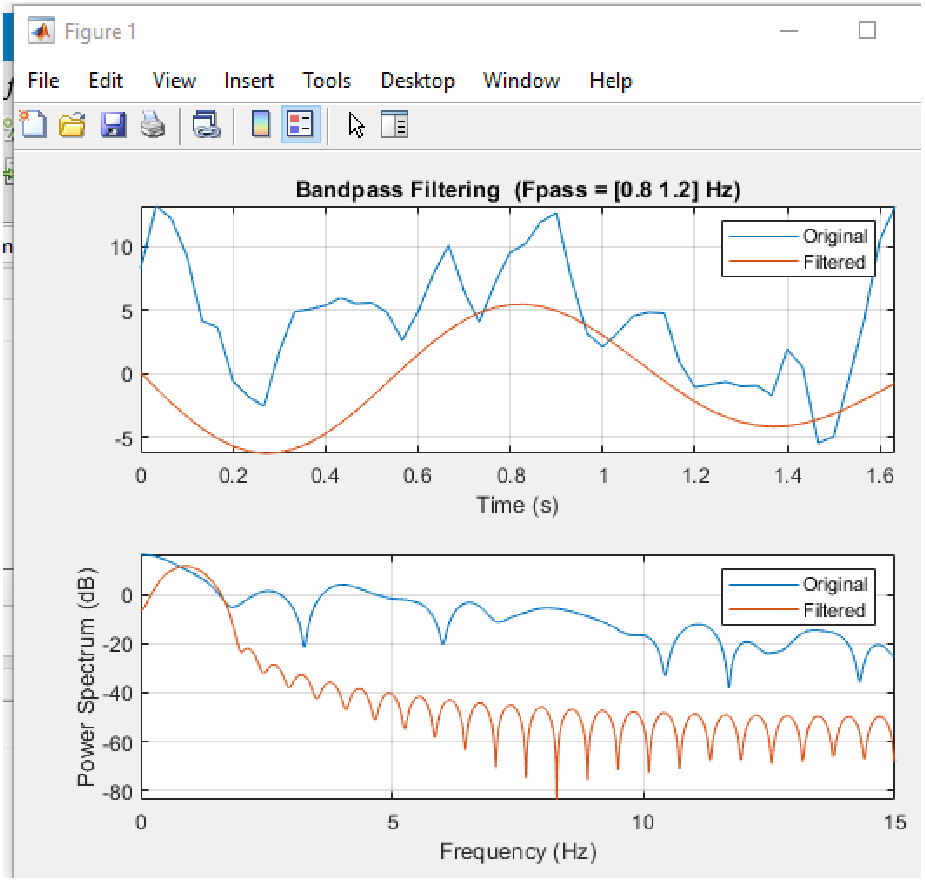
```
load('train_subject1_psd01.mat') % Loading data 3a Subject A
column2 = s;
out = reshape(column2(1:100), [], 1)
N=length(out); % Get length
frequency_s=1000; % Setting the frequency to 60 Hz
t=(0:N-1)/frequency_s; % Generating time vector
means5 = mean(out, 2)
figure(1)
bandpass(means5,[0.3 0.6],fs/2)
hold on
Fs = 1000;                                                  % Setting the frequency to 60 Hz
Fn = Fs/2;                                                  % Setting value for Nyquist
Frequency (Hz)
Wp  =  [0.6  20]/Fn;                                        % Passband Frequency (Normalised)
Ws  =  [0.3  21]/Fn;                                        % Stopband Frequency (Normalised)
Rp =  1;                                                    % Passband Ripple (dB)
Rs = 150;                                                   % Stopband Ripple (dB)
[n,Ws] = cheb2ord(Wp,Ws,Rp,Rs);                             % Filter Order
[z,p,k] = cheby2(n,Rs,Ws);                                  % Filter Design
[sosbp,gbp] = zp2sos(z,p,k);                                % Convert To Second-Order-Section
For Stability
figure(2)
freqz(sosbp, 2^16, Fs)                                      % Filter Bode Plot
%filtered signal = filtfilt(sosbp, gbp, singleStimulus P5);    % Filter Signal
```



3. Filter the signals and find the different bands corresponding to the mentioned tasks.

Matlab Commands and Plots for Subject 1 :

```
load('train_subject1_psd01.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```



Matlab Commands and Plots for Subject 1 :

```
load('train_subject1_psd02.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

Matlab Commands and Plots for Subject 1 :

```
load('train_subject1_psd03.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

Matlab Commands and Plots for Subject 2 :

```
load('train_subject2_psd01.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

```
load('train_subject1_psd02.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
```

Matlab Commands and Plots for Subject 2 :

```
load('train_subject2_psd02.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

Matlab Commands and Plots for Subject 2:

```
load('train_subject2_psd03.mat') % Loading data Subject 2
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

Matlab Commands and Plots for Subject 3 :

```
load('train_subject3_psd01.mat') % Loading data 3a Subject A
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

Matlab Commands Subject 3 :

```
load('train_subject3_psd02.mat') % Loading data Sub 3
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

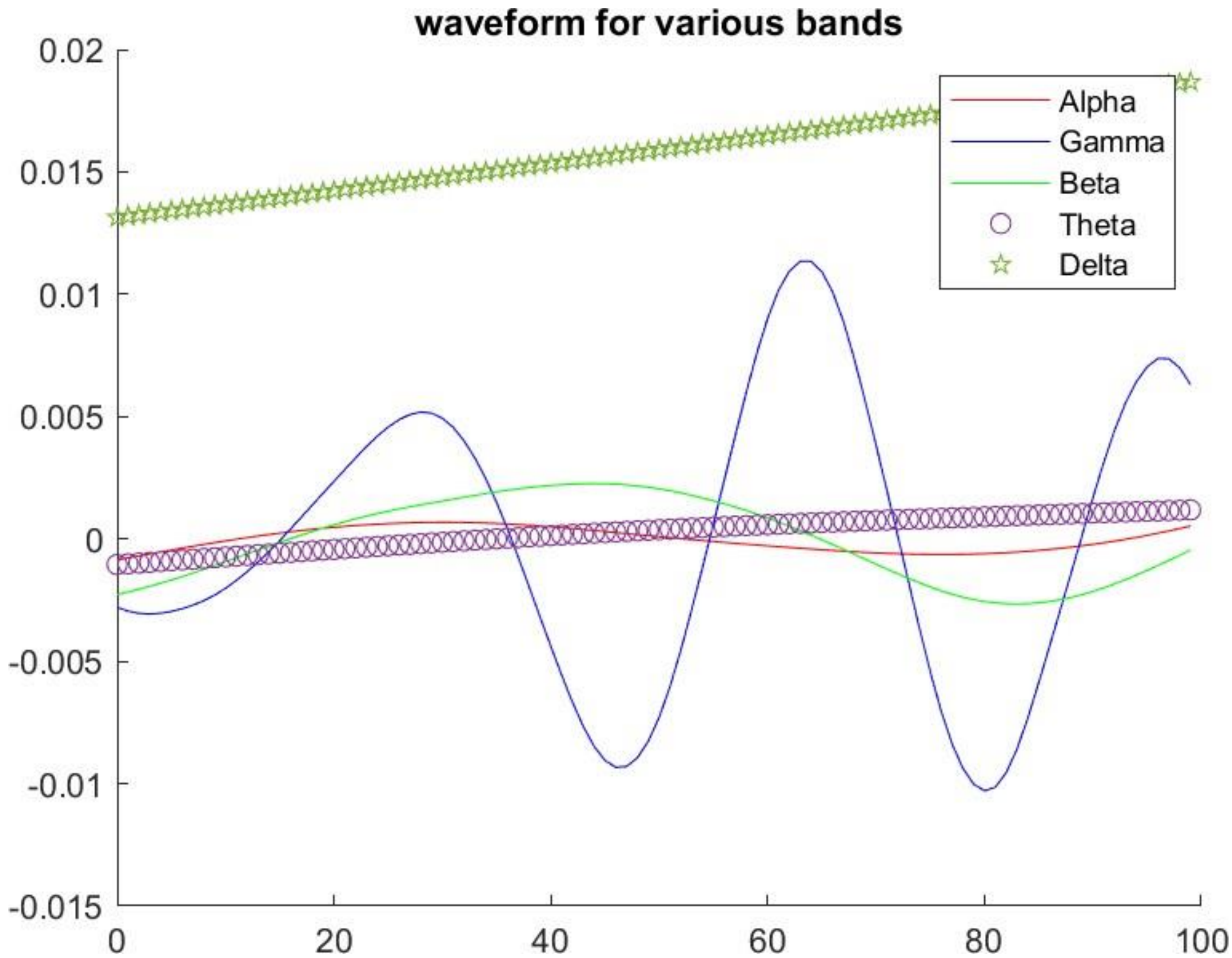
Matlab Commands Subject 3 :

```
load('train_subject3_psd03.mat') % Loading data Sub 3
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singl
eStimulus_C3+singleStimulus_C4+singleStimulus_C5+singleStimulus_C6+si
ngleStimulus_C7+singleStimulus_C8+singleStimulus_C9+singleStimulus_C1
0+singleStimulus_C11+singleStimulus_C12)/12
figure(1)
bandpass(singleStimulus_frontal_avg,[0.8 1.2],fs/2)
```

4. Extimate the power spectrum of the and lable the compoenets corresponding to activitiies.

Matlab Commands : Power spectrum made in part 1, Coefficients code and plot:

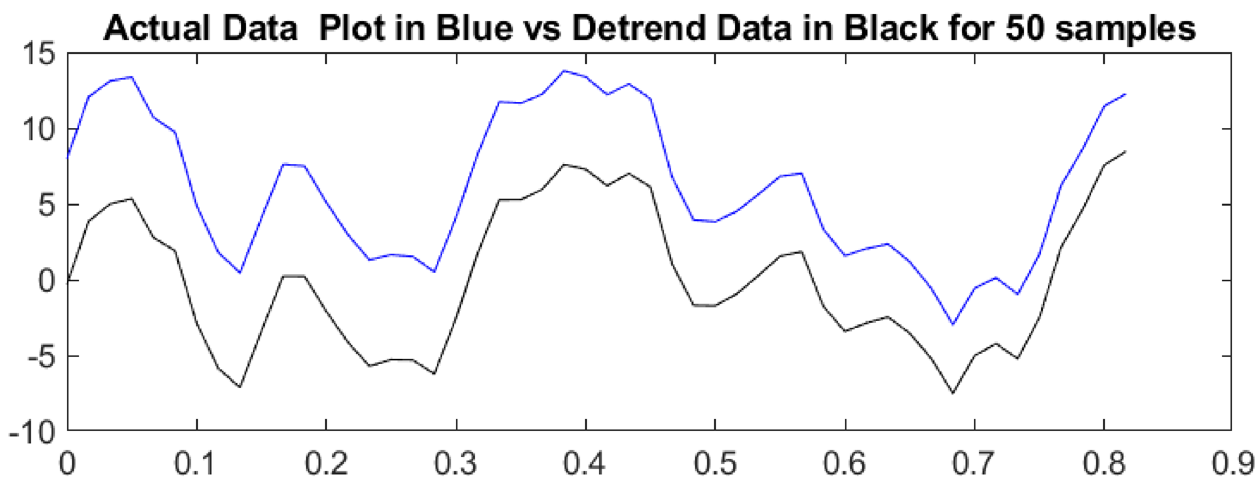
```
load('train_subject3_psd03.mat') % Loading data 3a Subject A
column2 = X;
out = reshape(column2(1:100), [], 1)
S=out;
waveletFunction = 'db8';
[ZZ,LE] = wavedec(S,8,waveletFunction);
%%Coffiecient Vectors
cofD1 = detcoef(ZZ,LE,1);                    %NOISE
cofD2 = detcoef(ZZ,LE,2);                    %NOISE
cofD3 = detcoef(ZZ,LE,3);                    %NOISE
cofD4 = detcoef(ZZ,LE,4);                    %NOISE
cofD5 = detcoef(ZZ,LE,5);                    %gamma
cofD6 = detcoef(ZZ,LE,6);                    %beta
cofD7 = detcoef(ZZ,LE,7);                    %alpha
cofD8 = detcoef(ZZ,LE,8);                    %theta
cofA8 = appcoef(ZZ,LE,waveletFunction,8);    %delta
% Vectors
D1 = wrcoef('d',ZZ,LE,waveletFunction,1); %noise
D2 = wrcoef('d',ZZ,LE,waveletFunction,2); %noise
D3 = wrcoef('d',ZZ,LE,waveletFunction,3); %npise
D4 = wrcoef('d',ZZ,LE,waveletFunction,4); %noise
Gamma = wrcoef('d',ZZ,LE,waveletFunction,5); %gamma
Beta = wrcoef('d',ZZ,LE,waveletFunction,6); %beta
Alpha = wrcoef('d',ZZ,LE,waveletFunction,7); %alpha
Theta = wrcoef('d',ZZ,LE,waveletFunction,8); %theta
Delta = wrcoef('a',ZZ,LE,waveletFunction,8); %delta
ts=1;
t=0:ts:99;
hold on
plot(t,Alpha,'r','DisplayName','Alpha')
plot(t,Gamma,'b','DisplayName','Gamma')
plot(t,Beta,'g','DisplayName','Beta')
plot(t,Theta,'o','DisplayName','Theta')
plot(t,Delta,'p','DisplayName','Delta')
title('waveform for various bands')
legend
```



5. Detend the signal

Subject A

```
load('train_subject1_psd01.mat') % Loading data 3a Subject A
% points from Subject A, 50
singleStimulus_P5 = squeeze(s(1:50,end))
detrend_sdata = detrend(singleStimulus_P5);
trend = singleStimulus_P5 - detrend_sdata;
mean(detrend_sdata)
frequency_s=60; % Setting the frequency to 60 Hz
N=length(singleStimulus_P5); % Get length of average per 5 trails
t=(0:N-1)/frequency_s; % Generating time vector
plot(t,detrend_sdata,'k');
hold on
plot(t,singleStimulus_P5,'b');
title('Actual Data Plot in Blue vs Detrend Data in Black for 50 samples');
hold off
```



Subject 2

```
load('train_subject2_psd01.mat') % Loading data 3a Subject A
% points from Subject A, 50
singleStimulus_P5 = squeeze(s(1:50,end))
detrend_sdata = detrend(singleStimulus_P5);
trend = singleStimulus_P5 - detrend_sdata;
mean(detrend_sdata)
frequency_s=60; % Setting the frequency to 60 Hz
N=length(singleStimulus_P5); % Get length of average per 5 trails
t=(0:N-1)/frequency_s; % Generating time vector
plot(t,detrend_sdata,'k');
hold on
plot(t,singleStimulus_P5,'b');
title('Actual Data Plot in Blue vs Detrend Data in Black for 50 samples');
hold off
```

Subject 3

```
load('train_subject3_psd01.mat') % Loading data 3a Subject A
% points from Subject A, 50
singleStimulus_P5 = squeeze(s(1:50,end))
detrend_sdata = detrend(singleStimulus_P5);
trend = singleStimulus_P5 - detrend_sdata;
mean(detrend_sdata)
frequency_s=60; % Setting the frequency to 60 Hz
N=length(singleStimulus_P5); % Get length of average per 5 trails
t=(0:N-1)/frequency_s; % Generating time vector
plot(t,detrend_sdata,'k');
hold on
plot(t,singleStimulus_P5,'b');
title('Actual Data Plot in Blue vs Detrend Data in Black for 50 samples');
hold off
title('Actual Data Plot in Blue vs Detrend Data in Black for 50 samples');
hold off
```

6. Extract P300 or ERP from the signals based on the type of task.

The desired task was achieved using

1. Band pass filter
2. Fast Fourier transform
3. Focused channels

Subject 1

```
load('train_subject1_psd01.mat') % Loading data
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singleStimulus_C3+singleStimul
us_C4+singleStimulus_C5+singleStimulus_C6+singleStimulus_C7+singleStimulus_C8+singleStimulus_C
9+singleStimulus_C10+singleStimulus_C11+singleStimulus_C12)/12
t=(0:N-1)/fs; % Generating time vector
figure(1)
bandpass(singleStimulus_P5,[0.15 40],fs/2);
figure(2)
bandpass(singleStimulus_Train_A_parietal_avg,[0.15 40],fs/2)
figure(3)
Y=fft(singleStimulus_P5);
Fs = 1000;              % Sampling frequency
T = 1/Fs;               % Sampling period
t = (0:N-1)*T;          % Time vector
P2 = abs(Y/N);
P1 = P2(1:N/2+1);
P1(2:end-1) = 2*P1(2:end-1);
f = Fs*(0:(N/2))/N;
plot(f,P1)
title('Single-Sided Amplitude Spectrum of Signal(t)');
xlabel('f (Hz)');
ylabel('|P1(f)|');
```

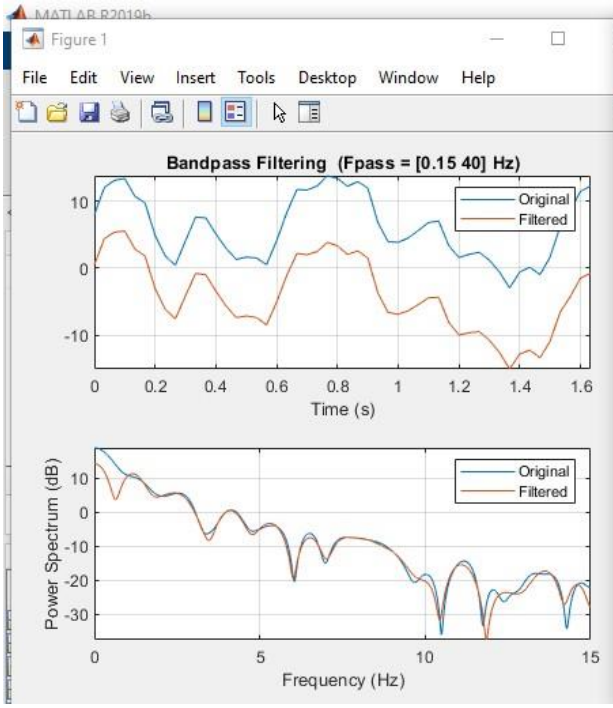


Figure 1
File Edit View Insert Tools Desktop Window Help
Bandpass Filtering (Fpass = [0.15 40] Hz)
Original
Filtered
Time (s)
Power Spectrum (dB)
Frequency (Hz)

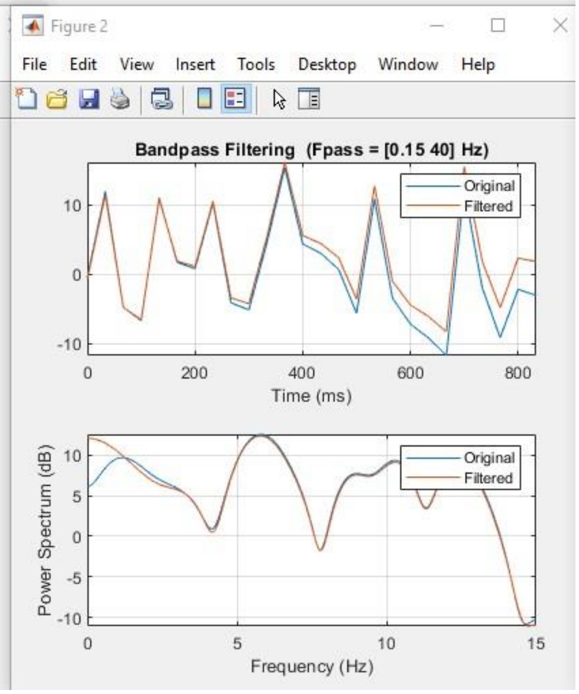


Figure 2
File Edit View Insert Tools Desktop Window Help
Bandpass Filtering (Fpass = [0.15 40] Hz)
Original
Filtered
Time (ms)
Power Spectrum (dB)
Frequency (Hz)

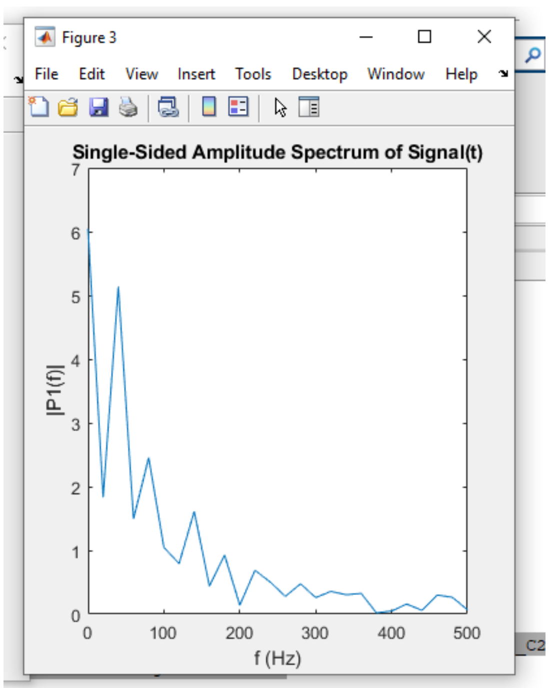


Figure 3
File Edit View Insert Tools Desktop Window Help
Single-Sided Amplitude Spectrum of Signal(t)
|P1(f)|
f (Hz)

Subject 2

```
load('train_subject2_psd01.mat') % Loading data
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singleStimulus_C3+singleStimul
us_C4+singleStimulus_C5+singleStimulus_C6+singleStimulus_C7+singleStimulus_C8+singleStimulus_C
9+singleStimulus_C10+singleStimulus_C11+singleStimulus_C12)/12
t=(0:N-1)/fs; % Generating time vector
figure(1)
bandpass(singleStimulus_P5,[0.15 40],fs/2);
figure(2)
bandpass(singleStimulus_Train_A_parietal_avg,[0.15 40],fs/2)
figure(3)
Y=fft(singleStimulus_P5);
Fs = 1000;            % Sampling frequency
T = 1/Fs;             % Sampling period
t = (0:N-1)*T;        % Time vector
P2 = abs(Y/N);
P1 = P2(1:N/2+1);
P1(2:end-1) = 2*P1(2:end-1);
f = Fs*(0:(N/2))/N;
plot(f,P1)
title('Single-Sided Amplitude Spectrum of Signal(t)');
xlabel('f (Hz)');
ylabel('|P1(f)|');
```

Subject 3

```
load('train_subject3_psd01.mat') % Loading data
fs= 60; % Setting the frequency to 60 Hz
singleStimulus_C1 = squeeze(s(1:50,30))
singleStimulus_C2 = squeeze(s(1:50,31))
singleStimulus_C3 = squeeze(s(1:50,32))
singleStimulus_C4 = squeeze(s(1:50,33))
singleStimulus_C5 = squeeze(s(1:50,34))
singleStimulus_C6 = squeeze(s(1:50,35))
singleStimulus_C7 = squeeze(s(1:50,36))
singleStimulus_C8 = squeeze(s(1:50,37))
singleStimulus_C9 = squeeze(s(1:50,38))
singleStimulus_C10 = squeeze(s(1:50,22))
singleStimulus_C11 = squeeze(s(1:50,23))
singleStimulus_C12 = squeeze(s(1:50,24))
N=length(singleStimulus_C12); % Get length
singleStimulus_frontal_avg=(singleStimulus_C1+singleStimulus_C2+singleStimulus_C3+singleStimul
us_C4+singleStimulus_C5+singleStimulus_C6+singleStimulus_C7+singleStimulus_C8+singleStimulus_C
9+singleStimulus_C10+singleStimulus_C11+singleStimulus_C12)/12
t=(0:N-1)/fs; % Generating time vector
figure(1)
bandpass(singleStimulus_P5,[0.15 40],fs/2);
figure(2)
bandpass(singleStimulus_Train_A_parietal_avg,[0.15 40],fs/2)
figure(3)
Y=fft(singleStimulus_P5);
Fs = 1000;             % Sampling frequency
T = 1/Fs;              % Sampling period
t = (0:N-1)*T;         % Time vector
P2 = abs(Y/N);
P1 = P2(1:N/2+1);
P1(2:end-1) = 2*P1(2:end-1);
f = Fs*(0:(N/2))/N;
plot(f,P1)
title('Single-Sided Amplitude Spectrum of Signal(t)');
xlabel('f (Hz)');
ylabel('|P1(f)|');
```