```
% Christopher Morales
% 4/7/2022 EE 4820
```

Problem 1

```
% Import file
load time_freq1.mat;

% Checking what is inside the file
whos

% Resolution
Nfft = 2^9;

% Creating the length
L = length(x);

% Creating how many windows we will have
Lwin15 = round(L/15);
Lwin25 = round(L/25);
Lwin35 = round(L/35);
Lwin45 = round(L/45);
Lwin55 = round(L/55);
Lwin65 = round(L/65);

% Creating the type of window
win15 = window(@gausswin, Lwin15);
win25 = window(@gausswin, Lwin25);
win35 = window(@gausswin, Lwin35);
win45 = window(@gausswin, Lwin45);
win55 = window(@gausswin, Lwin55);
win65 = window(@gausswin, Lwin65);


% Creating the overlap for the window
Noverlap15 = round(Lwin15 * 0.10);
Noverlap25 = round(Lwin25 * 0.10);
Noverlap35 = round(Lwin35 * 0.10);
Noverlap45 = round(Lwin45 * 0.10);
Noverlap55 = round(Lwin55 * 0.10);
Noverlap65 = round(Lwin65 * 0.10);

% Applying the Short Time Fourier Transform
[y15, f15, t15] = stft(x, fs,'window', win15, 'OverlapLength',Noverlap15, 'FFTlength', Nfft );
[y25, f25, t25] = stft(x, fs,'window', win25, 'OverlapLength',Noverlap25, 'FFTlength', Nfft );
[y35, f35, t35] = stft(x, fs,'window', win35, 'OverlapLength',Noverlap35, 'FFTlength', Nfft );
[y45, f45, t45] = stft(x, fs,'window', win45, 'OverlapLength',Noverlap45, 'FFTlength', Nfft );
[y55, f55, t55] = stft(x, fs,'window', win55, 'OverlapLength',Noverlap55, 'FFTlength', Nfft );
[y65, f65, t65] = stft(x, fs,'window', win65, 'OverlapLength',Noverlap65, 'FFTlength', Nfft );
```

```matlab
% Creating a figure
figure(1)

% Frequency Color Map, 15 Gausswin Windows
subplot(6,1,1);
imagesc(t15,f15,abs(y15));
colorbar;
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 15 Gausswin Windows');

% Frequency Color Map, 25 Gausswin Windows
subplot(6,1,2);
imagesc(t25,f25,abs(y25));
colorbar;
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 25 Gausswin Windows');

% Frequency Color Map, 35 Gausswin Windows
subplot(6,1,3);
imagesc(t35,f35,abs(y35));
colorbar;
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 35 Gausswin Windows');

% Frequency Color Map, 45 Gausswin Windows
subplot(6,1,4);
imagesc(t45,f45,abs(y45));
colorbar;
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 45 Gausswin Windows');

% Frequency Color Map, 55 Gausswin Windows
subplot(6,1,5);
imagesc(t55,f55,abs(y55));
colorbar;
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 55 Gausswin Windows');

% Frequency Color Map, 65 Gausswin Windows
subplot(6,1,6);
imagesc(t65,f65,abs(y65));
colorbar;
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 65 Gausswin Windows');
```
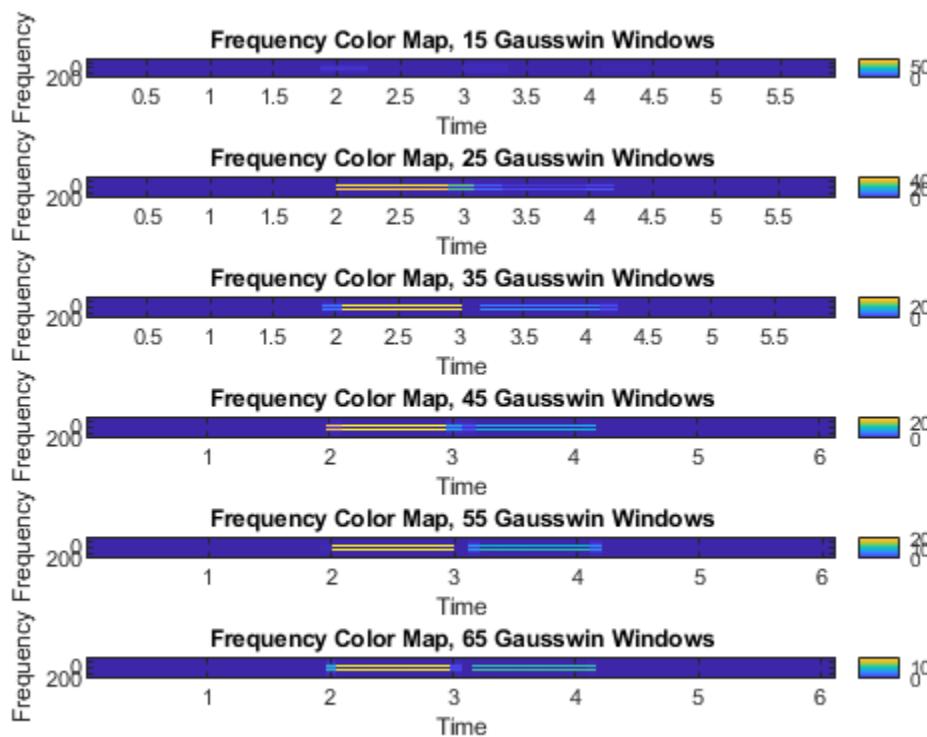
```
Name          Size              Bytes  Class     Attributes

fs            1x1                   8  double
x             1x2462            19696  double
```


Frequency Color Map, 15 Gausswin Windows

Frequency Color Map, 25 Gausswin Windows

Frequency Color Map, 35 Gausswin Windows

Frequency Color Map, 45 Gausswin Windows

Frequency Color Map, 55 Gausswin Windows

Frequency Color Map, 65 Gausswin Windows

Problem 2

```matlab
% Load file
load time_freq2.mat;

% Checking the contents
whos

% Sample Frequency
fs = 600;

% Resolution
Nfft = 2^9;

% Creating the length
L = length(x);

% Creating how many windows
Lwin80 = round(L/80);
Lwin20 = round(L/20);
```

```matlab
% Creating the type of window (either rectangular or hamming window and 80 or 20 windows)
winRectangular80 = window(@rectwin, Lwin80);
winHamming80 = window(@hamming, Lwin80);
winRectangular20 = window(@rectwin, Lwin20);
winHamming20 = window(@hamming, Lwin20);


% How much to overlap on the window
Noverlap80 = round(Lwin80*0.50);
Noverlap20 = round(Lwin20*0.50);


% Applying Short Time Fourier Transfer
[yRect80, fRect80, tRect80] = stft(x, fs, "Window", winRectangular80, "OverlapLength",
Noverlap80, "FFTLength", Nfft);
[yRect20, fRect20, tRect20] = stft(x, fs, "Window", winRectangular20, "OverlapLength",
Noverlap20, "FFTLength", Nfft);
[yHam80, fHam80, tHam80] = stft(x, fs, "Window", winHamming80, "OverlapLength", Noverlap80,
"FFTLength", Nfft);
[yHam20, fHam20, tHam20] = stft(x, fs, "Window", winHamming20, "OverlapLength", Noverlap20,
"FFTLength", Nfft);

% Creating a figure
figure(2);

% Plotting Rectangluar with 80 windows
subplot(4,1,1);
imagesc(tRect80,fRect80, abs(yRect80));
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 80 Rectangular Windows');
colorbar;

% Plotting Rectanular with 20 windows
subplot(4,1,2);
imagesc(tRect20,fRect20, abs(yRect20));
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 20 Rectangular Windows');
colorbar;

% Plotting Hamming with 80 windows
subplot(4,1,3);
imagesc(tHam80,fHam80, abs(yHam80));
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 80 Hamming Windows');
colorbar;

% Plotting Hamming with 20 windows
subplot(4,1,4);
```
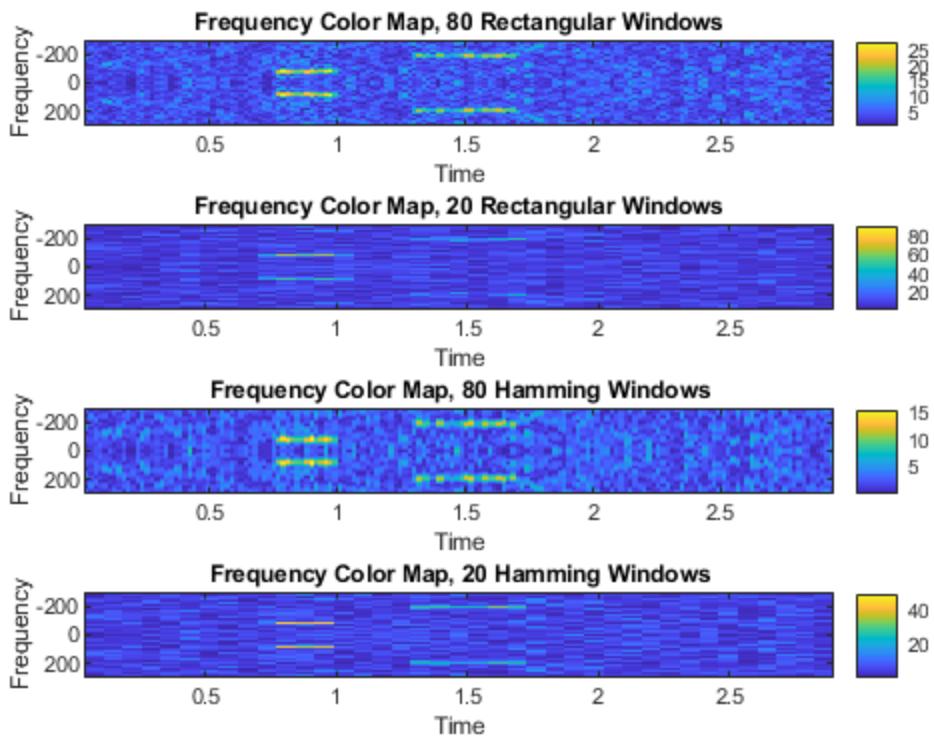
```
imagesc(tHam20,fHam20, abs(yHam20));
xlabel('Time');
ylabel('Frequency');
title('Frequency Color Map, 20 Hamming Windows');
colorbar;
```

Name	Size	Bytes	Class	Attributes
L	1x1	8	double	
Lwin15	1x1	8	double	
Lwin25	1x1	8	double	
Lwin35	1x1	8	double	
Lwin45	1x1	8	double	
Lwin55	1x1	8	double	
Lwin65	1x1	8	double	
Nfft	1x1	8	double	
Noverlap15	1x1	8	double	
Noverlap25	1x1	8	double	
Noverlap35	1x1	8	double	
Noverlap45	1x1	8	double	
Noverlap55	1x1	8	double	
Noverlap65	1x1	8	double	
f15	512x1	4096	double	
f25	512x1	4096	double	
f35	512x1	4096	double	
f45	512x1	4096	double	
f55	512x1	4096	double	
f65	512x1	4096	double	
fs	1x1	8	double	
t15	16x1	128	double	
t25	27x1	216	double	
t35	38x1	304	double	
t45	50x1	400	double	
t55	61x1	488	double	
t65	72x1	576	double	
win15	164x1	1312	double	
win25	98x1	784	double	
win35	70x1	560	double	
win45	55x1	440	double	
win55	45x1	360	double	
win65	38x1	304	double	
x	1x1772	14176	double	
y15	512x16	131072	double	complex
y25	512x27	221184	double	complex
y35	512x38	311296	double	complex
y45	512x50	409600	double	complex
y55	512x61	499712	double	complex
y65	512x72	589824	double	complex

Frequency Color Map, 80 Rectangular Windows

Frequency Color Map, 20 Rectangular Windows

Frequency Color Map, 80 Hamming Windows

Frequency Color Map, 20 Hamming Windows

Problem 3

```matlab
% Loading in the 8 EEG signals
load eeg1-c3.dat;
load eeg1-c4.dat;
load eeg1-f3.dat;
load eeg1-f4.dat;
load eeg1-o1.dat;
load eeg1-o2.dat;
load eeg1-p3.dat;
load eeg1-p4.dat;

% Creating an array
eegTotal = [eeg1_c3 eeg1_c4 eeg1_f3 eeg1_f4 eeg1_o1 eeg1_o2 eeg1_p3 eeg1_p4];

% Resolution
Nfft = 256;

% Sample Frequency
fs = 100;

% Getting the length
L = length(eeg1_c3);

% Time domain
t1 = [1:L]/fs;
```

```matlab
% Creating how many windows
Lwin = round(L/60);

% Creating the type of window
win = window(@gausswin, Lwin);

% How much to overlap on the window
Noverlap = round(Lwin*0.50);

% Applying Short Time Fourier Transfer
[y, f, t] = stft(eeg1_c3, fs, "Window", win, "OverlapLength", Noverlap, "FFTLength", Nfft);
[y1, f, t] = stft(eeg1_c4, fs, "Window", win, "OverlapLength", Noverlap, "FFTLength", Nfft);
[y2, f, t] = stft(eeg1_f3, fs, "Window", win, "OverlapLength", Noverlap, "FFTLength", Nfft);
[y3, f, t] = stft(eeg1_f4, fs, "Window", win, "OverlapLength", Noverlap, "FFTLength", Nfft);
[y4, f, t] = stft(eeg1_o1, fs, "Window", win, "OverlapLength", Noverlap, "FFTLength", Nfft);
[y5, f, t] = stft(eeg1_o2, fs, "Window", win, "OverlapLength", Noverlap, "FFTLength", Nfft);
[y6, f, t] = stft(eeg1_p3, fs, "Window", win, "OverlapLength", Noverlap, "FFTLength", Nfft);
[y7, f, t] = stft(eeg1_p4, fs, "Window", win, "OverlapLength", Noverlap, "FFTLength", Nfft);


% Creating a figure
figure(3)

% Plotting all the EEG Signals in Frequency Colormap
subplot(8,1,1);
imagesc(t,f, abs(y));
xlabel('Time');
ylabel('EEG Signal, C3');
title('Time vs EEG Signal');

subplot(8,1,2);
imagesc(t,f, abs(y1));
xlabel('Time');
ylabel('EEG Signal, C4');
title('Time vs EEG Signal');

subplot(8,1,3);
imagesc(t,f, abs(y2));
xlabel('Time');
ylabel('EEG Signal, f3');
title('Time vs EEG Signal');

subplot(8,1,4);
imagesc(t,f, abs(y3));
xlabel('Time');
ylabel('EEG Signal, f4');
title('Time vs EEG Signal');

subplot(8,1,5);
imagesc(t,f, abs(y4));
xlabel('Time');
ylabel('EEG Signal, o1');
```

```matlab
title('Time vs EEG Signal');

subplot(8,1,6);
imagesc(t,f, abs(y5));
xlabel('Time');
ylabel('EEG Signal, o2');
title('Time vs EEG Signal');

subplot(8,1,7);
imagesc(t,f, abs(y6));
xlabel('Time');
ylabel('EEG Signal, p3');
title('Time vs EEG Signal');

subplot(8,1,8);
imagesc(t,f, abs(y7));
xlabel('Time');
ylabel('EEG Signal, p4');
title('Time vs EEG Signal');



% Creating a figure
figure(4)

% Plotting Time Domain vs Power Density
subplot(8,1,1);
plot(t, abs(y));
xlabel('Time');
ylabel('EEG Signal, c3');
title('Time vs Power Density');

subplot(8,1,2);
plot(t, abs(y1));
xlabel('Time');
ylabel('EEG Signal, c4');
title('Time vs Power Density');

subplot(8,1,3);
plot(t, abs(y2));
xlabel('Time');
ylabel('EEG Signal, f3');
title('Time vs Power Density');

subplot(8,1,4);
plot(t, abs(y3));
xlabel('Time');
ylabel('EEG Signal, f4');
title('Time vs Power Density');

subplot(8,1,5);
plot(t, abs(y4));
xlabel('Time');
```

```matlab
ylabel('EEG Signal, o1');
title('Time vs Power Density');

subplot(8,1,6);
plot(t, abs(y5));
xlabel('Time');
ylabel('EEG Signal, o2');
title('Time vs Power Density');

subplot(8,1,7);
plot(t, abs(y6));
xlabel('Time');
ylabel('EEG Signal, p3');
title('Time vs Power Density');

subplot(8,1,8);
plot(t, abs(y7));
xlabel('Time');
ylabel('EEG Signal, p4');
title('Time vs Power Density');


% Creating a figure
figure(5)

% Plotting Time Domain vs Power Density
subplot(8,1,1);
plot(f, abs(y));
xlabel('Frequency');
ylabel('EEG Signal, c3');
title('Frequency vs Power Density');

subplot(8,1,2);
plot(f, abs(y1));
xlabel('Frequency');
ylabel('EEG Signal, c4');
title('Frequency vs Power Density');

subplot(8,1,3);
plot(f, abs(y2));
xlabel('Frequency');
ylabel('EEG Signal, f3');
title('Frequency vs Power Density');

subplot(8,1,4);
plot(f, abs(y3));
xlabel('Frequency');
ylabel('EEG Signal, f4');
title('Frequency vs Power Density');

subplot(8,1,5);
plot(f, abs(y4));
```

```matlab
xlabel('Frequency');
ylabel('EEG Signal, o1');
title('Frequency vs Power Density');

subplot(8,1,6);
plot(f, abs(y5));
xlabel('Frequency');
ylabel('EEG Signal, o2');
title('Frequency vs Power Density');

subplot(8,1,7);
plot(f, abs(y6));
xlabel('Frequency');
ylabel('EEG Signal, p3');
title('Frequency vs Power Density');

subplot(8,1,8);
plot(f, abs(y7));
xlabel('Frequency');
ylabel('EEG Signal, p4');
title('Frequency vs Power Density');


fprintf('I plotted (Time vs Power Density), (Frequency vs Power Density), and (Frequency
Colormap) \n');
fprintf('To see any coorelation, where in time the rythmn is located for (Time vs Density) \n');
fprintf('Then using, (Frequency vs Power Density), to determine where the peak is located at \n')
fprintf('Once observing the two plots, I verify with the (Frequency Colormap) \n');
fprintf('For each eeg to see what is coorelation \n');
fprintf('From my observation, around or close to 0, the signal is most active \n');
fprintf('Finally, from observing from each (Frequency Colormap), I noticed the bright spots \n');
fprintf('The bright spots duration is from 0 - 200 second around 0 Hz \n');

% Identify axes coordinates
%[x,y] = ginput(eegTotal);
```
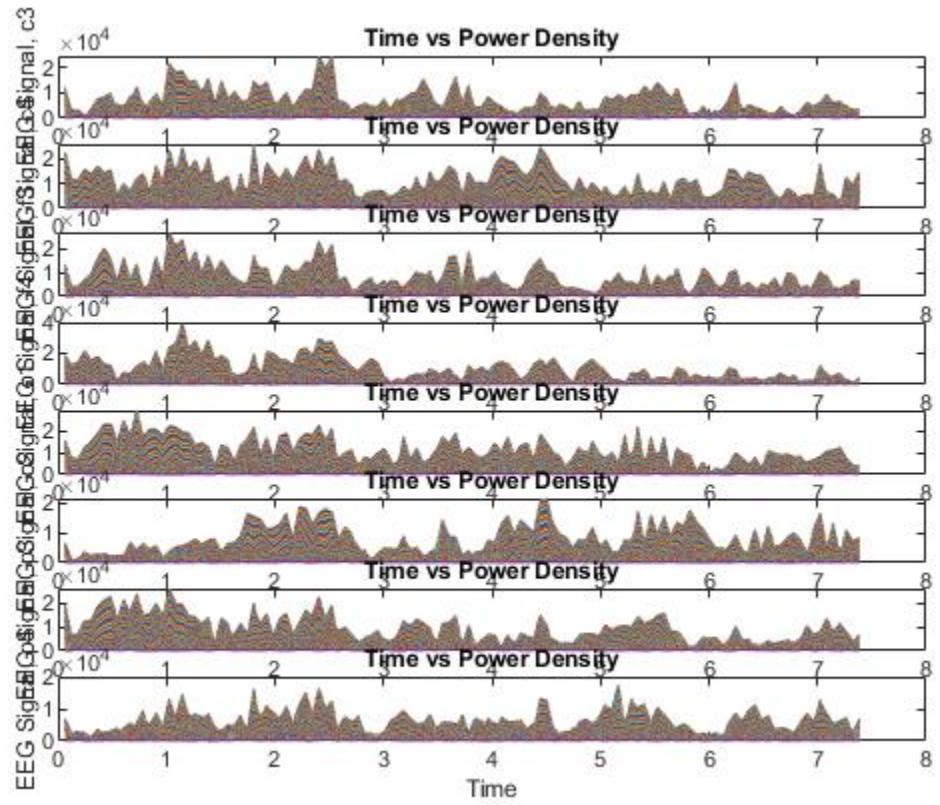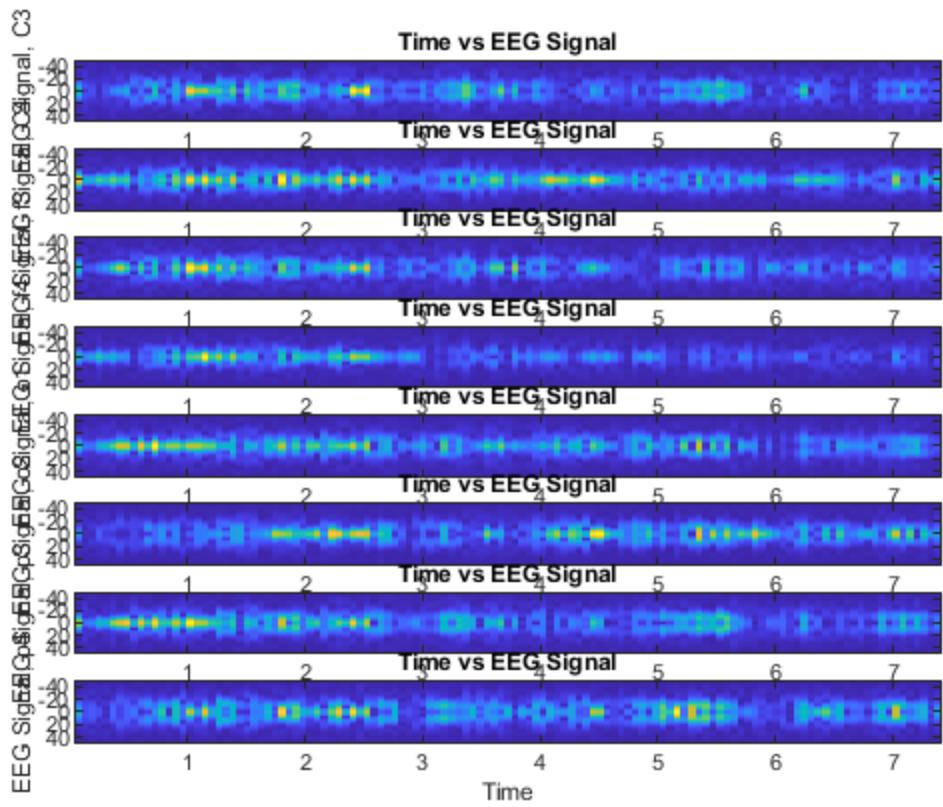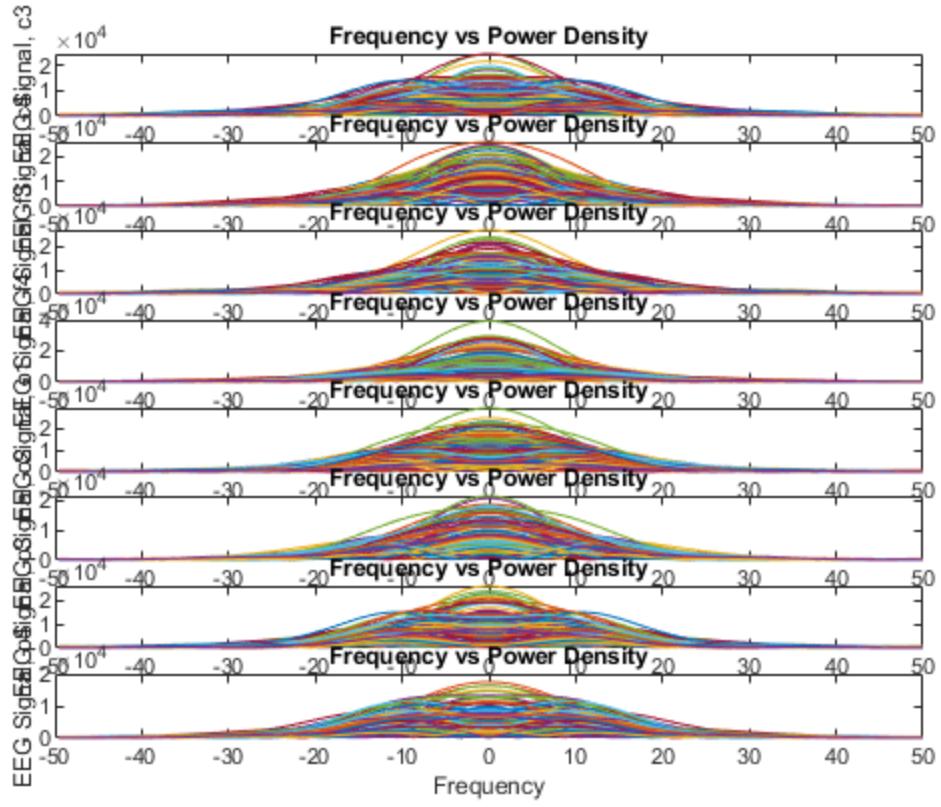
I plotted (Time vs Power Density), (Frequency vs Power Density), and (Frequency Colormap)
To see any coorelation, where in time the rythmn is located for (Time vs Density)
Then using, (Frequency vs Power Density), to determine where the peak is located at
Once observing the two plots, I verify with the (Frequency Colormap)
For each eeg to see what is coorelation
From my observation, around or close to 0, the signal is most active
Finally, from observing from each (Frequency Colormap), I noticed the bright spots
The bright spots duration is from 0 - 200 second around 0 Hz

Time vs EEG Signal

Time vs Power Density