Assignment 6 - Dimitar Dimitrov - s1018291

8.3 - 1/f noise

8.3 - 1

```
load('tfr-data.mat');
```

8.3 - 2 - CODE

```
freq = 1/(time(2)-time(1));
```

8.3 - 2 - ANSWER

the sampling frequency is 300hz

8.3 - 3

```
dfft = fft(data,[], 2);
```

8.3 - 4

```
n=length(dfft);
T = n/freq;
df= 1/T;
f = 0:df:(freq-df); % frequency range
n=length(dfft);
n_cutoff = floor(n/2);
range = f(1:n_cutoff); % cut off the data at nyquist frequency
```

8.3 - 4 ANSWER

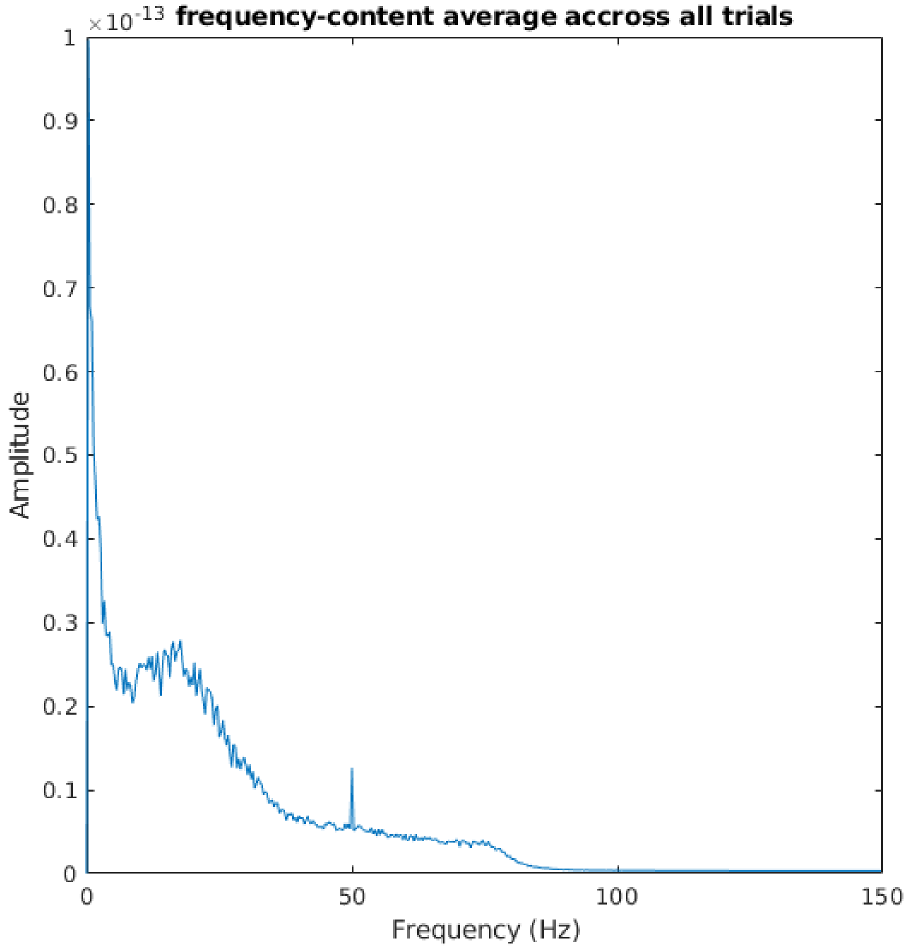
The associated frequency range is 300hz, nyquist frequency is then 150hz

8.3 - 5

```
amplitude = abs(dfft)/n;
amplitude = 2 * amplitude(:,1:n_cutoff);
amplitude(:,1) = amplitude(:,1)/2;
```

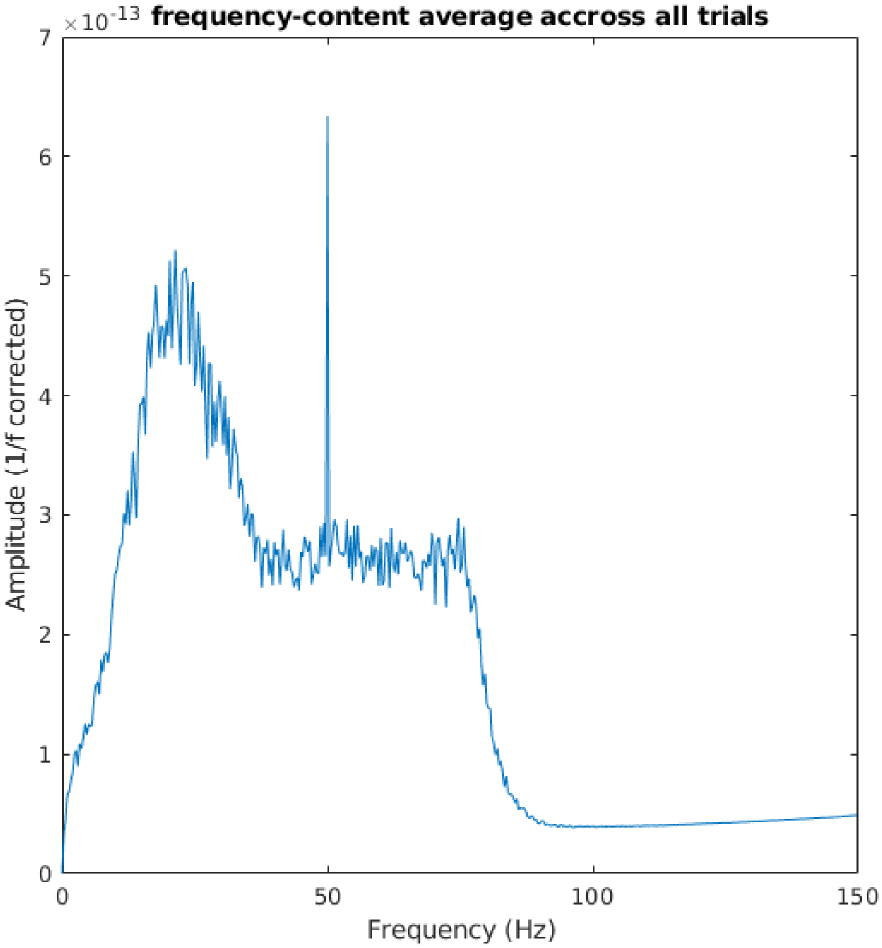
8.3 - 6

```
amp_mean = mean(amplitude);
plot(range, amp_mean);
xlabel('Frequency (Hz)');
ylabel('Amplitude');
title('frequency-content average accross all trials');
set(gcf, 'Position', [10,10,600,600]);
```



8.3 - 7

```
new_amp_mean = amp_mean.*range;
plot(range, new_amp_mean);
xlabel('Frequency (Hz)');
ylabel('Amplitude (1/f corrected)');
title('frequency-content average accross all trials');
set(gcf, 'Position', [10,10,600,600]);
```



8.3 - 7 - ANSWER

the noise at the beginning of the spectrum seems to be gone, the rest of the graph is rescaled so now the highest peak is at 50hz

8.3 - 8

the 50hz frequency occurs most frequently because of the power outlet

8.3 - 9

activity seems to occur in the bandwidth 0 to 80 but that seems to be comprised of 3 main bandwidths - 0 to 80 with moderate amplitude, 0-40 with a huge peak in the middle, and the spike at 50hz

8.4 - slice fft

8.4

```
load('tfr-data.mat');
freq = 1/(time(2)-time(1));
```

8.4 - 1

```
s_begin = 1;
s_end = 100;
```

8.4 - 2

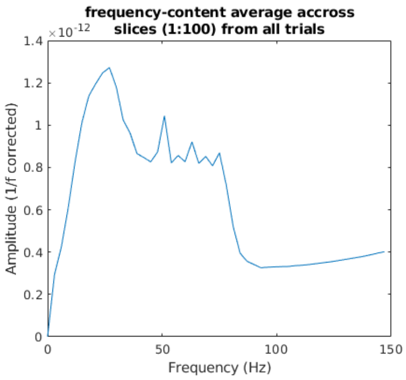
```
slice = data(:,s_begin:s_end);
```

8.4 - 3

```
[range, amplitude] = fourier_transform(freq, slice);
```

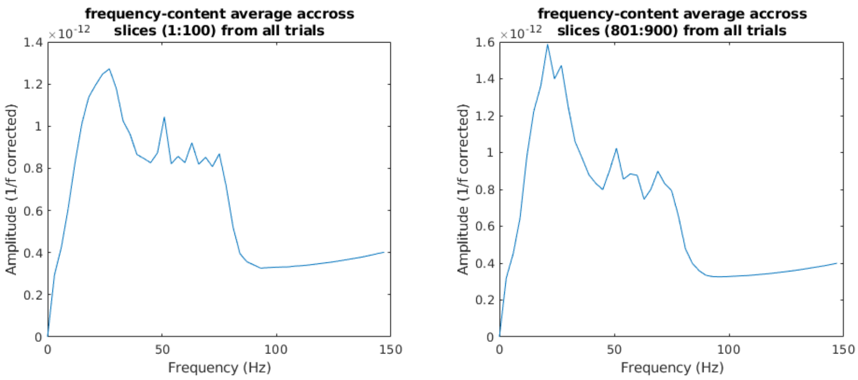
8.4 - 4

```
subplot(121);
amp_mean = mean(amplitude);
denoised = amp_mean.*range;
plot(range, denoised);
xlabel('Frequency (Hz)');
ylabel('Amplitude (1/f corrected)');
title([{'frequency-content average accross'},
    {'slices (1:100) from all trials'}]);
set(gcf, 'Position', [10,10,1100,400]);
```



8.4 - 5

```
subplot(122)
s_begin = 801;
s_end = 900;
slice = data(:,s_begin:s_end);
[range, amplitude] = fourier_transform(freq, slice);
amp_mean = mean(amplitude);
denoised = amp_mean.*range;
plot(range, denoised);
xlabel('Frequency (Hz)');
ylabel('Amplitude (1/f corrected)');
title([{'frequency-content average accross'},
    {'slices (801:900) from all trials'}]);
set(gcf, 'Position', [10,10,1100,400]);
```



8.4 - 5 ANSWER

it belongs to timeslot starting at 1.667 seconds and ending at 1.9967 seconds

8.4 - 6

the shape is generally the same, the (801-900) slice exhibits slightly higher amplitude values

8.4 - 7

```
[v, idx] = nearest_value(range, 29);
amp_twni = amp_mean(idx);
```

8.4 - 7 ANSWER

the mean amplitude at frequency of 29Hz is 4.1526e-14 (note that this is for the window slice from samples 801 to 900)

8.5 get_single_amplitude

```
function [amplitude] = get_single_amplitude(data, fs, s_begin, s_end, foi)
% function [amplitude] = get_single_amplitude(data, fs, s_begin, s_end, foi)
% takes signal data matrix, frequency, beginning index of slice, end index
% of slice and a frequency of interest and returns the amplitude of the
% frequency
if (s_begin < 1 || s_end > size(data,2))
    amplitude = NaN;
else
    slice = data(:,s_begin:s_end);
    [range, amplitudes] = fourier_transform(fs, slice);
    amp_mean = mean(amplitudes);
    [~, idx] = nearest_value(range, foi);
    amplitude = amp_mean(idx);
end
end
```

8.6 mean amplitude

8.6

```
load('tfr-data.mat');
window_size = 100;
foi = 29;
fs = 1/(time(2)-time(1));
```

8.6 - a)

```
amps = zeros(1,size(data,2));
```

8.6 - b) + c)

```
for t=1:size(data,2)
    s_begin = t-floor(window_size/2);
    s_end = t+ceil(window_size/2)-1;
    amps(t) = get_single_amplitude(data, fs, s_begin, s_end, foi);
end
```

8.7 sliding window analysis

get_amplitude function

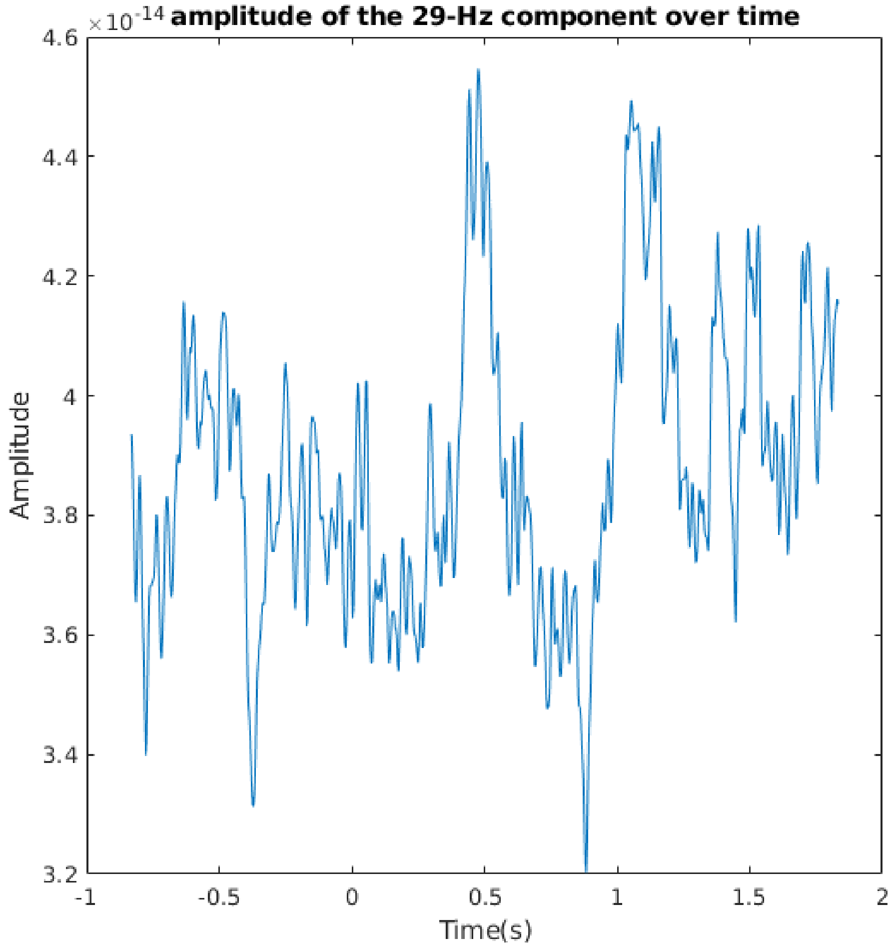
```
function [amplitudes] = get_amplitude(data, fs, window_size, foi)
% function [amplitudes] = get_amplitude(data, fs, window_size, foi)
% function takes data, sampling frequency, size of sample window and
% frequency of interest and returns vector of the amplitudes of that
% frequency for each window, having as many windows as data points per
% sensor in the data

amplitudes = zeros(1,size(data,2));

for t=1:size(data,2)
    s_begin = t-floor(window_size/2);
    s_end = t+ceil(window_size/2)-1;
    amplitudes(t) = get_single_amplitude(data, fs, s_begin, s_end, foi);
end
```

8.7

```
load('tfr-data.mat');
window_size = 100;
foi = 29;
fs = 1/(time(2)-time(1));
```

8.7 a)

```
plot(time, get_amplitude(data, fs, window_size, foi));
xlabel('Time(s)');
ylabel('Amplitude');
title('amplitude of the 29-Hz component over time');
set(gcf, 'Position', [10,10,600,600]);
```



8.8 tfr

8.8

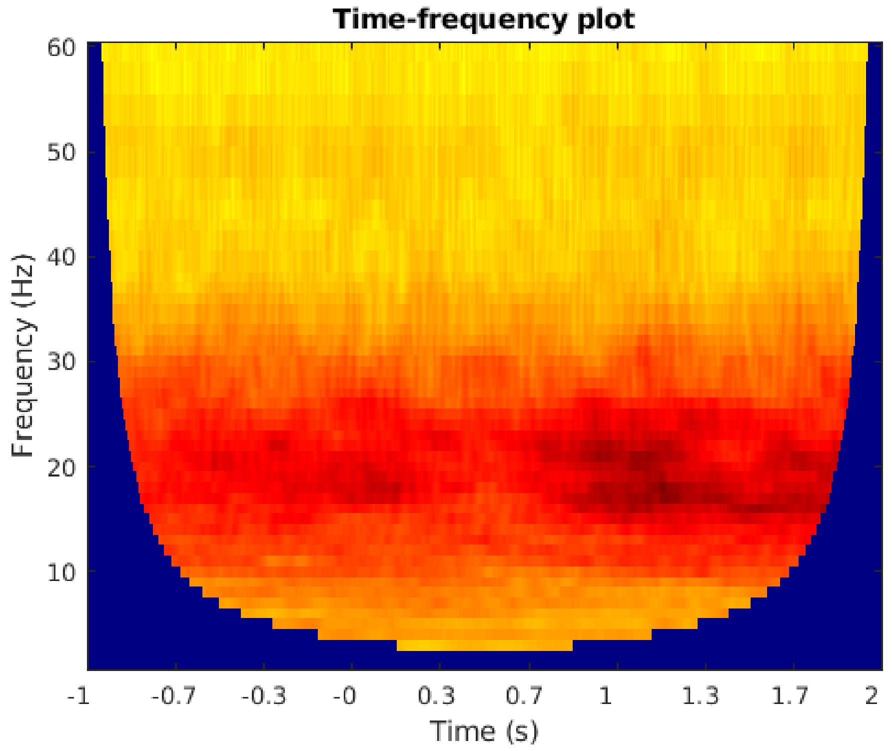
```
load('tfr-data.mat');
fs = 1/(time(2)-time(1));
tfr = [];
```

8.8 a)

```
for freq = 1:60
    window_size = ( (1/freq)*fs) * 7;
    tfr = [tfr; get_amplitude(data, fs, window_size, freq)];
end
```

8.8 b)

```
image(128 + 128* tfr./max( max( abs(tfr) ) ) );
set(gca, 'YDIR', 'normal');
set(gca, 'XTick', linspace(1,size(data,2), 10));
tf = time(1); tl = time(end);
set(gca, 'XTickLabel', round(10*(linspace(tf,tl,10)))/10);
colormap jet;
xlabel('Time (s)');
ylabel('Frequency (Hz)');
title('Time-frequency plot');
```



8.9 corrected tfr

8.9

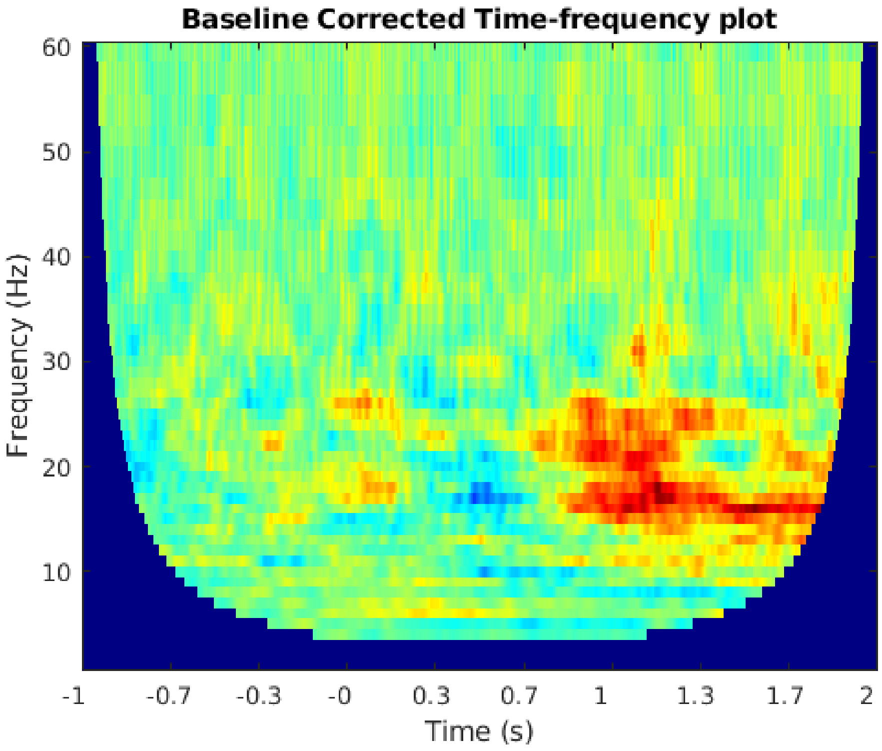
```
load('tfr-data.mat');
fs = 1/(time(2)-time(1));
tfr = [];
for freq = 1:60
    window_size = ( (1/freq)*fs) * 7;
    tfr = [tfr; get_amplitude(data, fs, window_size, freq)];
end
```

8.9 - a)

```
baseline_tfr = tfr(:,time<0);
baseline_mean = nanmean(baseline_tfr,2);
tfr_corrected = tfr - repmat(baseline_mean, 1, size(tfr,2));
```

8.9 - b)

```
image(128 + 128* tfr_corrected./max( max( abs(tfr_corrected) ) ) );
set(gca, 'YDIR', 'normal');
set(gca, 'XTick', linspace(1,size(data,2), 10));
tf = time(1); tl = time(end);
set(gca, 'XTickLabel', round(10*(linspace(tf,tl,10)))/10);
colormap jet;
xlabel('Time (s)');
ylabel('Frequency (Hz)');
title('Baseline Corrected Time-frequency plot');
```



Misc: modified Fourier Transform function, similar to the one i previously forgot to submit

```
function[range, amplitude] = fourier_transform(fs, signal)
% function[range, amplitude] = fourier_transform(time, signal)
% takes a frequency scalar and data matrix, returns the range and amplitude
% of the fourier transform of that signal.

% convert signal from time to frequency domain
Y = fft(signal,[], 2);
n = size(signal, 2);

% get the amplitude
amplitude = abs(Y)/n;

% construct the associated frequency vector:
T=n/fs;
df=1/T;
f=0:df:(fs-df);

% take Nyquist into account
n = size(Y,2);
n_cutoff = floor(n/2);
range = f(1:n_cutoff);
amplitude = 2 * amplitude(:,1:n_cutoff);
amplitude(:,1) = amplitude(:,1)/2;
end
```