Computer assignment 1

→EEG signals processing and frequency filtering←

PRINCIPLES OF BIOELECTRICAL ENGINEERING

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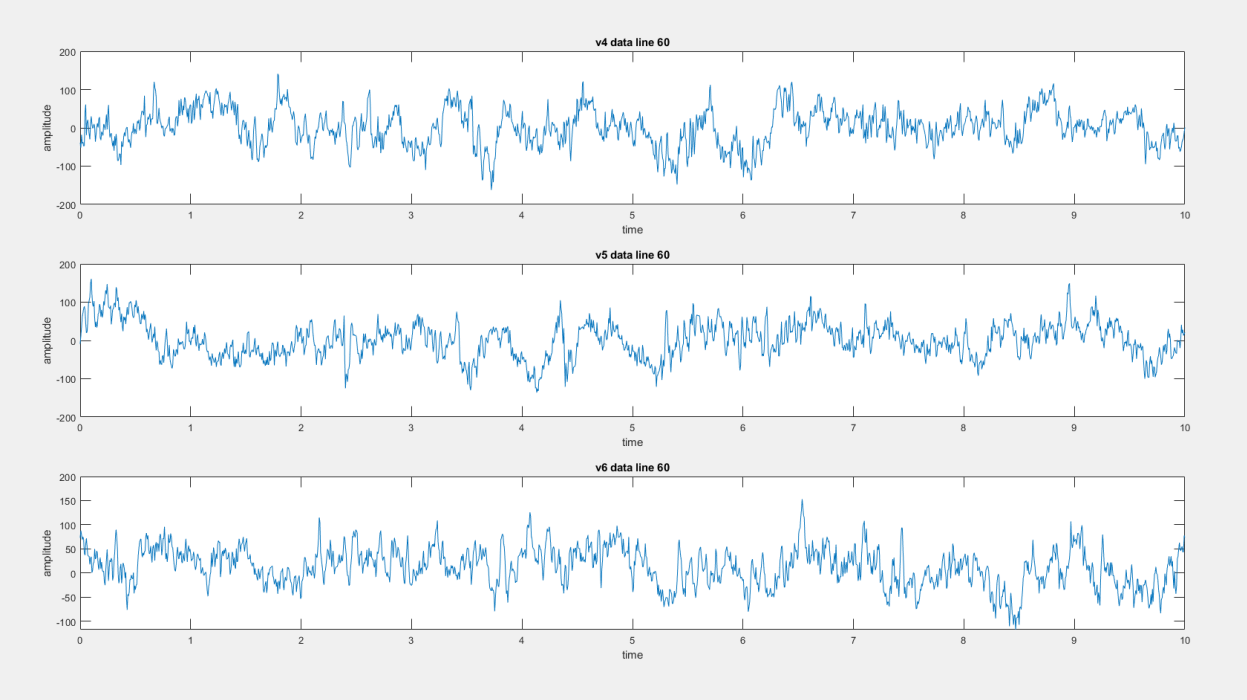
Phase 1.1:

It this phase we plot the EEG signal (my plot uses 60th line of var4/5/6.mat for sample data) in time domain. The plots are fully shown below.

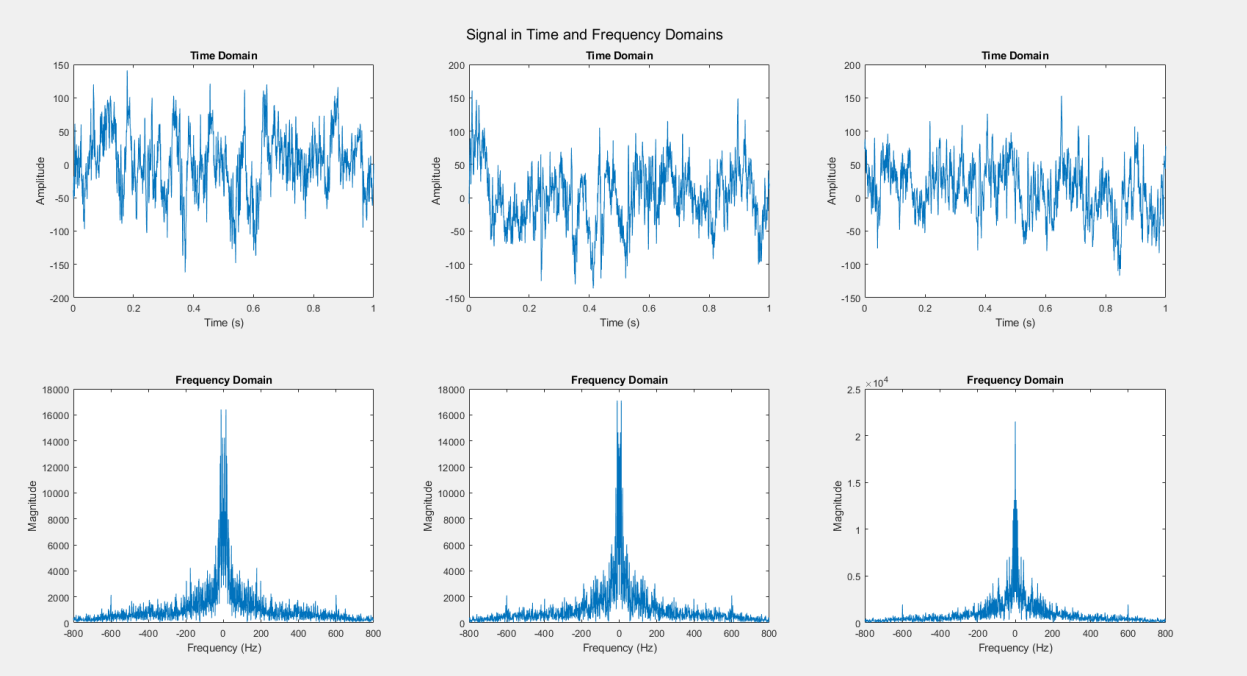


Notes:

- These signals are specified for 10 seconds EEG signal of brain.
- Figure contains three plots below one another to ease comparing.
- All three samples are for line 60 of data set.
- The data of v4, v5 and v6 are used.

Phase 1.2:

In this phase we plot the EEG signals in frequency domain and compare in with time domain.



Notes:

- These signals are specified for 10 seconds EEG signal of brain.
- Figure contains three plots below one another to ease comparing.
- All three samples are for line 60 of data set.
- The data of v4, v5 and v6 are used.

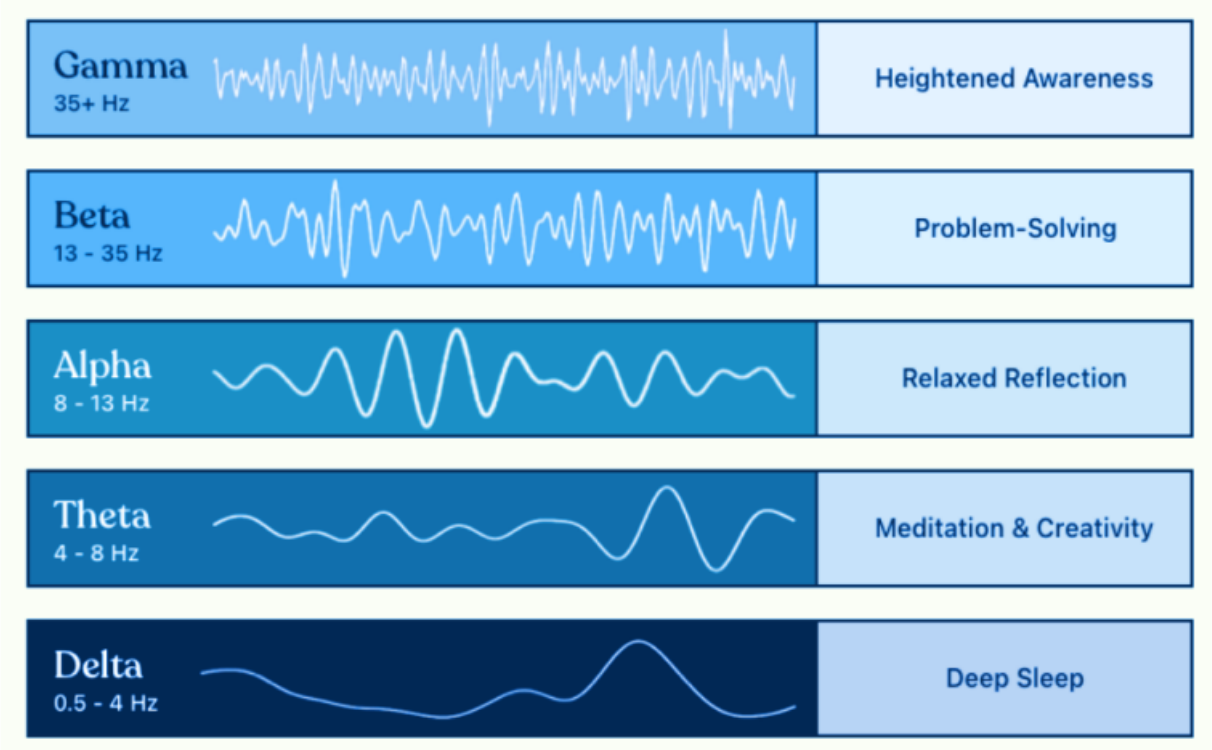
Question: can we find a relation between EEG domain** and frequency of the signal?

Answer:

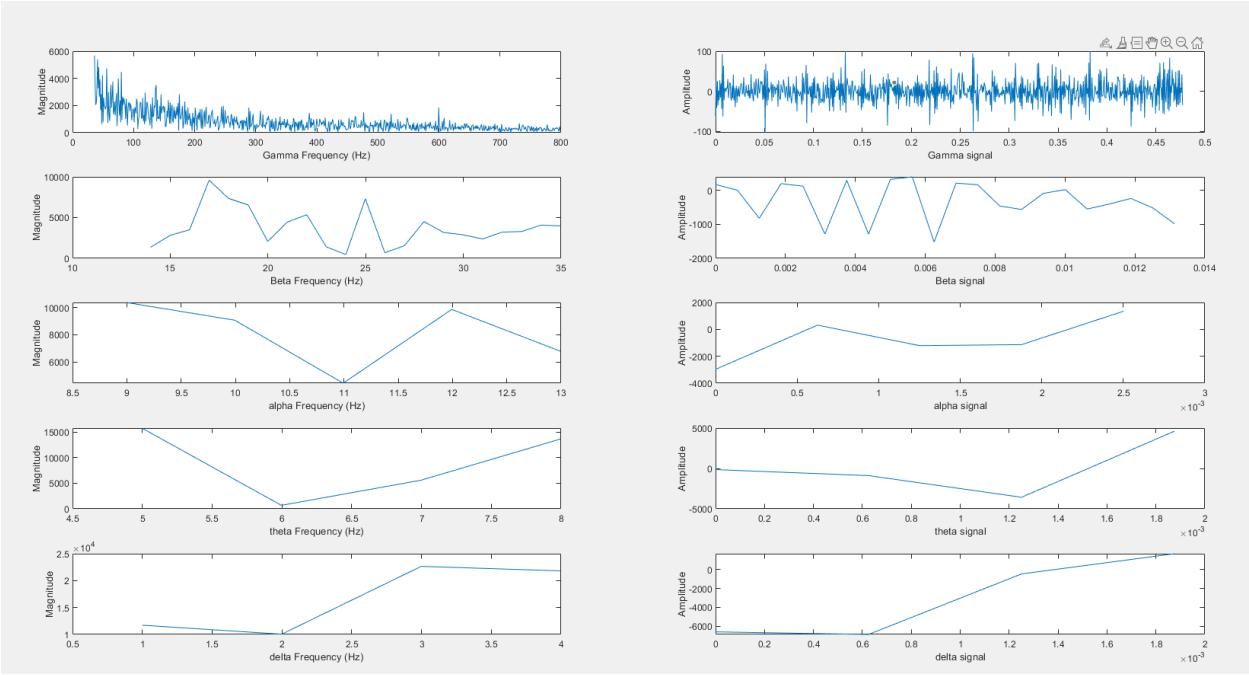
In time domain we cant say anything about the signal and its almost unprocessable so we plot it in frequency domain to analyze it.

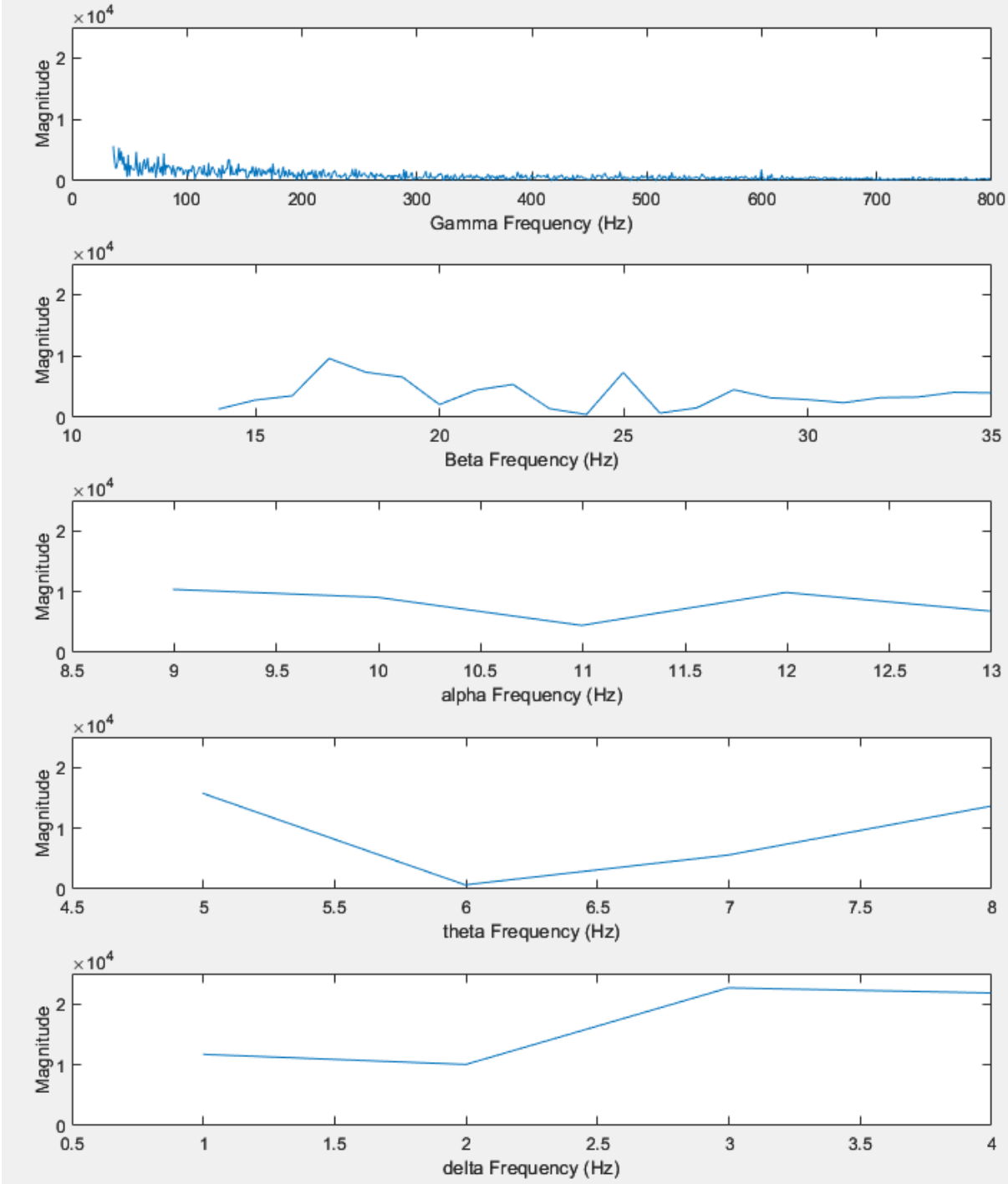
Phase 1.3:

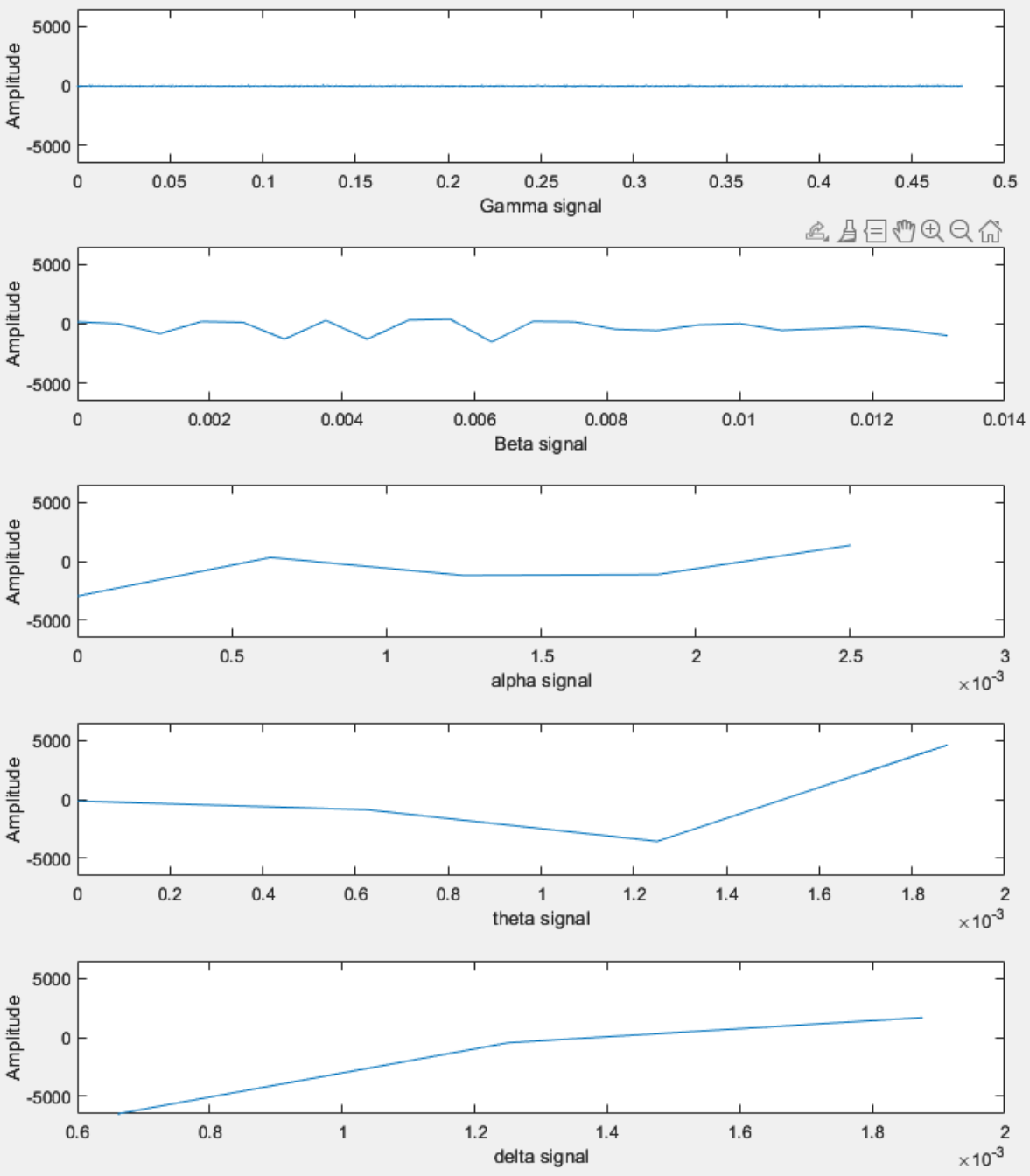
In this phase we try to filter a sample signal in specific frequency to compare them and realize in which state of brain the patient's brain is functioning.

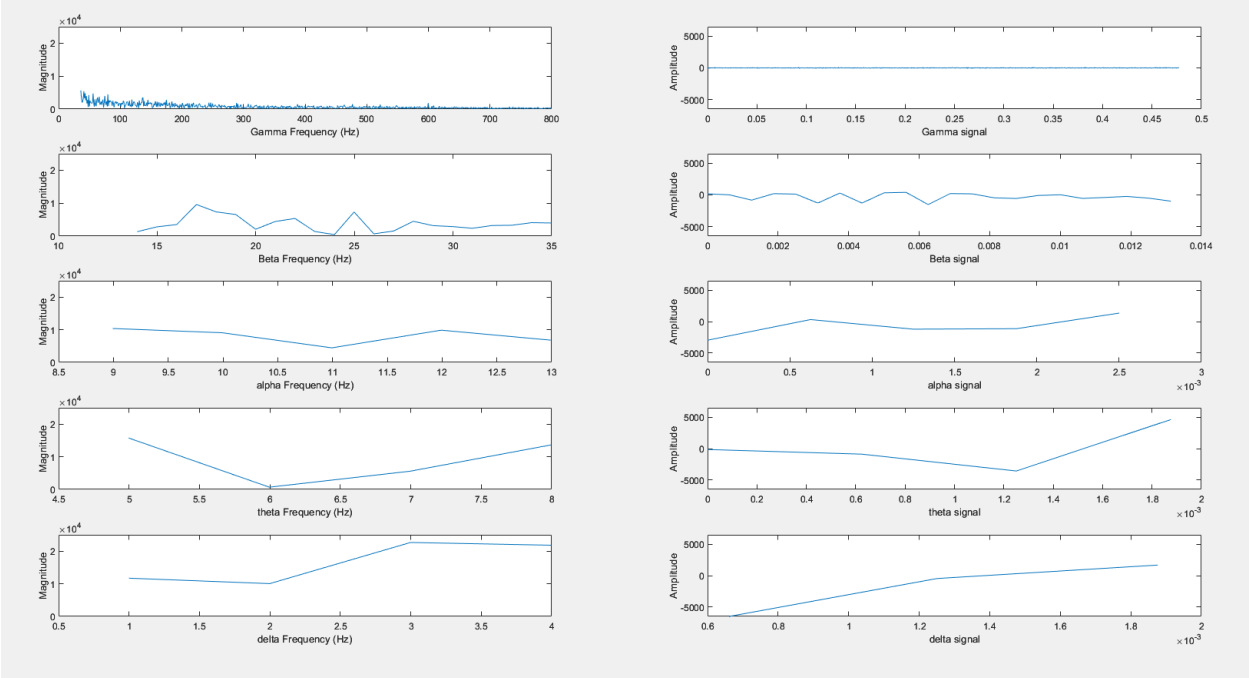


The figure is shown below:




×10^4
Magnitude
Gamma Frequency (Hz)
Beta Frequency (Hz)
alpha Frequency (Hz)
theta Frequency (Hz)
delta Frequency (Hz)


Amplitude
5000
0
-5000
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Gamma signal
Amplitude
5000
0
-5000
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
Beta signal
Amplitude
5000
0
-5000
0
0.5
1
1.5
2
2.5
3
alpha signal
×10-3
Amplitude
5000
0
-5000
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
theta signal
×10-3
Amplitude
5000
0
-5000
0.6
0.8
1
1.2
1.4
1.6
1.8
2
delta signal
×10-3



Notes:

- After filtering the signal in the frequency range that we wanted, now we can deicide in which state the brain is functioning.
- Ive used ylim command to scale the plots.

Phase 2.1:

In this phase we discuss different levels of sleep and their frequencies.

Each sleep stage has a unique function and role in maintaining your brain's overall cognitive performance. Some stages are also associated with physical repairs that keep you healthy and get you ready for the next day.

NREM Stage 1:

The first stage of the sleep cycle is a transition period between wakefulness and sleep. This brief period of sleep lasts for around five to 10 minutes. The brain is still relatively active and producing high amplitude theta waves, which are slow brainwaves occurring primarily in the brain's frontal lobe.

NREM Stage 2:

People spend about half of their total sleep time during NREM stage 2, which lasts for about 20 minutes per cycle. While this is occurring, your body slows down in preparation for NREM stage 3 sleep and REM sleep—the deep sleep stages when the brain and body repair, restore, and reset for the coming day

NREM Stage 3:

Deep, slow brain waves known as delta waves begin to emerge during NREM stage 3 sleep—a stage that is also referred to as delta sleep. This is a period of deep sleep where any environmental noises or activity may fail to wake the sleeping person. During this deep sleep stage, your body starts its physical repairs. Getting enough NREM stage 3 sleep makes you feel refreshed the next day.

Stage 4: REM Sleep:

While your brain is aroused with mental activities during REM sleep, the fourth stage of sleep, your voluntary muscles become immobilized. REM sleep begins approximately 90 minutes after falling asleep. At this time:

Your brain lights up with activity Your body is relaxed and immobilized Your breathing is faster and irregular Your eyes move rapidly You dream.

1. Sleep begins with NREM stage 1 sleep.

2. NREM stage 1 progresses into NREM stage 2.

3. NREM stage 2 is followed by NREM stage 3.

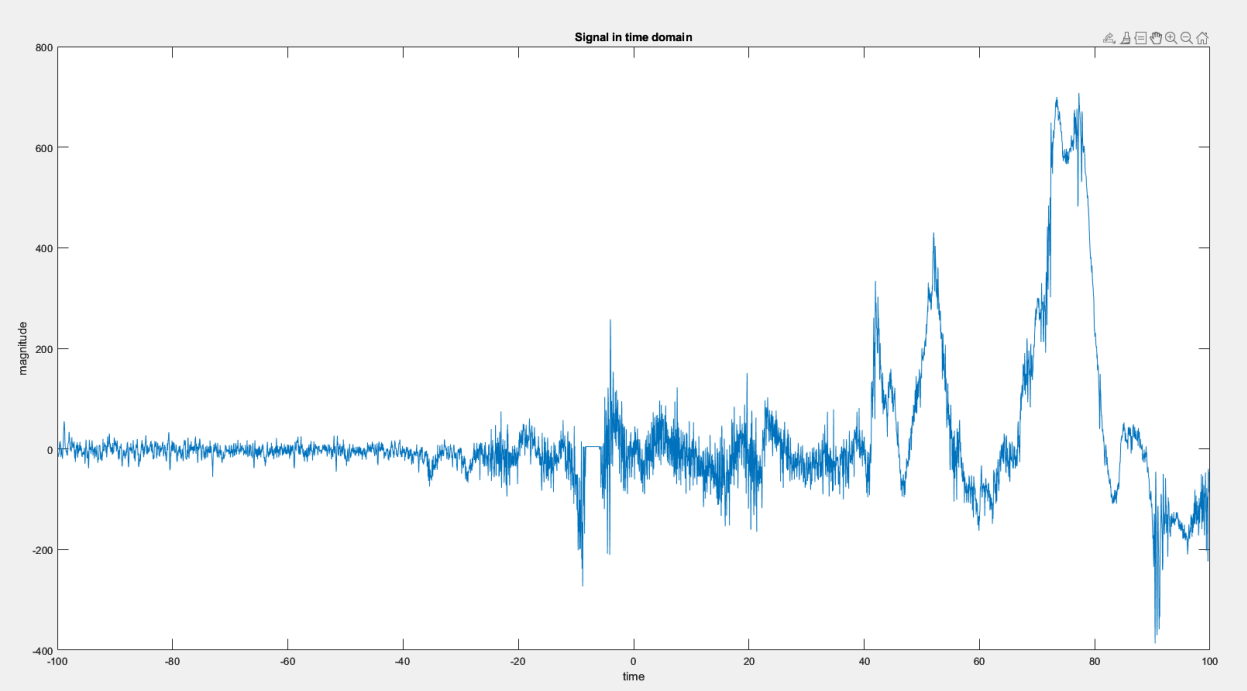
4. NREM stage 2 is then repeated.

5. Finally, you are in REM sleep.

Time spent in each stage changes throughout the night as the cycle repeats (about four to five times total).

Phase 2.2:

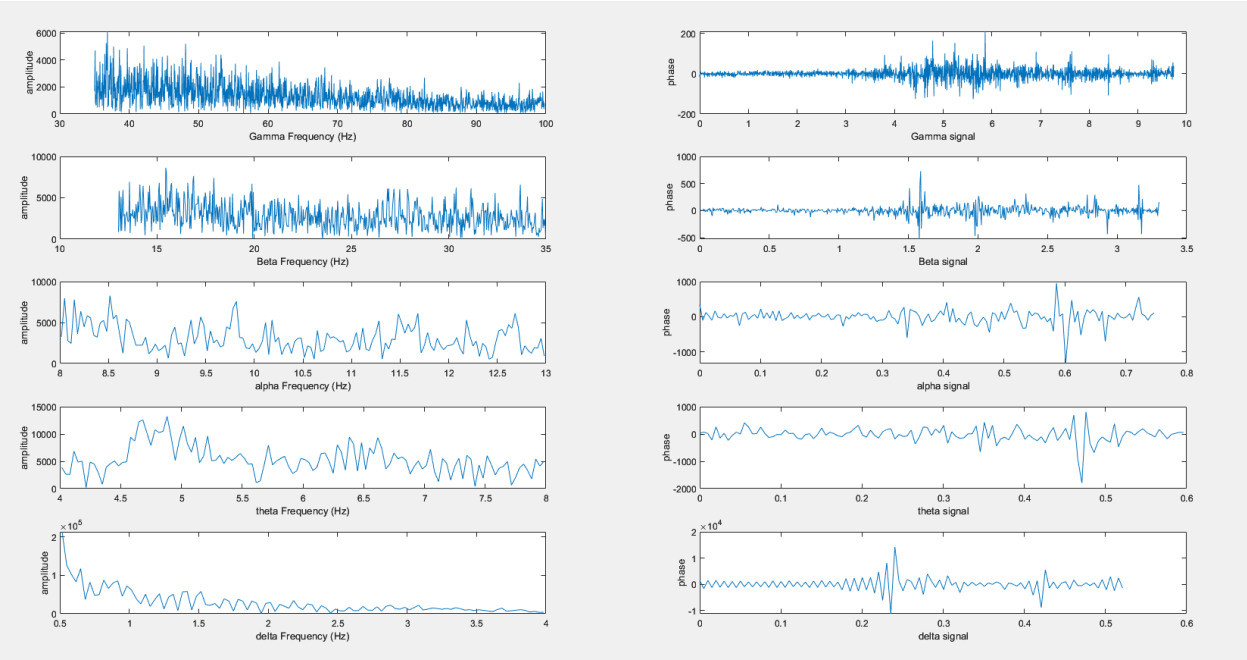
In this phase we plot an unfiltered figure for EEG signal of an sleeping person.

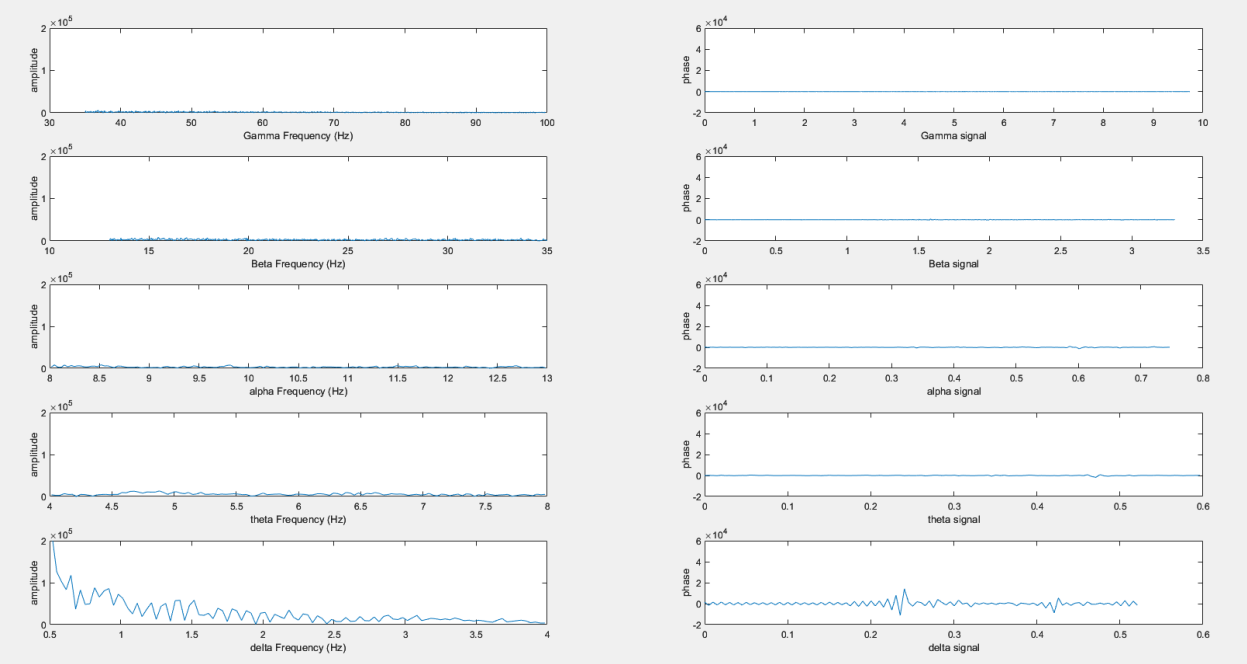


Phase 2.3:

In this phase we plot the signals in different frequencies and filter them in specific interval.

In first figure we plot the filtered signals without same scaling but in the second figure the plot is scaled in the same scale for better understanding of the brain state.



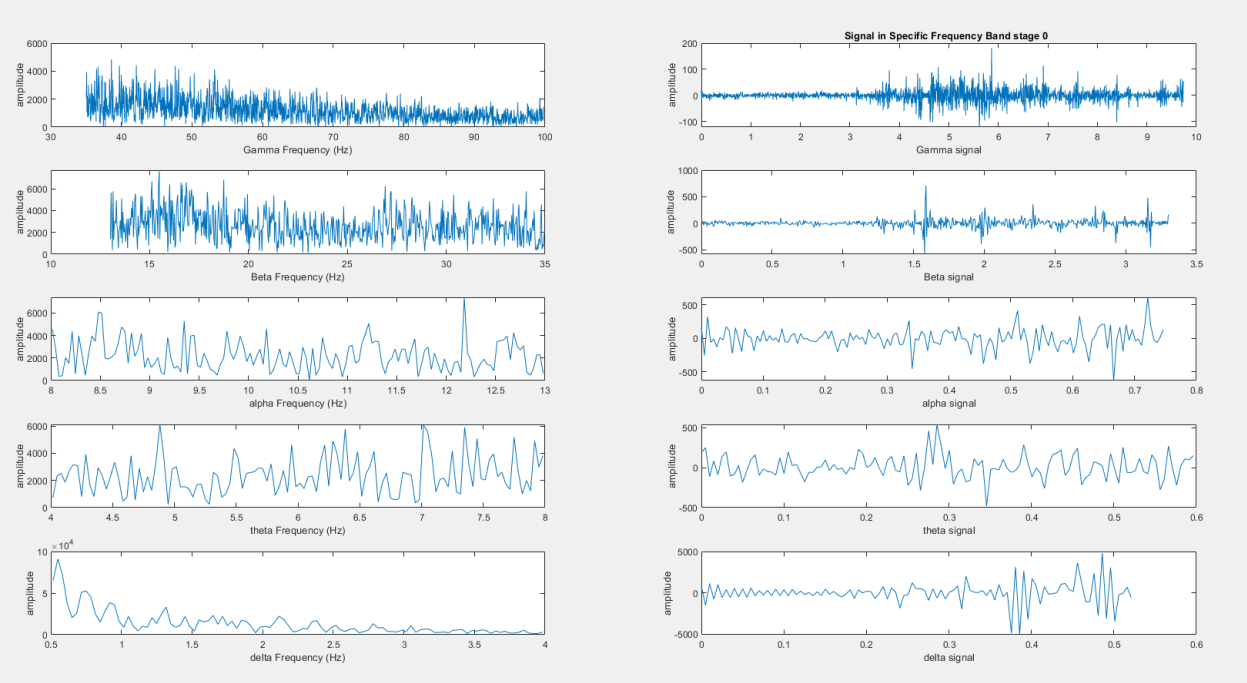


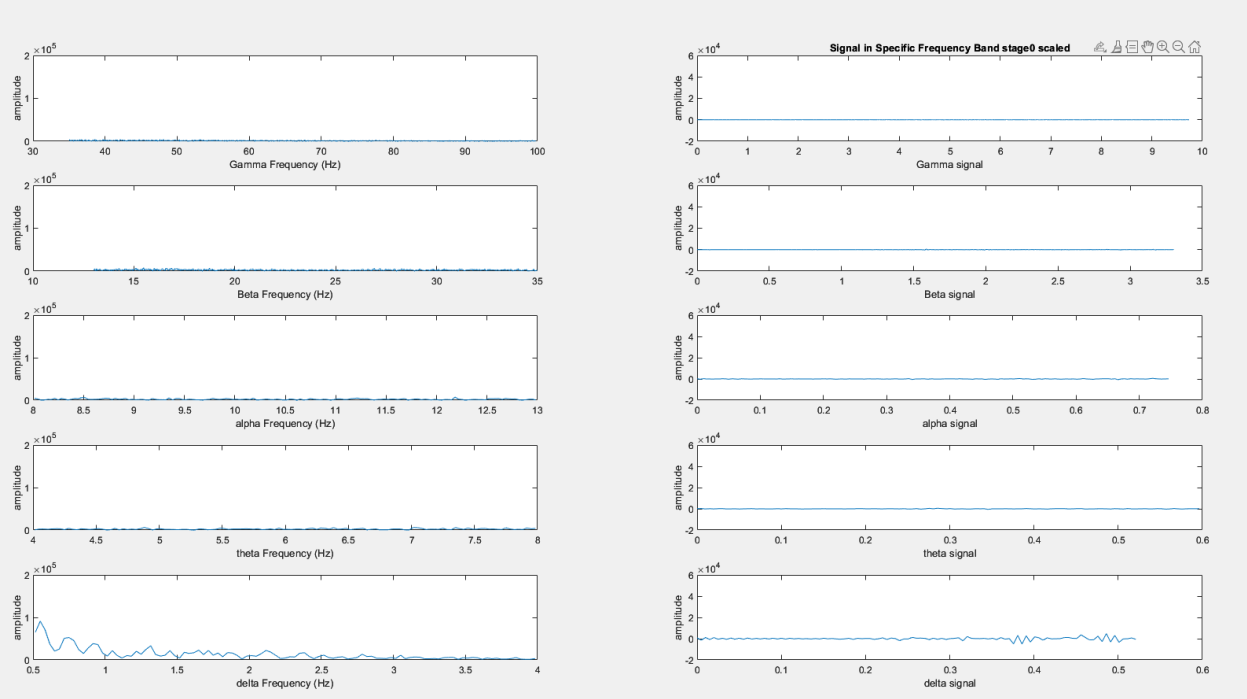
Phase 2.4:

In this phase we discuss in which state the brain is. First we show the stage0 and stage1 and stage2 output, I signal from each

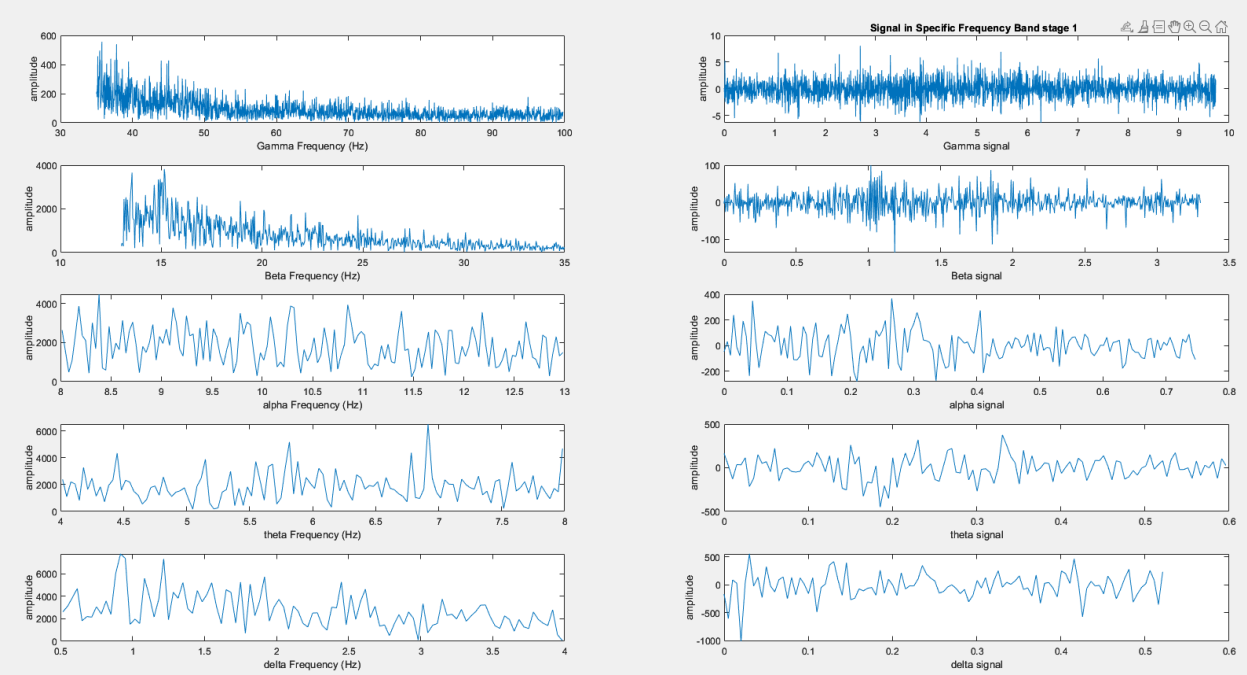
Then we show the plots of tofind0 and tofind1 to discuss and compare

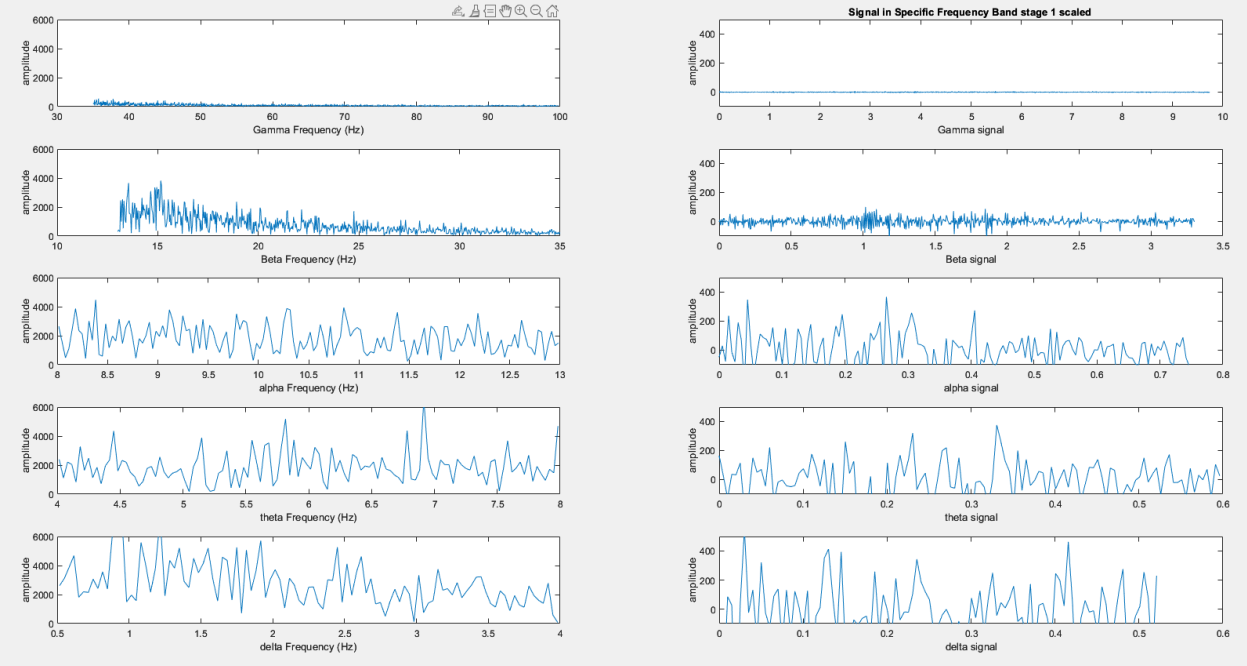
Stage0:



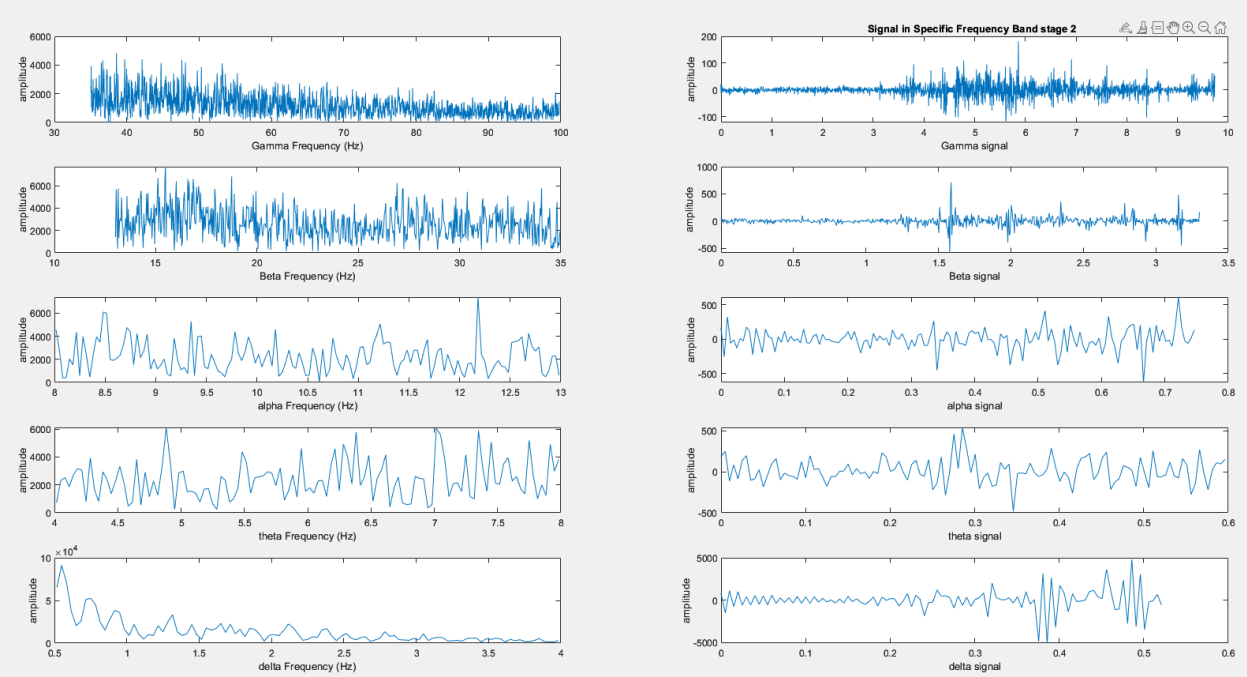


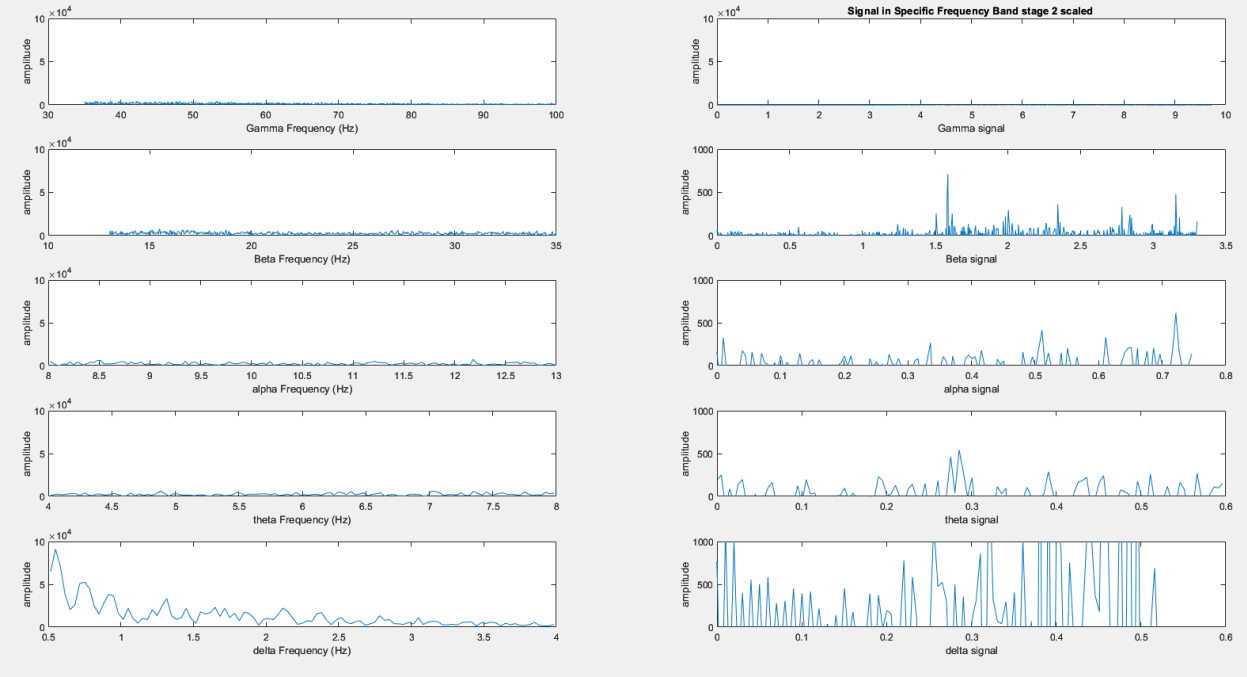
Stage1:


Signal in Specific Frequency Band stage 1
amplitude
Gamma Frequency (Hz)
Beta Frequency (Hz)
alpha Frequency (Hz)
theta Frequency (Hz)
delta Frequency (Hz)
Gamma signal
Beta signal
alpha signal
theta signal
delta signal

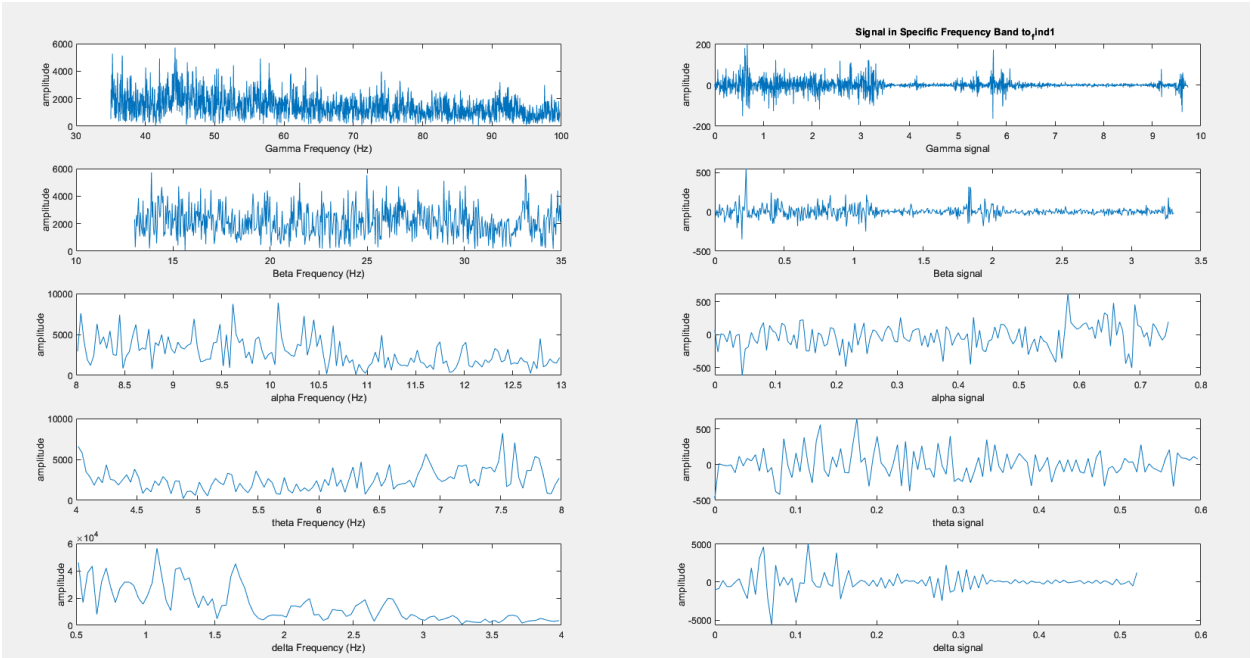

Signal in Specific Frequency Band stage 1 scaled
amplitude
Gamma Frequency (Hz)
Beta Frequency (Hz)
alpha Frequency (Hz)
theta Frequency (Hz)
delta Frequency (Hz)
Gamma signal
Beta signal
alpha signal
theta signal
delta signal

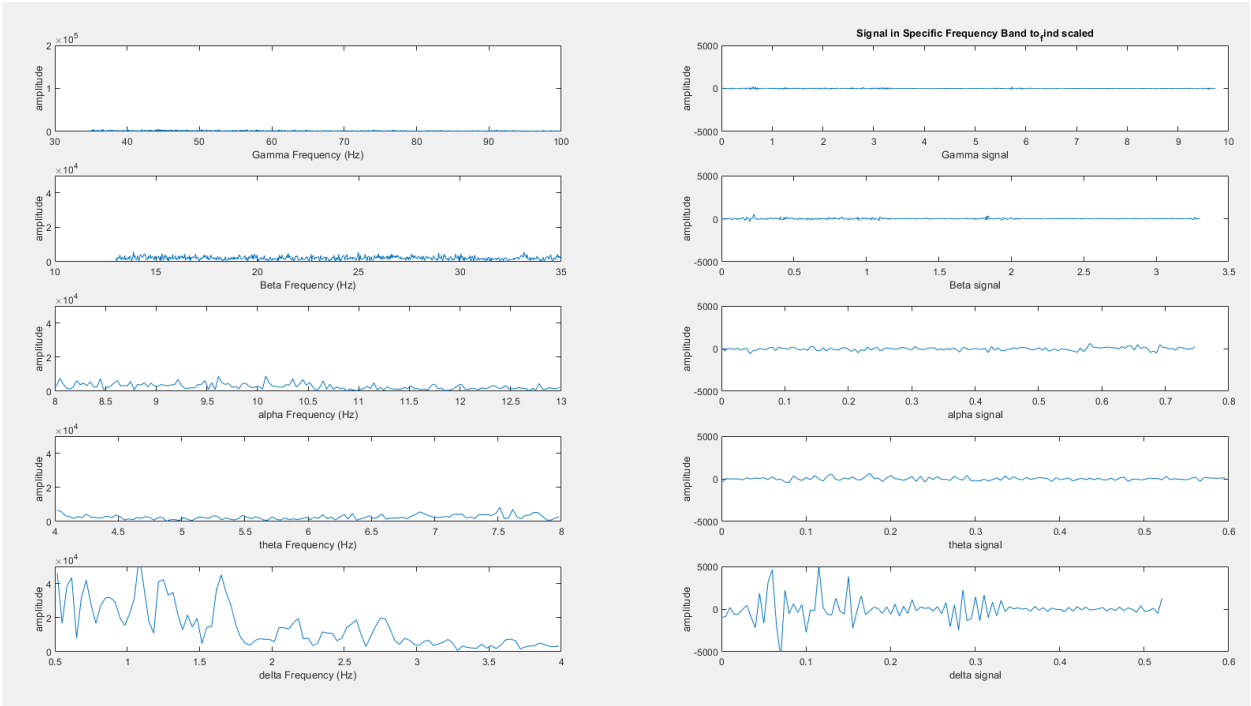
Stage2:


Signal in Specific Frequency Band stage 2
amplitude
Gamma Frequency (Hz)
Beta Frequency (Hz)
alpha Frequency (Hz)
theta Frequency (Hz)
delta Frequency (Hz)
Gamma signal
Beta signal
alpha signal
theta signal
delta signal

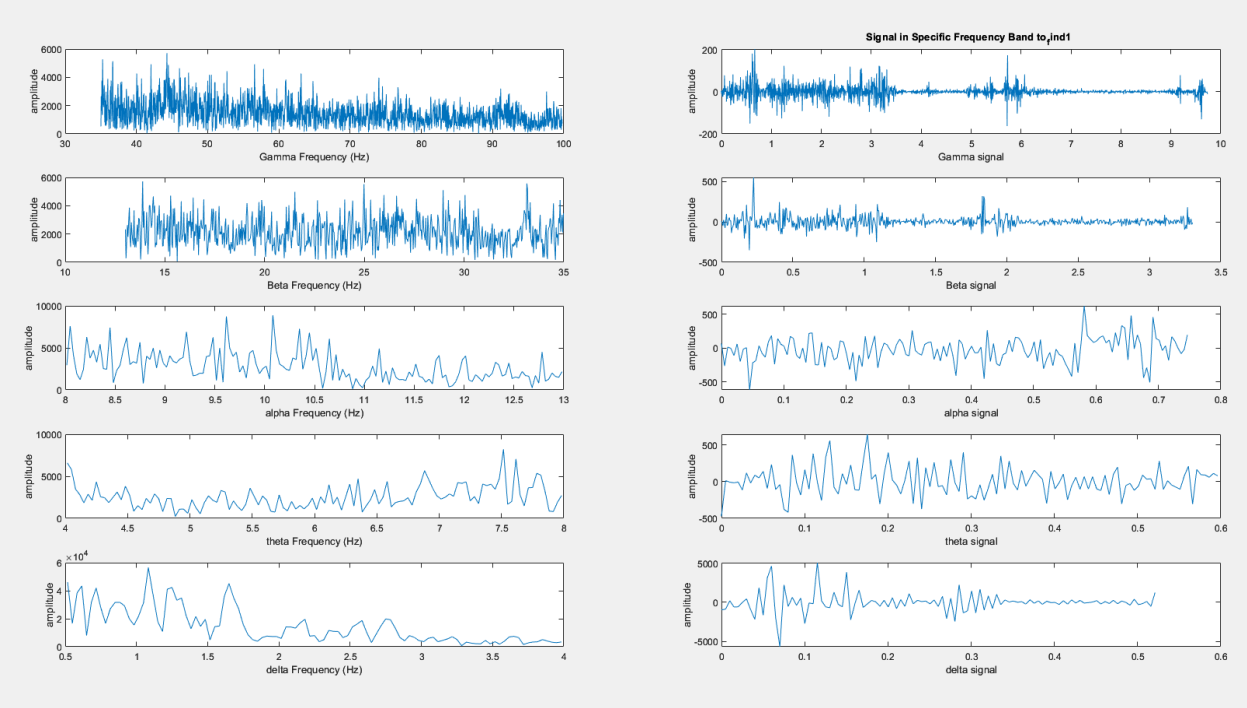

Signal in Specific Frequency Band stage 2 scaled
amplitude
Gamma Frequency (Hz)
Beta Frequency (Hz)
alpha Frequency (Hz)
theta Frequency (Hz)
delta Frequency (Hz)
Gamma signal
Beta signal
alpha signal
theta signal
delta signal

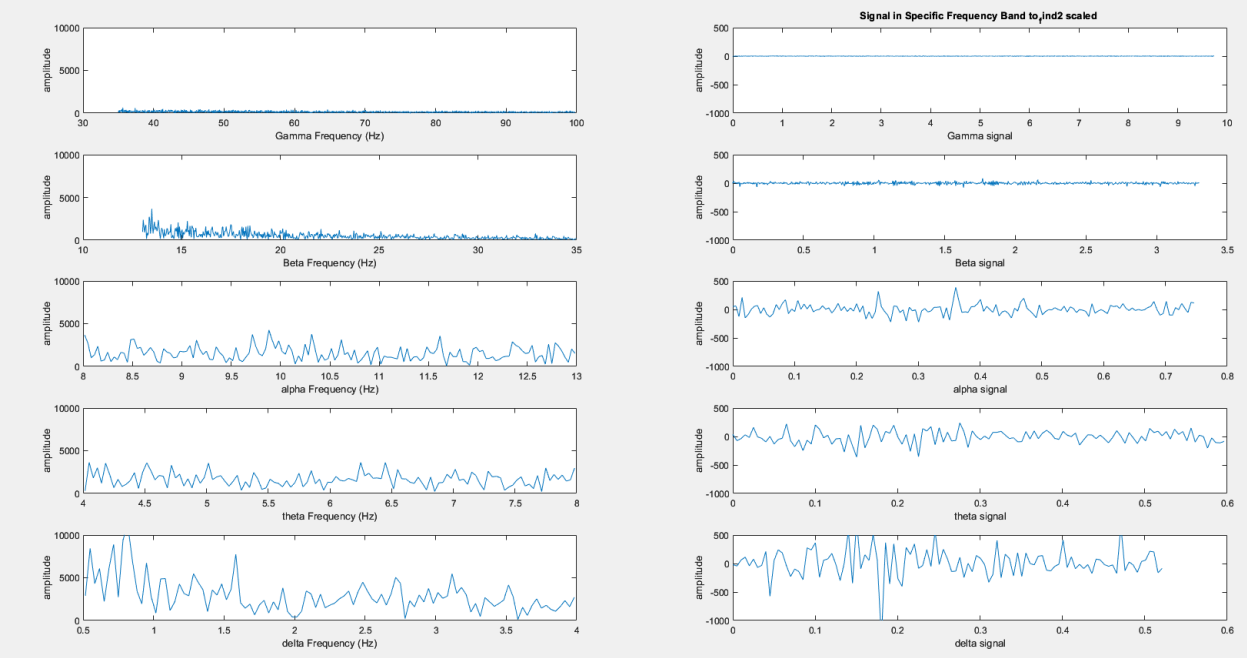
To find :


Signal in Specific Frequency Band to find1
amplitude
Gamma Frequency (Hz)
Beta Frequency (Hz)
alpha Frequency (Hz)
theta Frequency (Hz)
delta Frequency (Hz)
Gamma signal
Beta signal
alpha signal
theta signal
delta signal


Signal in Specific Frequency Band to find scaled
amplitude
Gamma Frequency (Hz)
Beta Frequency (Hz)
alpha Frequency (Hz)
theta Frequency (Hz)
delta Frequency (Hz)
Gamma signal
Beta signal
alpha signal
theta signal
delta signal

To find 1:





Notes:

- The brain is functioning in delta range. Its obvious in scaled plot.
- The power of signals are show below:

- $$P = \frac{1}{T}\int_{t1}^{t2} |x(t)|^2\, dt$$
- Command Window

```
power_gamma_0: 1290.0347
power_alpha_0: 81380.5314
power_beta_0: 15266.5179
power_theta_0: 297423.1431
power_delta_0: 17496777.7618
power_gamma_1: 15.8092
power_alpha_1: 25799.7268
power_beta_1: 1066.3117
power_theta_1: 42134.7879
power_delta_1: 170836.382
power_gamma_2: 43.167
power_alpha_2: 15364.5217
power_beta_2: 799.2351
power_theta_2: 36966.0957
power_delta_2: 225243.3655
```

- Command Window

```
power_gamma_1: 1204.9683
power_alpha_1: 123544.8328
power_beta_1: 10434.0648
power_theta_1: 466662.235
power_delta_1: 15702477.7268
power_gamma_2: 23.1231
power_alpha_2: 12184.9873
power_beta_2: 770.6747
power_theta_2: 20699.6556
power_delta_2: 79174.2846
```

- As shown above, the power and amplitude and power of tofind1 is close to stage0 and the amplitude and power of tofind2 is close to stage2.