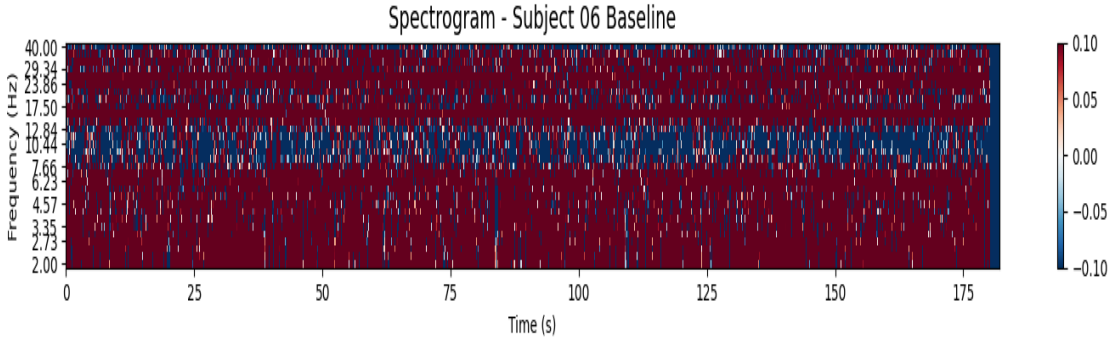
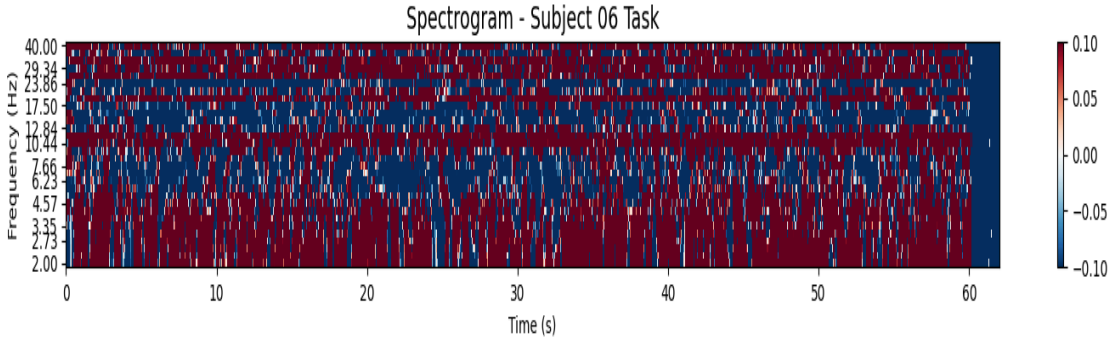
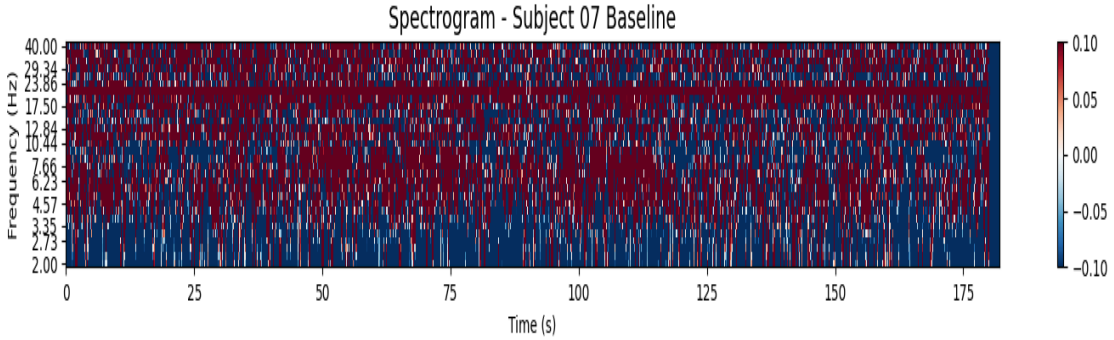
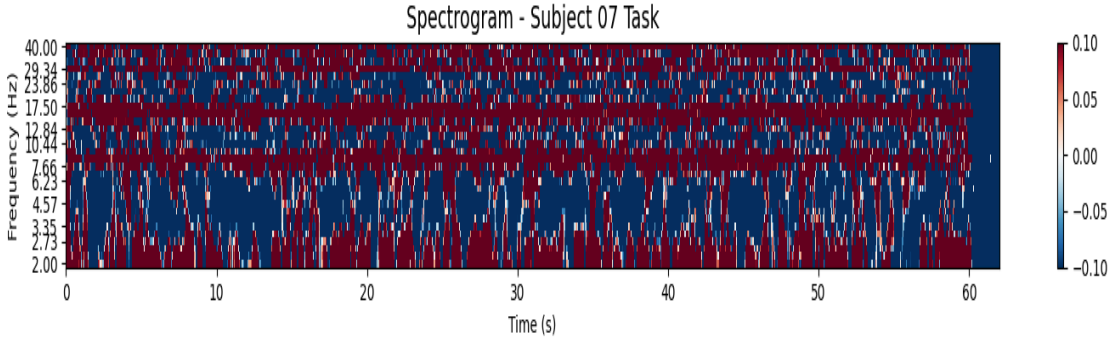
Question 2


Spectrogram - Subject 06 Baseline
Frequency (Hz)
40.00
29.34
23.86
17.50
12.84
10.44
7.66
6.23
4.57
3.35
2.73
2.00
0
25
50
75
100
125
150
175
Time (s)
0.10
0.05
0.00
−0.05
−0.10


Spectrogram - Subject 06 Task
Frequency (Hz)
40.00
29.34
23.86
17.50
12.84
10.44
7.66
6.23
4.57
3.35
2.73
2.00
0
10
20
30
40
50
60
Time (s)
0.10
0.05
0.00
−0.05
−0.10


Spectrogram - Subject 07 Baseline
Frequency (Hz)
40.00
29.34
23.86
17.50
12.84
10.44
7.66
6.23
4.57
3.35
2.73
2.00
0
25
50
75
100
125
150
175
Time (s)
0.10
0.05
0.00
−0.05
−0.10


Spectrogram - Subject 07 Task
Frequency (Hz)
40.00
29.34
23.86
17.50
12.84
10.44
7.66
6.23
4.57
3.35
2.73
2.00
0
10
20
30
40
50
60
Time (s)
0.10
0.05
0.00
−0.05
−0.10

Discussion:

During the baseline condition, both subjects exhibit higher alpha power (8-13 Hz), indicating a relaxed state, as seen by consistent red bands in the spectrograms. In contrast, during the task condition, there is a noticeable reduction in alpha power and an increase in beta power (13-30 Hz), indicating cognitive engagement and mental activity. These changes are more noticeable in Subject 06, suggesting stronger involvement or focus compared to Subject 07 during the task. Overall, the spectrograms reveal a shift from relaxed alpha activity to more alert beta activity when moving from baseline to task conditions.

Code:

```
import mne
import os
import pandas as pd
from plot_psd import plot_psd
from mne.time_frequency import tfr_multitaper
import numpy as np
import matplotlib.pyplot as plt

# Load subject 6 edf files
subject_06_baseline = mne.io.read_raw_edf(os.path.join("data", "Subject06_1.edf"))
subject_06_task = mne.io.read_raw_edf(os.path.join("data", "Subject06_2.edf"))

# Load subject 7 edf files
subject_07_baseline = mne.io.read_raw_edf(os.path.join("data", "Subject07_1.edf"))
subject_07_task = mne.io.read_raw_edf(os.path.join("data", "Subject07_2.edf"))

# Load csv file
csv_file = pd.read_csv(os.path.join("data", "subject-info.csv"))

# Create list of raw data (for easy use)
raw_data = [subject_06_baseline, subject_06_task, subject_07_baseline,
subject_07_task]

# Clean up channels
for raw in raw_data:
    # Rename channels
    raw.rename_channels({
        'EEG Fp1': 'Fp1', 'EEG Fp2': 'Fp2', 'EEG F3': 'F3', 'EEG F4': 'F4',
        'EEG F7': 'F7', 'EEG F8': 'F8', 'EEG T3': 'T3', 'EEG T4': 'T4',
        'EEG C3': 'C3', 'EEG C4': 'C4', 'EEG T5': 'T5', 'EEG T6': 'T6',
        'EEG P3': 'P3', 'EEG P4': 'P4', 'EEG O1': 'O1', 'EEG O2': 'O2',
        'EEG Fz': 'Fz', 'EEG Cz': 'Cz', 'EEG Pz': 'Pz', 'EEG A2-A1': 'A2',
        'ECG ECG': 'ECG'
    })

    # Set channel types for ECG
    raw.set_channel_types({'ECG': 'ecg'})

    # Set the standard montage (10-20 system)
    raw.set_montage(mne.channels.make_standard_montage('standard_1020'))
```

```
freqs = np.logspace(*np.log10([2, 40]), num=30)  # Frequencie range from 2 to 40 Hz
n_cycles = freqs / 2.  # Number of cycles
time_bandwidth = 2.0   # Time bandwidth product

# Figure for spectrograms
fig, axes = plt.subplots(4, 1, figsize=(15, 20))

# List of subjects and their corresponding data
subjects = [
   ('Subject 06 Baseline', subject_06_baseline),
   ('Subject 06 Task', subject_06_task),
   ('Subject 07 Baseline', subject_07_baseline),
   ('Subject 07 Task', subject_07_task)
]

# Compute and plot spectrograms for each subject
for i, (title, raw) in enumerate(subjects):
   power = tfr_multitaper(raw, freqs=freqs, n_cycles=n_cycles,
                          time_bandwidth=time_bandwidth, return_itc=False)
   power.plot([0], baseline=(None, 0), mode='logratio', axes=axes[i], show=False)
   axes[i].set_title(f'Spectrogram - {title}', fontsize=14)

# Plot data
plt.tight_layout(rect=[0, 0.03, 1, 0.95])
plt.subplots_adjust(hspace=0.5)
plt.show()
```