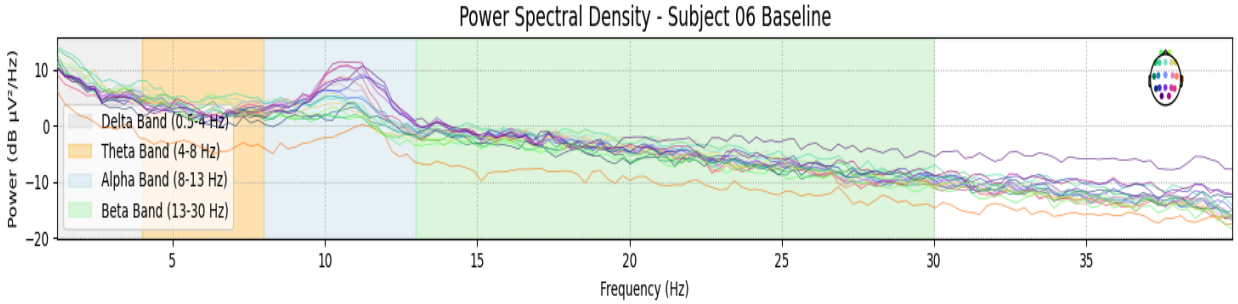
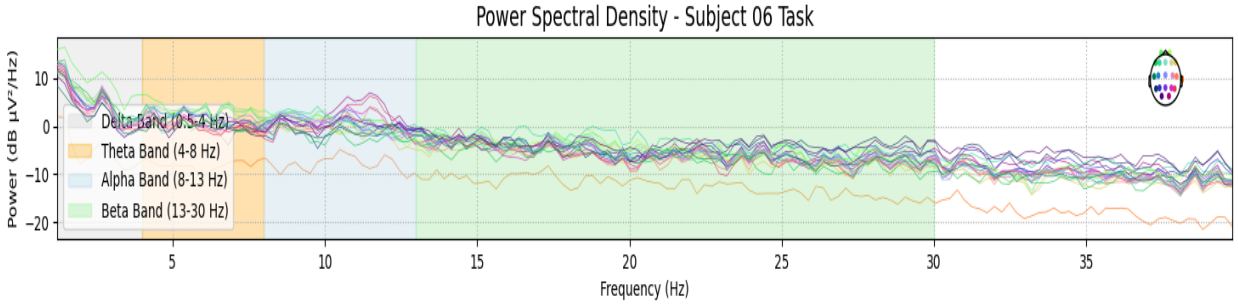
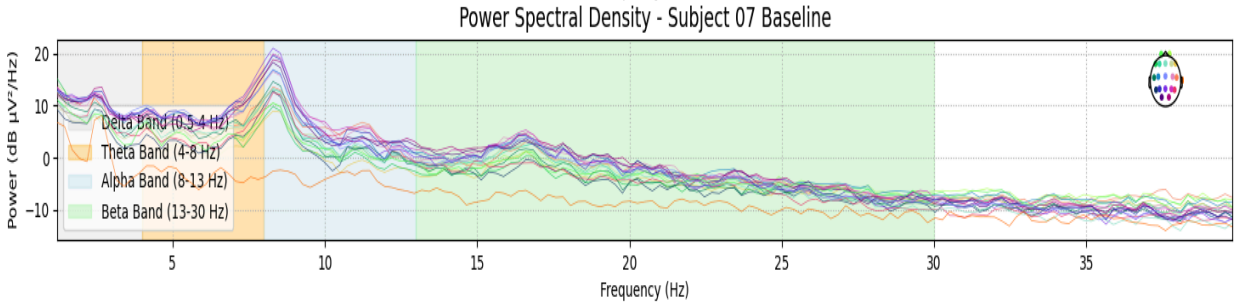
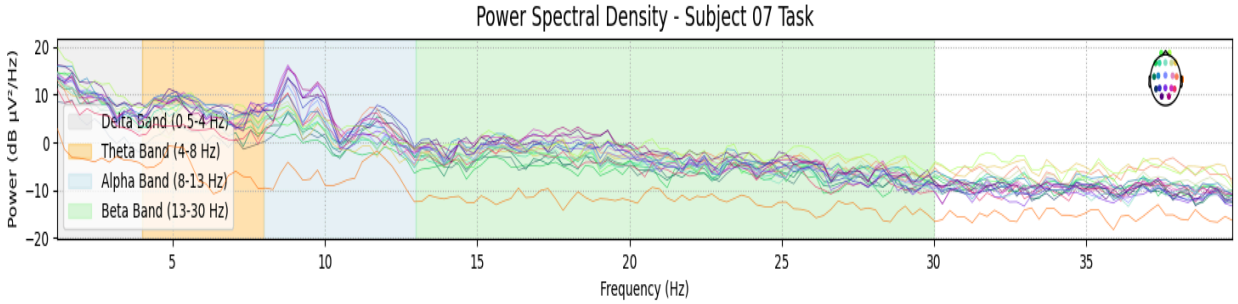
Question 1


Power Spectral Density - Subject 06 Baseline
Power (dB µV²/Hz)
Frequency (Hz)
Delta Band (0.5-4 Hz)
Theta Band (4-8 Hz)
Alpha Band (8-13 Hz)
Beta Band (13-30 Hz)


Power Spectral Density - Subject 06 Task
Power (dB µV²/Hz)
Frequency (Hz)
Delta Band (0.5-4 Hz)
Theta Band (4-8 Hz)
Alpha Band (8-13 Hz)
Beta Band (13-30 Hz)


Power Spectral Density - Subject 07 Baseline
Power (dB µV²/Hz)
Frequency (Hz)
Delta Band (0.5-4 Hz)
Theta Band (4-8 Hz)
Alpha Band (8-13 Hz)
Beta Band (13-30 Hz)


Power Spectral Density - Subject 07 Task
Power (dB µV²/Hz)
Frequency (Hz)
Delta Band (0.5-4 Hz)
Theta Band (4-8 Hz)
Alpha Band (8-13 Hz)
Beta Band (13-30 Hz)

Discussion:

During the task condition, both Subject 06 and Subject 07 show notable differences in power spectral density (PSD) compared to the baseline condition. Specifically, there is a clear reduction in alpha power (8-13 Hz) during the task, indicating a transition from a relaxed, idle state to one of more focus and cognitive activity. This reduction, called alpha desynchronization, is typical when an individual becomes engaged in a task. Simultaneously, an increase in beta power (13-30 Hz) is observed in both subjects during the task condition, which is associated with enhanced mental activity and attention. Subject 06 shows a more noticeable increase in beta power compared to Subject 07, suggesting stronger engagement or cognitive effort during the task. Overall, these shifts in alpha and beta power provide insight into how the brain adapts from a resting state to an active, engaged state, with Subject 06 demonstrating a stronger response.

Code:

```
import mne
import os
import pandas as pd
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'))

# Plot PSD for Subject 06 and 07 Baseline and Task
fig, axes = plt.subplots(4, 1, figsize=(15, 24))  # Adjusted to 4 subplots
```

```
# Subject 06 Baseline PSD
subject_06_baseline.plot_psd(fmin=1, fmax=40, ax=axes[0], show=False)
axes[0].set_title('Power Spectral Density - Subject 06 Baseline', fontsize=14)
axes[0].set_xlabel('Frequency (Hz)', fontsize=10)
axes[0].set_ylabel('Power (dB μV²/Hz)', fontsize=10)
axes[0].axvspan(0.5, 4, color='lightgray', alpha=0.3, label='Delta Band (0.5-4 Hz)')
axes[0].axvspan(4, 8, color='orange', alpha=0.3, label='Theta Band (4-8 Hz)')
axes[0].axvspan(8, 13, color='lightblue', alpha=0.3, label='Alpha Band (8-13 Hz)')
axes[0].axvspan(13, 30, color='lightgreen', alpha=0.3, label='Beta Band (13-30 Hz)')
axes[0].legend(loc='lower left')
axes[0].grid(True)

# Subject 06 Task PSD
subject_06_task.plot_psd(fmin=1, fmax=40, ax=axes[1], show=False)
axes[1].set_title('Power Spectral Density - Subject 06 Task', fontsize=14)
axes[1].set_xlabel('Frequency (Hz)', fontsize=10)
axes[1].set_ylabel('Power (dB μV²/Hz)', fontsize=10)
axes[1].axvspan(0.5, 4, color='lightgray', alpha=0.3, label='Delta Band (0.5-4 Hz)')
axes[1].axvspan(4, 8, color='orange', alpha=0.3, label='Theta Band (4-8 Hz)')
axes[1].axvspan(8, 13, color='lightblue', alpha=0.3, label='Alpha Band (8-13 Hz)')
axes[1].axvspan(13, 30, color='lightgreen', alpha=0.3, label='Beta Band (13-30 Hz)')
axes[1].legend(loc='lower left')
axes[1].grid(True)

# Subject 07 Baseline PSD
subject_07_baseline.plot_psd(fmin=1, fmax=40, ax=axes[2], show=False)
axes[2].set_title('Power Spectral Density - Subject 07 Baseline', fontsize=14)
axes[2].set_xlabel('Frequency (Hz)', fontsize=10)
axes[2].set_ylabel('Power (dB μV²/Hz)', fontsize=10)
axes[2].axvspan(0.5, 4, color='lightgray', alpha=0.3, label='Delta Band (0.5-4 Hz)')
axes[2].axvspan(4, 8, color='orange', alpha=0.3, label='Theta Band (4-8 Hz)')
axes[2].axvspan(8, 13, color='lightblue', alpha=0.3, label='Alpha Band (8-13 Hz)')
axes[2].axvspan(13, 30, color='lightgreen', alpha=0.3, label='Beta Band (13-30 Hz)')
axes[2].legend(loc='lower left')
axes[2].grid(True)

# Subject 07 Task PSD
subject_07_task.plot_psd(fmin=1, fmax=40, ax=axes[3], show=False)
axes[3].set_title('Power Spectral Density - Subject 07 Task', fontsize=14)
axes[3].set_xlabel('Frequency (Hz)', fontsize=10)
axes[3].set_ylabel('Power (dB μV²/Hz)', fontsize=10)
axes[3].axvspan(0.5, 4, color='lightgray', alpha=0.3, label='Delta Band (0.5-4 Hz)')
```

```
axes[3].axvspan(4, 8, color='orange', alpha=0.3, label='Theta Band (4-8 Hz)')
axes[3].axvspan(8, 13, color='lightblue', alpha=0.3, label='Alpha Band (8-13 Hz)')
axes[3].axvspan(13, 30, color='lightgreen', alpha=0.3, label='Beta Band (13-30 Hz)')
axes[3].legend(loc='lower left')
axes[3].grid(True)

# Adjust layout to avoid overlap
plt.tight_layout(rect=[0, 0.03, 1, 0.95])
plt.subplots_adjust(hspace=0.5)
plt.show()
```