



**POLITECNICO**  
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# **Biomedical Signal Processing Assignment**

## **Topic 3** **EEG during mental arithmetics**

**GROUP 18**

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## Introduction

Electroencephalogram (EEG) is widely used for studying brain activity by capturing frequency-based changes associated with different mental states.

In this study, EEGs performed during rest and during mental calculations were analysed.

## Material and Methods

EEG data was collected from six subjects at a 500 Hz sampling rate across 19 channels (10-20 system) [1].  $\delta$  (0.5 - 4 Hz),  $\theta$  (4 - 8 Hz),  $\alpha$  (8 - 12 Hz),  $\beta$  (12 - 30 Hz) bands were analysed.

Preprocessing included band-pass filtering (0.5 - 45 Hz) to remove non-informative frequencies and normalization for inter-subject comparability.

Power Spectral Density (PSD) was calculated using Welch Method (10 s Hamming window, 0.1 s overlap), and each frequency range was normalized to the maximum value.

Power Density Maps (PDMs) enabled the visualization of spatial power distribution, while Compressed Spectral Array (CSA) analysis captured temporal frequency changes, using a 3-seconds window, 50% overlap, and 2048-point FFT.

The analytical approach was adapted from the methodology presented in [2].

## Results

The study highlighted marked differences between brain activity during resting state and during mental calculation.

On average, an increase in  $\theta$  band in orbito-frontal and central areas and an increase in  $\beta$  band in posterior areas was observed during mental calculation.

Increase in power of  $\delta$  frequencies and decrease in power of  $\alpha$  frequencies were also observed.

## Discussion

An increase in central areas of  $\theta$ -frequencies and in occipital areas of  $\beta$ -frequencies was expected, as it has been shown to be correlated with the execution of complex mental tasks [2].

The observed decrease in  $\alpha$  power could be coherent with the understanding that  $\alpha$ -activity is associated with resting state and its desynchronization with cognitive activity [2].

Differences in PDMs between this study and previous analysis [2] could be due to the smaller number of subjects considered.

[1]

Zyma, Igor; Tukaev, Sergii; Seleznov, Ivan; Kiyono, Ken; Popov, Anton; Chernykh, Mariia and Shpenkov, Oleksii (2019). Electroencephalograms during Mental Arithmetic Task Performance. *Data* 4, no. 1: 14.

[2]

Seleznov, Ivan; Zyma, Igor; Kiyono, Ken; Tukaev, Sergii; Popov, Anton; Chernykh, Mariia and Shpenkov, Oleksii (2019). Detrended Fluctuation, Coherence, and Spectral Power Analysis of Activation Rearrangement in EEG Dynamics During Cognitive Workload. *Frontiers in Human Neuroscience*. Vol. 13, 1662-5161