How to submit your answers.

The answers can be typed in the Exam.net editor.
Write the answers in the same sequence as the questions (A1, A2, ...) and write the same headers as the test on a separate line just above your answer, e.g.:

Problem
A1
<your answer to question A1 goes here>
A2
<your answer to question A2 goes here>
...

Textual answers must be typed in the editor. When graphical elements are required in the answer, the latter can be written on paper.

Keep your answers tidy. Messy, hard-to-read answers may penalize your mark.

The maximum total score for part II is **8**.

Carefully read the following scenario and answer the questions listed below.

During the planning and execution of a motor task, the amplitude of sensorimotor rhythms is modulated. Event-related Desynchronization/Synchronization (ERD/S) can be used as an index to quantify the modulation induced by the motor task.

Motor task.
At the beginning of each trial, the subject is promted with one of three possible cues: "Right hand", "Left hand", "Feet". The subject can wait a self-decided interval of time in the range between 3 and 6 serconds since the appearance of the cue, and then perform a brisk extension of the wrist/ankle, in agreement with the cue they received.
Four runs of this task containing 20 trials each were interleaved with 2 minutes of rest.

EEG Data acquisition.
Simultaneous data was obtained for EEG, EMG, and movement onset (the latter via a custom movement detection device). A commercial system and software were used to acquire and process surface EEG signals. Electrodes were placed on the scalp over the sensorimotor brain areas. The experimenter mounted the EEG electrodes according to the 10-10 system (see endnote i), specifically only the five rows whose electrodes have labels starting with the following letters:

F, FC (or FT), C (or T), CP (or TP), and P.

Impedance at lower than 5 kΩ was obtained prior to data collection. The recording electrodes were referenced to the linked ears. EEG signals were amplified (×50 000), band-pass filtered (0.1–70 Hz), and digitized (500 sample/s).
In addition to the dataset acquired for the experimental (motor) task, one run of rest with open eyes (1 minute) and one run of rest with closed eyes (1 minute) were acquired.

EEG Data processing.
For each of the runs associated with the motor task, EEG trials were segmented from -5 s to +5 s with respect to the onset of the EMG signal recorded on the target limb.
EEG trials were visually inspected to detect artifacts produced by eye blinks, facial muscle contractions, or head movements and discarded if artifacts were found.
For the resting EEG runs, the artifact rejects was performed on the raw recording, marking as "invalid" those time intervals containing an artifact, thus preventing them from being considered for subsequent analysis.
Power Spectral Density was estimated for each of the three conditions (motor tasks). Results from electrodes C3, Cz and C4 are shown in *Figure 1*.
ERD/S in the beta band (26-30 Hz) was estimated according to the original algorithm proposed by Pfurtscheller et al. in 1999 ([1]) . The results of each step of the procedure is shown in *Figure 2*.
A periodogram was computed, after artifact removal, on the longest uninterrupted interval of EEG acquired in the open-eyes condition. Results from electrode Pz are shown in *Figure 3*

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[1] Which is the algorithm that was presented in class.

Questions

Write all your answer in the exam.net editor

Q1. (1.5 points) How many EEG electrodes did the experimenter mount of the subject's head?
Justify in <u>max 1 line</u>.

Q2. (1 point) How long (in samples) is the window that was used to estimate the spectra in Figure 1 using the Welch algorithm?
Justify in <u>max 1 line</u>.

Q3. (2 points) Associate each of the spectra (A-C) in figure 1 to one of the motor tasks?
Justify in <u>max 2 lines</u>.

Q4. (2.5 points) Name the processing steps of the ERD/S computation, whose results are shown in panels (a-e) of Figure 2.

Q5. (1 point) What is the duration (in seconds) of the signal that was used to estimate the periodogram in Figure 3?
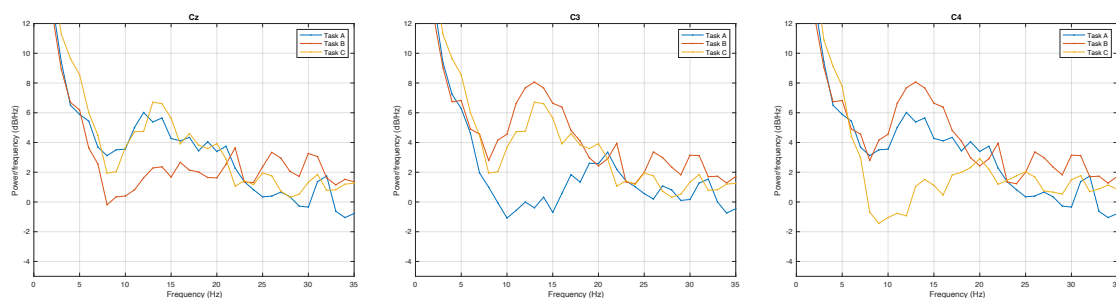Justify in <u>max 1 line</u>.
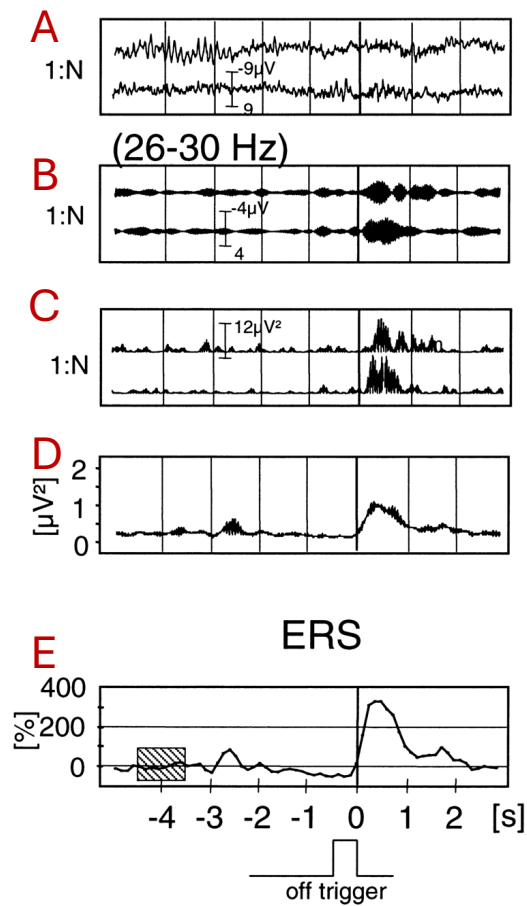

Figure 1. PSD (Welch)
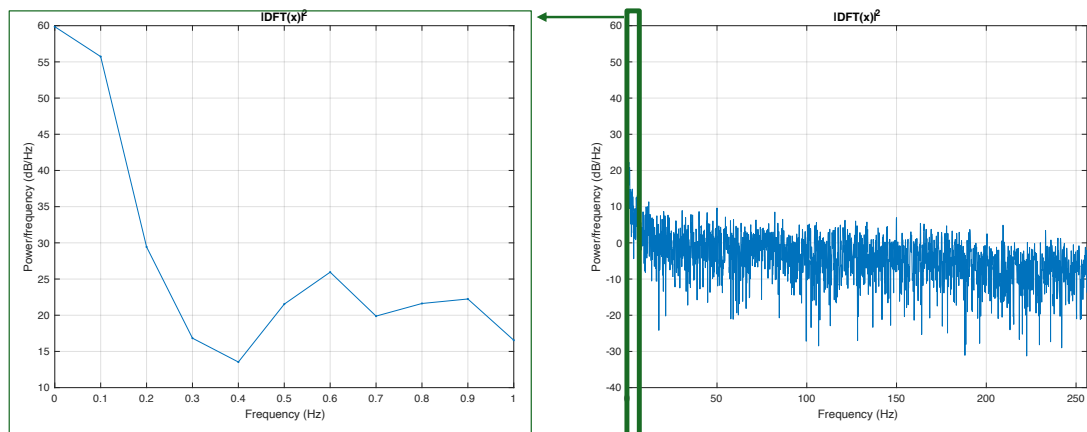
Figure 2. ERD/S estimation steps

Figure 3. Right panel: Periodogram estimated on the run acquired while the subject was resting with open eyes. Left panel: Zoomed view of the same periodogram.

[i] With respect to the 10-20 system, in the 10-10 system an extra electrode is placed between each original pair of electrodes, in the longitudinal, transverse and both diagonal directions. For instance, the following figure shows of the additional electrodes placed between Cz and its 10-20 neighbors.