Neuroengineering 2021-2022
Exam 21 July 2022 – Part II (odd seats)

How to submit your answers.

Most answers can be typed in the Exam.net editor.
Write the answers in the same sequence as the questions (Q1, Q2, …) and write the same headers as the test on a separate line just above your answer, e.g.:

> Problem
> Q1
> *<your answer to question Q1 goes here>*
> Q2
> *<your answer to question Q2 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 and scanned using your mobile phone <u>at the end</u> of the exam.
It should always be possible to use a single sheet of paper for all answers to a specific problem. Anyway, always use separate sheets of paper for problems A and B.

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

Your answers should not exceed the length recommended in each question.
Answers significantly longer than requested may reflect poor understanding of the problem, and thus will likely receive a lower mark.

The maximum total score for part II is 11.

Problem

A P300 event-related potential (ERP) is elicited by means of a "oddball" paradigm, i.e. delivering to the subject a train of stimuli randomly chosen between two option. In this experiment, the stimuli were visual and consisted of either an 'O' or a 'X' presented on a computer screen, with the timing shown in *Figure 1(A)*. Three channels (Fz, Cz, and Pz) of monopolar EEG potentials are recorded, segmented into trials, and selectively averaged. The waveforms in *Figure 1(B)* correspond to the average of the 'X' stimuli only, which is presented with a probability P=20%. Also check the information embedded in *Figure 1*.

Questions (Q1-Q5):

Type all answers in the exam.net editor following the template provided.

Mathematical formulas can be handwritten and a reference to the scan can be included in the text.

Q1. *(2 points)* Would a high-pass filter with cutoff frequency at 30 Hz significantly affect the amplitude of the ERPs shown in *Figure 1(B)*? Justify.
   Start your answer with a line containing only Yes or No
   Justify in <u>max 2 lines</u>.

Q2. *(1 point)* Determine the approximate latency of the P300 component on a frontal channel.
   Start your answer with a line containing the latency
   Describe the measurement process in <u>max 2 lines</u>.

Q3. *(2 points)* Determine the approximate amplitude of the P300 component on each channel. State whether the ERP more positive on the anterior or posterior part of the scalp.
   In the first line of your answer report the amplitude on each channel. Use the second line for the statement.

Q4. *(3 points)* How long would the data recording session last if we need to reduce the amplitude of the spontaneous EEG by a factor of K=10 with respect to the unaveraged trial? Justify.
   Start your answer with a line reporting the duration of the recording session
   <u>Justify in max 5 lines</u>.

Q5. *(3 points)* Since only 20% of the trials contain a 'X' stimulus, could the experimenter increase the signal to noise ratio of the ERP by raising the proportion of X's to 80% (thus quadrupling the number of useful trials)? Justify.
   Start your answer with a line containing only Yes or No
   <u>Justify in max 5 lines</u>.
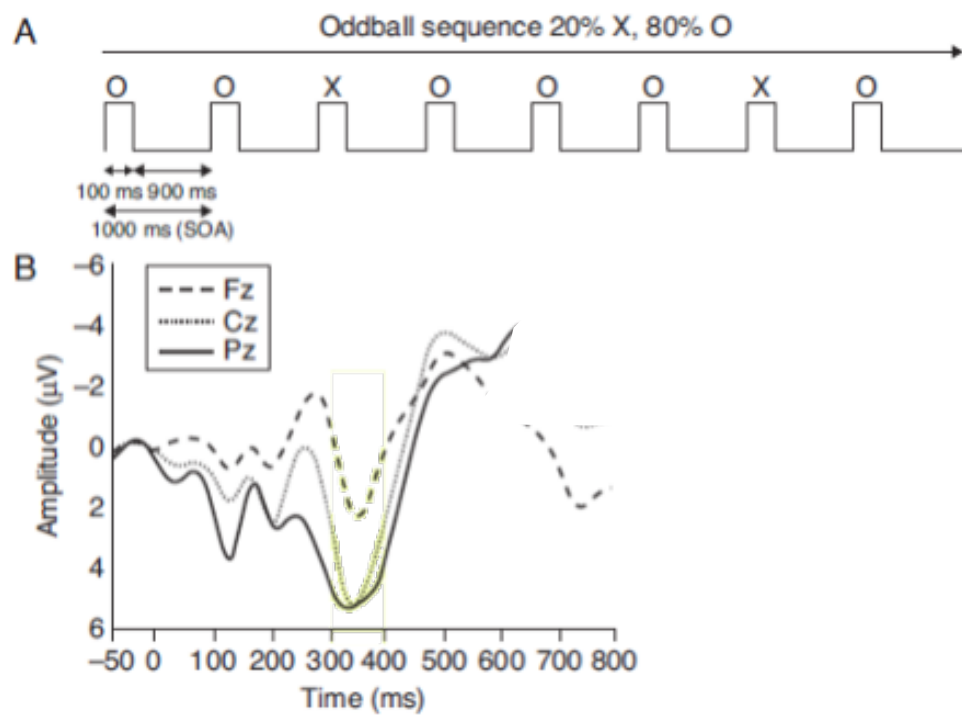
(The Figure is on the next page)

Figure 1. (A) Timeline of the experimental paradigm, showing trials containing 'O' and 'X' stimuli (B) Synchronized averages of 'X' trials.