Neuroengineering 2024-2025
Exam 3 July 2025
Part I

How to submit your answers.

Type your answers in the provided text file.

Write the answers in the same sequence as the questions. Use a separate line for each question. Start the line with the question number. Use dashes ('--') to indicate skipped answers. For example:

```
Section A
1. T
2. F
3. F
4. --
5. T
…
Section B
1. …
```

In the exceptional case that one or more of your answers require specific assumptions that were omitted in the question, you can add short comments **at the end of each section**. Start the **optional** comment with the number of the question it refers to. For example:

```
…

Comments
Q7: I assumed that the sinewave frequency is lower than the Nyquist frequency.
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The total score will be computed summing the contribution of each answer, whose maximum partial score is shown on the right of each question, according to the following rules:
- a correct T/F answer contributes 0.5 points,
- a missing T/F answer contributes 0 points,
- a wrong T/F answer contributes -0.25 points.

The maximum total score for part I is 24.
A minimum score of 14 points in Part I is required to pass the exam.

Section A

Unless stated otherwise, each correct answer will contribute 0.5 points to the grade (yielding a maximum of 12 points for Section A). Wrong answers will receive a penalty of -0.25 points.

#	Question
1	Ion pumps are based on a passive membrane transportation mechanism.
2	Given that at a certain temperature T the Cl^- equilibrium potential is equal to -80 mV, and the membrane potential is equal to -70 mV, the Cl^- net current will be directed from the inside of the cell toward the outside.
3	In chemical synapses, when a neurotransmitter opens the K^+ gated channels, the resulting PSP is an inhibitory one.
4	The continuous conduction is faster than the saltatory (myelinated) one.
5	Two ipsilateral regions belong to the same hemisphere.
6	The unmasking of latent synaptic connections is part of the mechanisms behind brain plasticity.
7	To detect a sequence of action potentials over the axon of a neural cell *in vivo*, the correct procedure is to record extracellular measures.
8	The cortical pyramidal neurons are oriented tangentially to the cortical surface.
9	Synchronously activated neurons produce a larger EEG signal than the same group of neurons when they are asynchronous.
10.	Deep (subcortical) regions of the brain produce a less blurred scalp EEG than cortical ones.
11	(Not available)
12	(Not available)
13	(Not available)
14	(Not available)
15	(Not available)
16	(Not available)
17	If a time series is not Fourier-transformable, it is impossible to compute its PSD.

#	Question
18	A necessary condition for a linear autoregressive (AR) model is that the time series to be modeled is wide-sense stationary.
19	PDC is a spectral, bivariate method.
20	The use of Ordinary Coherence can mitigate the problem of the common source.
21	A negative value of the Granger Index $G_{x \to y}$ should never occur if the two AR models that are compared to compute the index are correct.
22	In a graph, the distance $d(i,j)$ between two nodes is given by the average length of the paths that link them.
23	In a graph, the Global Efficiency $\in[0, 1]$.
24	In an undirected graph, I cannot compute the indegree and the outdegree.

(continues on the next page)

Section B

Unless stated otherwise, each correct answer will contribute 0.5 points to the grade (yielding a maximum of 12 points for Section B). Wrong answers will receive a penalty of -0.25 points.

#	Question
1	The oscillations of mu rhythm are more "arc-shaped" than the alpha rhythm's, which is comparatively a more symmetrical sinewave
2	The potential at the peak of the EP component P20 is higher than the potential at the peak of the N100 component
3	The CMRR of an EEG amplifier should be higher than 90 dB
4	When sampling at 100 Hz, a 75 Hz analog signal component will alias and appear at 25 Hz.
5	The RMS and the standard deviation of a zero-mean signal have the same value (assume that the number of samples $N \rightarrow \infty$).
6	Synchronized averaging of N EEG trials produces N values each corresponding to the average value of the potential in each trial.
7	A rectangular window is always the best choice for spectral analysis because it has the narrowest main lobe and no sidelobes.
8	The P300 ERP generated by attending a target stimulus is exploited to build virtual keyboards based on a BCI
9	In a 3-channel EEG recording, if the potentials at a given instant are $+10\mu V$, $-5\mu V$, and $-15\mu V$, the Common Average Reference (CAR) value is $+10\mu V$.
10	The RMS is the average of the squared value of the samples of a signal
11	The measurement of a single EMG signal requires three electrodes – two as input to the differential amplifier and one to provide the ground potential.
12	Notch filters effectively remove powerline noise because they reject all signals above their corner frequency.
13	An eyeblink produces an artifact which often interferes with the analysis of the beta band of the EEG.
14	Quantization divides the input range of the ADC into (approximately) NBITS intervals, where NBITS is the number of bits of the ADC.

#	Question
15	The most common and theoretically perfect method for reconstructing an analog signal from its samples is by connecting the sample points with straight lines (linear interpolation).
16	The DFT of a digital signal with N samples yields N/2 values of the signal's spectrum.
17	The SOA is always greater than the ISI
18	The proper (visual) alpha rhythm is generated in the frontal lobe of the cerebral cortex.
19	Given 100 independent and identically distributed random variables with variance equal to 4, the variance of their average is 0.04?
20	A single cell of the muscular tissue is known as a muscle fiber.
21	A 'run' is a portion of recording in an experimental protocol that contains no breaks, i.e. all samples contained therein have been acquired $1/f_s$ seconds after the previous (f_s being the sampling frequency)
22	A key advantage of FIR filters is their ability to be designed with linear phase, thus avoiding the introduction of time-domain waveform distortions.
23	The Butterworth filter is a design method in the family of Finite Impulse Response filters
24	Averaging raw EEG trials before computing the power spectrum is the standard method for analyzing non-phase-locked induced activity.

(end of Part I)