

Neuroengineering 2024-2025  
**Exam 10 September 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.
```

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	The sodium-potassium pump is a passive transportation mechanism.
2	The resting membrane potential for the neural cell is typically around +70 mV.
3	In an excitatory synapse, the post-synaptic membrane current is always hyperpolarizing.
4	In the Nernst equation, the temperature is expressed in Celsius degrees
5	The resting membrane potential is entirely due to the sum of the effects of the electrical forces acting on the ions and of the ion pumps.
6	Given an ion family with negative valence, if at a given temperature T its equilibrium potential is equal to -90 mV and the membrane potential is equal to -70 mV, the ions net current will be directed from the outside of the cell toward the inside.
7	The spatial and temporal summations of post-synaptic potentials are mutually exclusive.
8	The primary visual region, the primary auditory region and both Penfield Homunculi are all cortical areas.
9	Long-term synaptic plasticity involves structural changes in the post-synaptic membrane.
10.	Local Field Potentials are noninvasive correlates of brain activity.
11	The electrical variation of the membrane potential that mainly contributes to EEG is the action potential.
12	Scalp EEG is mainly produced by deep (subcortical) regions.
13	If a time series is not Fourier-transformable, it is impossible to compute its power spectral density.
14	Partial Directed Coherence is directional.
15	Anatomical connectivity can be estimated noninvasively.
16	The only way to estimate Causality in the sense of temporal precedence is to perturb the brain activity.

#	Question
17	Wiener-Granger Causality is based on the autoregressive modeling of time series.
18	Given the Granger Index $G_{xy}$ between two time series $x$ and $y$ , a negative value of $G_{x \rightarrow y}$ means an inverse precedence between the two time series.
19	The hidden source problem can be completely solved by using multivariate approaches.
20	In the event of data paucity, the Partial Directed Coherence (PDC) is the most accurate estimator of causality in the statistical sense.
21	A Modularity equal to -0.3 is a plausible result.
22	A Divisibility equal to 0 is a plausible result.
23	Random networks have a smaller Local Efficiency than regular (lattice) networks.
24	In terms of Local Efficiency, a Small World Network is closer to a Regular than to a Random Network.

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## 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 “waxing and waning” of the alpha rhythm is a change of amplitude whose duration is in the order of magnitude of 1 second.
2	The SOA is always greater than the ISI
3	The CMRR of a bipolar amplifier measures how much higher is the gain of the potential difference between the input electrodes with respect to the gain of their average with respect to the electrical ground.
4	Appropriate application of a high-pass digital filter may prevent saturation by removing high amplitude slow artifacts.
5	The DFT of a signal represents the amplitude $A_i$ and initial phases $\phi_i$ of sinewave components of the signal at frequencies $f_i$ ranging from 0Hz (included) to the sampling frequency (excluded).
6	A negative peak in a ERP recorded on a specific subject with a latency of 108ms may still be named N100, if it matches the physiological phenomenon of the nominal N100 component.
7	The purpose a filter is to allow desired spectral component of a signal to pass almost unaltered, while attenuating undesired spectral components
8	Increasing the Inter-Electrode Distance (IED) in a bipolar recording decreases the signal amplitude and increases selectivity.
9	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)
10	It is more likely that samples of zero mean a gaussian noise will have amplitude in the range [-0.5,+0.5] rather than in [0.5,1.5]
11	The EEG electrode Fz is located to the left of electrode Cz
12	In a typical single-trial recording, the peak amplitude of an Evoked Potential is larger than the amplitude of the background spontaneous EEG.
13	Notch filters effectively remove powerline noise because they reject all signals above their corner frequency.

#	Question
14	The synchronized average of N trials containing only spontaneous EEG whose variance is $var_{trial} = \sigma^2$ is a signal whose variance is $var_{avg} = \sigma^2/N$
15	When sampling at 100 Hz, a 75 Hz analog signal component will alias and appear at 25 Hz.
16	In ERP analysis where preserving the exact shape of the waveform is critical, a linear-phase FIR filter is generally a better choice than an IIR filter.
17	Event-Related Desynchronization/Synchronization (ERD/S) quantify phase-locked brain activity in response to an event
18	The $\eta$ (eta) rhythm is an oscillatory component of the spontaneous EEG
19	Spectral leakage spreads each frequency sample of the original spectrum with a pattern defined by the DFT of the windowing function, and thus is characterized by a main lobe and several side lobes.
20	Raw EMG amplitude in millivolts can be directly compared between different subjects without any normalization.
21	A sudden upwards movement of the eyes generates a positive deflection of EEG potentials (EOG) on the Fz channel.
22	A single cell of the muscular tissue is known as a muscle fiber.
23	The P300 ERP generated by attending a target stimulus is exploited to build virtual keyboards based on a BCI
24	The reconstruction of an analog signal from its sampled version is equivalent to the linear interpolation of the samples.

(end of Part I)