Neuroengineering 2022-2023

Exam 1 February 2024 – Part I

How to submit your answers.

Type your answers in the Exam.net editor.

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 a zero ('0') to indicate skipped answers. For example:

```
Section A
1. T
2. F
3. F
4. 0
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
7. I assumed that the sinewave frequency is lower than the Nyquist frequency.
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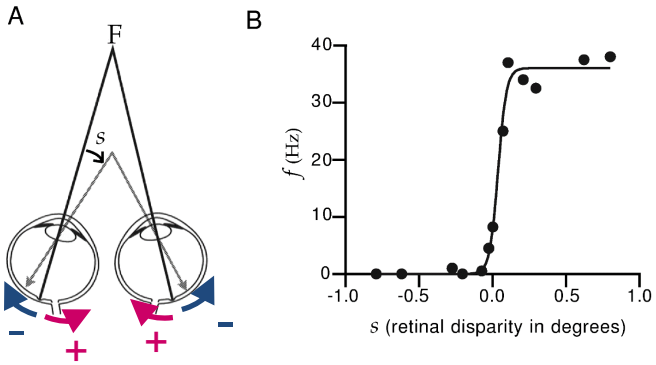
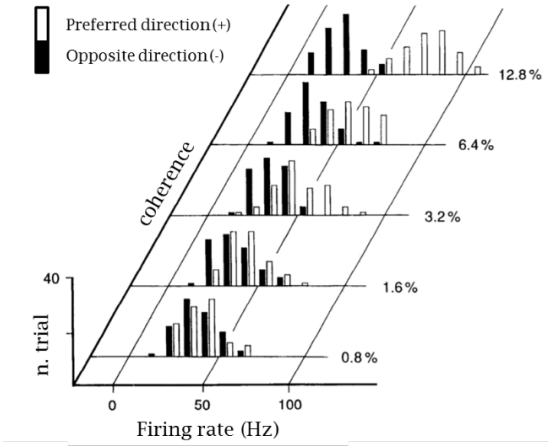
The total score will be computed summing the contribution of each answer, whose maximum partial score is shown on the right of each question, according to the following rules:

- 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 26.

Section A

	Question	Point (correct	Points (wrong)
1	An IPSP consists of a depolarization of the post-synaptic cell membrane.	0.5	-0.25
2	The voltage-gated Na^+ channel is responsible for the absolute refractory period.	0.5	-0.25
3	The most informative parameter of the spike train in output to a neuronal cell is the amplitude of the spikes.	0.5	-0.25
4	The firing rate of the pre-synaptic neuron influences the temporal summation of the PSPs in the post-synaptic cell.	0.5	-0.25
5	The frontal lobe houses the primary visual function.	0.5	-0.25
6	In the brain's primary motor cortex (Penfield homunculus) the extension of the cortical region which controls a specific body region is proportional to that body region's volume.	0.5	-0.25
7	The short-term synaptic plasticity involves an irreversible change in the post-synaptic membrane.	0.5	-0.25
8	To record in vivo measures of the membrane potential over the axon of a single neural cell, you will use extracellular measures.	0.5	-0.25
9	The EEG signal is mainly generated by action potentials.	0.5	-0.25
10	The tuning curve in the figure shows (panel B) the firing rate *f* of a neuron in the primary visual cortex as a function of the retinal disparity angle *s* (panel A).  From the figure, we can infer that the neuron responds mainly to positive *s* (far-tuned neuron).	0.5	-0.25
11	In reference to the previous figure (question 10): from the curve, if the neuron firing rate is equal to 0 Hz I can exactly infer which retinal disparity produced that response	0.5	-0.25
12	To record in vitro measures of the membrane potential over the dendrites of a neural cell, you will use extracellular measures	0.5	-0.25
13	The part of the pyramidal neuron that acts as a current dipole is the axon	0.5	-0.25

14	Given the distribution of firing rates in the figure:  The discriminability *d'* when the coherence=3.2% is higher than when it's =12.8%	0.5	-0.25
15	In reference to the previous figure (question 14), among the two distributions (r_+ or r_-), r_+ is the one affected by the coherence level	0.5	-0.25
16	The normalized Partial Directed Coherence $\in[0, 1]$	0.5	-0.25
17	The Granger Test is more suitable than the Ordinary Coherence to obtain a spectral measure	0.5	-0.25
18	If Cxy(f) is the ordinary coherence between x and y, Cxy(f)=Cyx(f)	0.5	-0.25
19	The difference between the Wiener's and Granger's definitions of causality in the statistical sense is that Granger indicated a modeling framework to be used to test causality	0.5	-0.25
20	Regular networks have a smaller Global Efficiency than random networks	0.5	-0.25
21	Regular networks have a smaller Local Efficiency than random networks	0.5	-0.25
22	Undirected graphs produce symmetrical adjacency matrices	0.5	-0.25
23	Given the Granger Index Gxy between two time series x and y, a negative value of Gx->y means an inverse precedence between the two time	0.5	-0.25
24	The long-term synaptic plasticity involves a structural change in the post-synaptic membrane.	0.5	-0.25
25	In an undirected graph, I cannot compute the indegree and the outdegree.	0.5	-0.25
26	The electrical variation of the membrane potential that mainly contributes to EEG is the action potential.	0.5	-0.25
TOT		13	

Section B

N.B. Wrong answers will receive a penalty equal to 50% of the correct question's points.

#	Question	Pts.
1	The frequency of oscillation of the beta rhythm is around 10 Hz	0.5
2	The mu rhythm is generated in the central regions of the cerebral cortex	0.5
3	The oscillations of mu rhythm are more "arc-shaped" than the alpha rhythm's, which is comparatively a more symmetrical sinewave	0.5
4	In the EEG terminology, impedance is a measure of the ability of an experimental subject to carry on an experiment	0.5
5	The advantage of a high CMRR amplifier is that it suppresses common-mode disturbances such as powerline (50 Hz) noise.	0.5
6	The contact impedances of a pair of electrodes should be large compared to the input impedance of the differential amplifier connected to them, otherwise the amplitude of the signal would be reduced as effect of the potential divider.	0.5
7	The EEG electrode Fz is located to the left of electrode Cz	0.5
8	The eye's potential is more negative in its frontal part than its posterior part, and thus its movements can generate large positive artifacts on the EEG.	0.5
9	Powerline noise is accentuated by asymmetries in the recording electrode pairs, such as impedances and cable path, because asymmetries prevent the noise to be rejected by the amplifier's common-mode rejection capabilities.	0.5
10	Notch filters effectively remove powerline noise because they selectively reject the narrow band affected by the artifact, preserving almost entirely the useful signal.	0.5
11	Movement of the subject's head may produce slow artifacts that are less pronounced when non-polarizable electrodes are used	0.5
12	The potential at the peak of the EP component P20 is higher than the potential at the peak of the N100 component	0.5
13	The ISI is always greater than the SOA	0.5
14	The averaging procedure can reliably uncover components of an ERP corresponding to evoked activity of the brain.	0.5
15	Event-Related Desynchronization/Synchronization (ERD/S) quantify phase-locked brain activity in response to an event	0.5
16	In analog-to-digital conversion, each spectral component of the analog signal should have frequency below the Nyquist frequency	0.5
17	When aliasing occurs in ADC, a sinusoidal component with frequency $f_0 = 0.7 \cdot f_s$ is reconstructed as a sinusoidal component at $f_1 = 0.2 \cdot f_s$ (f_s is the sampling frequency)	0.5
18	Quantization divides the input range of the ADC into (approximately) NBITS intervals, where NBITS is the number of bits of the ADC.	0.5
19	Appropriate application of a high-pass digital filter may prevent saturation by removing high amplitude slow artifacts.	0.5
20	The Average Rectified Value (ARV) is a measure of the amplitude of a signal, and it is obtained by summing the absolute values of all samples and dividing the result by the number of samples.	0.5

#	Question	Pts.
21	The frequency spectrum of white noise is flat, i.e. it has the same power at any frequency.	0.5
22	The Central Limit Theorem (CLT) states that the average of N independent identically distributed signals approaches zero for $N \to \infty$.	0.5
23	Given 100 independent and identically distributed random variables with variance equal to 4, the variance of their average is 0.2?	0.5
24	The method of the averaged periodogram to estimate the spectrum of a stochastic signal is applied when a lower variability of the PSD estimate at each frequency sample is desirable, while the spectral resolution Δf is higher than required.	0.5
25	The Butterworth filter is a design method in the family of FIR	0.5
26	The amplitude of sensorimotor rhythms can be voluntarily modulated through the exercise of motor imagery, to build a cursor control based on a BCI.	0.5
	Total Points	**13**