Neuroengineering 2019-2020

Exam 27 October 2020 – 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 dashes ('-') to indicate skipped answers. For example:

```
Section A
1. True
2. A
3. B and D
4. ---
5. 500 ms
…
Section B
1. …
```

In the exceptional case that one or more of your answer 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.
```

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:

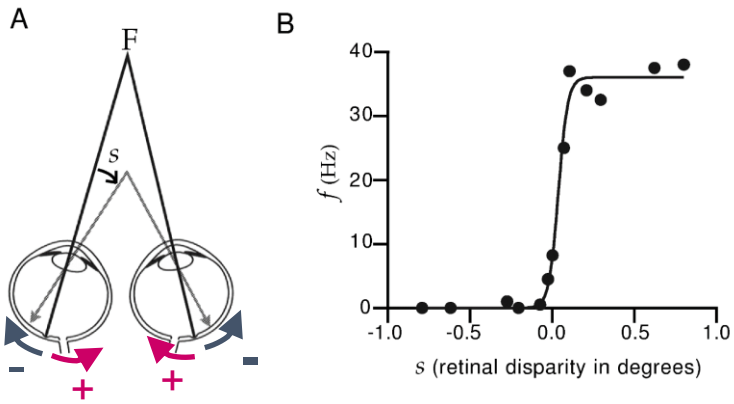
- correct and complete answer will contribute the maximum score
- partially correct or incomplete answers will contribute a fraction of the maximum score
- missing answers will not contribute
- wrong answers to the closed-ended questions (T/F, multiple choice, etc) will contribute with a negative score equal to –(max/N), where N is the number of possible choices.

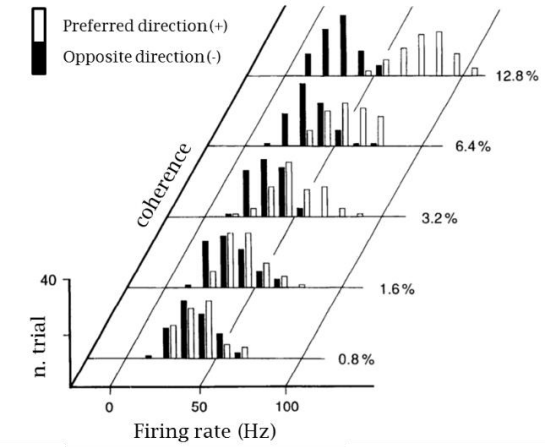
For instance:

- 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 22.

For all answers: Type True/False unless otherwise specified

#	Question – Section A	Points (correct)	Points (wrong)
1	We need to measure the amplitude and duration of an action potential each time it occurs to understand the cell behavior.	0.5	-0.25
2	The neuronal resting membrane potential is given by the sum of diffusional forces, electrical forces, and ion pumps activity	0.5	-0.25
3	The propagation of the action potential in myelinated axons is faster than the one in unmyelinated axons	0.5	-0.25
4	The visual function is housed in the frontal brain lobe	0.5	-0.25
5	The thalamus is a cortical region	0.5	-0.25
6	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
7	The part of the pyramidal neuron that acts as a current dipole is the axon	0.5	-0.25
8	The neurons' spatial orientation affects the amplitude of EEG signals	0.5	-0.25
9	The post-synaptic potentials are the electrical variation of the membrane potential that mainly contributes to EEG	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 only 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	In a Poisson process, when r increases, higher values of n are more likely	0.5	-0.25
13	The differences between the distribution of *isi* in real data and in simulated data produced by a Poisson spike generator are due to the refractory periods	0.5	-0.25

14	Given the distribution of firing rates in the figure:  The discriminability *d'* when the coherence=1.6 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 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
17	If Cxy is the ordinary coherence between x and y, Cxy=Cyx	0.5	-0.25
18	The normalized Partial Directed Coherence $\in[-\infty, \infty]$	0.5	-0.25
19	The Granger Test is more suitable than the Ordinary Coherence to obtain a spectral measure	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
	Total points for Section A (max)	**11**	

(Section B on the following pages)

For all answers: Type True/False unless otherwise specified

#	Question – Section B	Points (max)
1.	The amplitude of the mu rhythm is increased at the beginning of a motor task	
2.	The CMRR is usually expressed in decibel (dB) and high values characterizes better amplifiers.	
3.	The difference of contact impedances of electrodes should be small compared to the input difference of the differential amplifier, otherwise the resulting unbalance compromises its common-mode rejection capability.	
4.	Contact impedance of the electrodes is measured in kiloOhm ($k\Omega$) and must be measured using a direct current (DC).	
5.	The EEG electrode F8 is located to the left of electrode F6	
6.	EMG artifacts on a EEG recording mainly affects the alpha band and specifically the mu rhythm.	
7.	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.	
8.	Notch filters effectively remove powerline noise because they selectively reject the narrow band affected by the artifact, preserving almost entirely the useful signal.	
9.	The N20 component of an EP occurs before the stimulus (Negative latency) while the P300 occurs after the stimulus (Positive latency).	
10.	The amplitude of ERPs is measured with respect to a baseline epoch (usually preceding the stimulus), in which the amplitude is assumed to be zero.	
11.	Brain activity in response to a stimulus can be non-phase-locked, meaning that they show variable latency (jitter) at each repetition. This activity is called *induced*.	
12.	Event-Related Desynchronization/Synchronization (ERD/S) quantify relative changes of the power of the EEG rhythm in a predefined frequency range, relative to a baseline period.	
13.	In an ADC, quantization introduces a noise whose amplitude is proportional to the width of the quantization interval: $\sigma_{quant} = 1/\sqrt{12}\ LSB$	
14.	Aliasing occurs when an analog signal is sampled outside the conditions set by the Shannon's theorem.	
15.	Appropriate application of an analog filter (i.e. before the analog signal is converted) may prevent saturation by removing high amplitude artifacts in specific frequency bands.	
16.	The RMS and the ARV of a zero-mean signal have the same value (assume that the number of samples $N \to \infty$).	
17.	The frequency spectrum of a gaussian noise is flat, i.e. it has the same power at any frequency.	
18.	The synchronized average of N trials containing only spontaneous EEG whose $RMS_{trial} = \sigma^2$ is a signal $RMS_{avg} = \sigma^2/N$	
19.	The Butterworth filter is a design method in the family of IIR	

#	Question – Section B	Points (max)
20.	The spectral leakage phenomenon is observed, for instance, when comparing the spectrum of a signal with the spectrum of a short section of the same signal.	
21	The P300 ERP generated by attending a target stimulus is exploited to build virtual keyboards based on a BCI	
22	Order by ascending frequency of oscillations the following EEG rhythms: A. Alpha B. Beta C. Delta D. Gamma E. Theta Type the corresponding ordered sequence of letters, e.g. “E-D-C-B-A”	
	Total points for Section B (max)	**11**

(End of the test)