Neuroengineering 2021-2022

Exam September 15th, 2022 – Part 1

How to submit your answers.

Part 1.A

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:

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

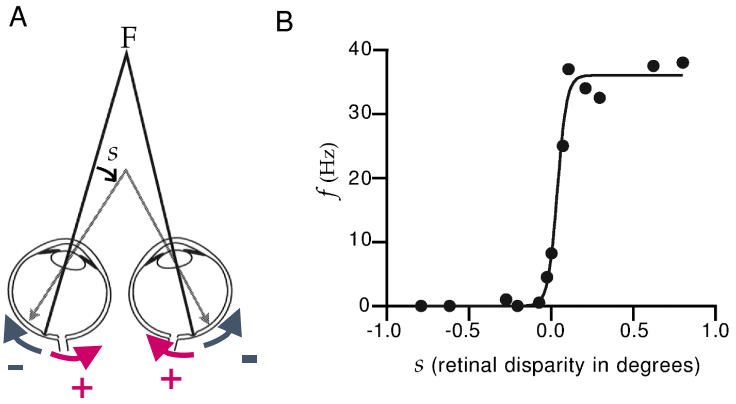
In the exceptional case that one or more of your answer require specific assumptions that were omitted in the question, you can add short comments at the end of each section. Start the optional comment with the number of the question it refers to. For example:

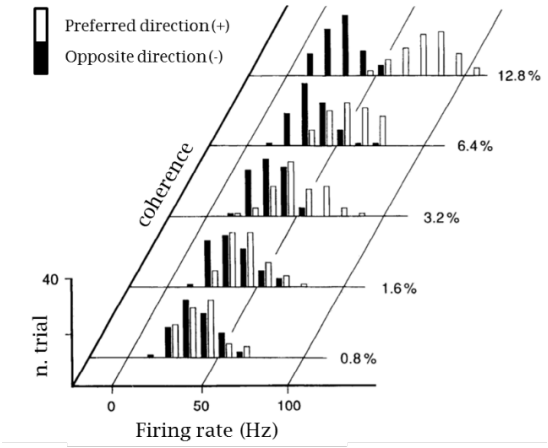
```
…

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.

The maximum total score for part 1.A is 11.

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 located in the brain frontal 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(f) is the ordinary coherence between x and y, Cxy(f)=Cyx(f)	0.5	-0.25
18	The normalized Partial Directed Coherence $\in[0, \infty]$	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 1.A (max)	**11**	

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For all answers: Type True/False unless otherwise specified

#	Question – Section B	Points (max)
1.	The theta rhythm includes oscillations with a frequency of 5 Hz	0.5
2.	With respect to the alpha rhythm, the oscillations of mu rhythm are more "arc-shaped", rather than resembling a regular sinewave	0.5
3.	The measurement of a single EMG signal requires three electrodes – two as input to the differential amplifier and one to provide the ground potential.	0.5
4.	The input impedance of a biosignal amplifier must be many orders of magnitude higher than the contact impedance of the electrodes	0.5
5.	The International 10-20 System for EEG electrodes placement takes its name from the fact that it describes the standard position of a set of at least 10 and up to 20 electrodes.	0.5
6.	Artifacts on biosignal recordings cannot have biological origin.	0.5
7.	An eyeblink produces an artifact which often interferes with the analysis of the beta band of the EEG.	0.5
8.	EMG artifacts on a EEG recording mainly affects the alpha band and specifically the mu rhythm.	0.5
9.	EMG artifact can easily appear on the EEG recording unless the subjects are specifically instructed by the experimenter on how to relax their face muscles.	0.5
10.	The estimation of ERPs requires the acquisition of numerous repetitions of the stimulus or event which evoked or induced the potential.	0.5
11.	The potential at the peak of the EP component N20 is lower than the potential at the peak of the P100 component	0.5
12.	Induced activity is best analyzed by applying synchronized averaging to the EEG trials.	0.5
13.	Event-Related Desynchronization/Synchronization (ERD/S) quantify the amount of coupling between signals on two EEG channels.	0.5
14.	The Nyquist frequency is the highest frequency of a component in an analog signal.	0.5
15.	Aliasing occurs when an artifact corrupts an otherwise healthy EEG recording.	0.5
16.	Aliasing can be prevented by applying a digital low-pass filter with cutoff frequency lower than the Nyquist frequency.	0.5
17.	$ARV_X = 1/N \sum_i x_i^2$, where the sum extends on the N samples of the signal X	0.5
18.	The frequency spectrum of a gaussian noise is flat, i.e. it has the same power at any frequency.	0.5
19.	Given 100 independent and identically distributed random variables with variance equal to 4, the variance of their average is 0.4?	0.5
20.	The higher the sampling frequency of a digital signal, the higher the frequency resolution of its spectrum.	0.5

#	Question – Section B	Points (max)
21	A FIR filter needs to be of a higher order to achieve the same quality specifications than a IIR filter.	0.5
22	The P300 ERP generated by attending a target stimulus is exploited to build virtual keyboards based on a BCI	0.5
	Total points for Section B (max)	**11**