Neuroengineering 2019-2020

Exam 9 June 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:

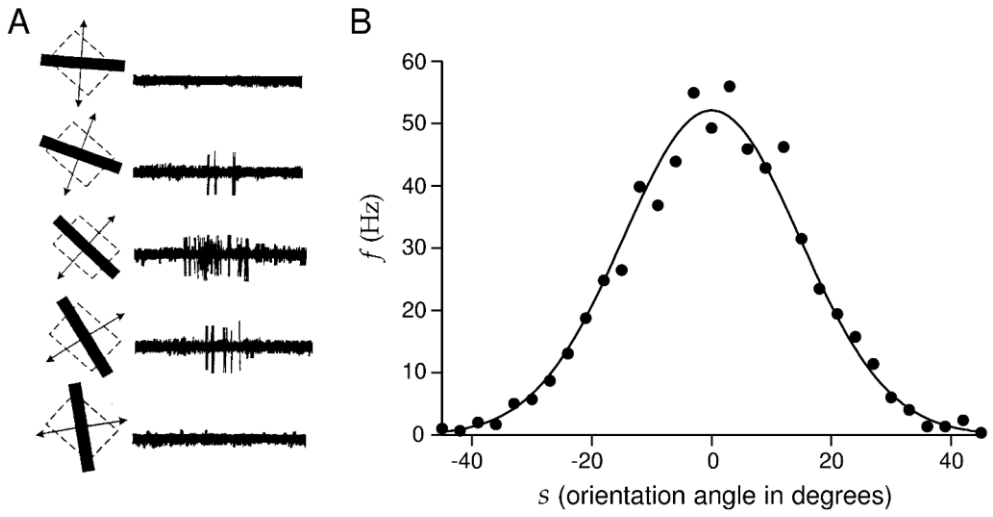
```
Section A
1. True
2. A
3. B and D
4. ---
5. 500 ms
…
Section B
1. …
```

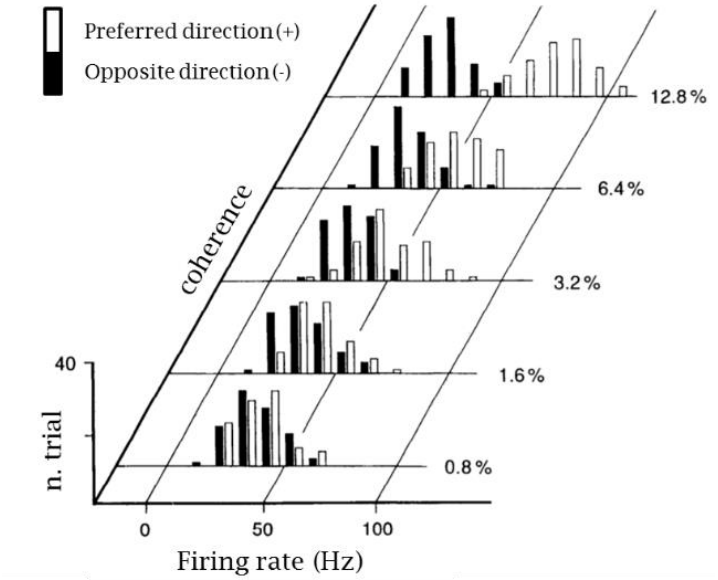
In the exceptional case that one or more of your answer require specific assumptions that were omitted in the question, you can add short comments at the end of each section. Start the optional comment with the number of the question it refers to. For example:

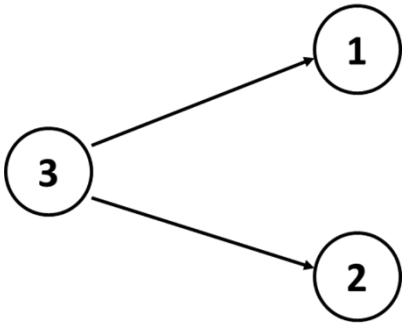
```
…

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 negatively, up to ½ of the maximum score.

#	Questions - Section A	Points (max)
1.	The voltage-gated Na^+ channel inactivation state is responsible for the absolute refractory period. Type T/F	0.5
2.	The voltage-gated K^+ channel is responsible for the repolarization phase of the action potential. Type T/F	0.5
3.	Given a spike train in output to a neuronal cell, what will the frequency of the spikes influence? A. The spatial summation of the PSPs B. The amplitude of the action potential produced by the post-synaptic cell C. The temporal summation of the PSPs Type the letter corresponding to the (only) correct answer.	1
4.	The short-term synaptic plasticity involves: A. A structural change in the post-synaptic membrane B. An increased number of membrane receptors C. The amount of neurotransmitter released in the synaptic cleft D. An irreversible change in the synaptic structure Type the letter corresponding to the (only) correct answer.	1
5.	Indicate which part of the brain tissue contributes more to the EEG signal: A. The cortical sulci B. The cortical gyri C. The subcortical regions D. The cerebellum Type the letter corresponding to the (only) correct answer.	1
6.	Given the following tuning curve:  A. If the measured firing rate is 20 Hz, can I infer which was the orientation angle that produced that response? Why? B. Is there a preferred stimulus orientation for which this neuron is designed to respond? How can I tell? Type a brief answer, max 2 lines for each question.	2

#	Questions - Section A	Points (max)
7.	In a Poisson spike generator: A. the program generates, at each time step, a random threshold, independent from *r*, and then compares the fixed *r* with the variable threshold B. the program generates a fixed threshold and, at each time step, compares the variable *r* with the fixed threshold C. the program generates, at each time step, a variable threshold dependent from *r* and then compares the variable *r* with the variable threshold Type the letter corresponding to the (only) correct answer.	1
8.	Given the distribution of firing rates in the figure, indicate, for each of the following sentences, if they are true or false:  A. The discriminability *d'* when the coherence =12.8% is higher than when it's =3.2% B. Higher coherence levels require lower values of the classification threshold *z* Type each letter followed by T or F	1
9.	Explain the difference between anatomical and functional connectivity Type a brief answer, max 5 lines.	1
10.	Given the Granger test between two time series x and y, indicate, for each of the following sentences, if they are true or false: A. $G_{x\to y}$ is always equal to $G_{y\to x}$ B. $G_{x\to y} \in [0, 1]$ Type each letter followed by T or F	1

#	Questions - Section A	Points (max)
11.	Given the following network, and assuming we can measure all the three signals and we have enough data, which approach is recommended to avoid spurious links?  Type a brief answer, max 1 line.	1
	Total points for section A (max)	**11**

(Continues with section B on the next page)

For all answers: Type True/False unless otherwise specified

#	Question – Section B	Points (max)
1.	The beta band identify frequencies lower than the alpha band	0.5
2.	The CMRR is usually expressed in decibel (dB) and high values characterizes better amplifiers.	0.5
3.	Ensuring a contact impedance below $5\ k\Omega$ is not relevant when the input impedance of the EEG amplifier is below $50\ k\Omega$	0.5
4.	An artifact is a potential difference due to sources outside the brain.	0.5
5.	Digital processing can remove all significant artifacts, and thus it is not worth using the measurement time to reduce their presence on the raw recording.	0.5
6.	A sudden movement of the eyes to the left generates a negative deflection of EEG potentials on the EEG channel F8.	0.5
7.	When recording EPs, the spontaneous EEG is to be considered a noise that completely masks the EPs on the recorded waveform.	0.5
8.	The amplitude of an ERP is measured with respect to its value at the time of the event.	0.5
9.	Evoked brain activity is phase-locked to the stimulus to which it is a response.	0.5
10.	The alpha rhythm is said to be synchronized when the amplitude of its oscillations increases.	0.5
11.	The Shannon's theorem states that a continuous signal can be properly sampled only if it does not contain frequency components above the sampling rate.	0.5
12.	Aliasing occurs when an analog signal is sampled outside the conditions set by the Shannon's theorem.	0.5
13.	An experimenter can reduce the chance of signal clipping by choosing a DAC with a lower number of bits.	0.5
14.	The RMS and the ARV of a zero-mean signal have the same value (assume that the number of samples $N \to \infty$).	0.5
15.	In a gaussian noise, the probability density that a sample has a given amplitude value follows the normal distribution with zero mean.	0.5
16.	Windowing the signal with a Blackman-Harris window reduces the spectral leakage effect because it reduces the width of the main lobe of the spectrum.	0.5
17.	Filters are categorized into four types depending on the basic shape of their frequency response: (i) low-pass; (ii) high-pass; (iii) low-stop; (iv) high-stop	0.5
18.	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 (A-E)	1
19.	Describe the main differences between gold and Ag/AgCl electrodes. Type a brief answer, max 2 lines	1

#	Question – Section B	Points (max)
20.	Given 100 independent and identically distributed random variables with variance equal to 4, what is the variance of average? Type the resulting number.	0.5
	Total points for Section B (max)	**11**

(End of the test)