Neuroengineering 2019-2020

Exam Example – 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. For example:

> Section A
> 1. True
> 2. A
> 3. B and D
> 4. 500 ms
> …
> Section B
> 1. …

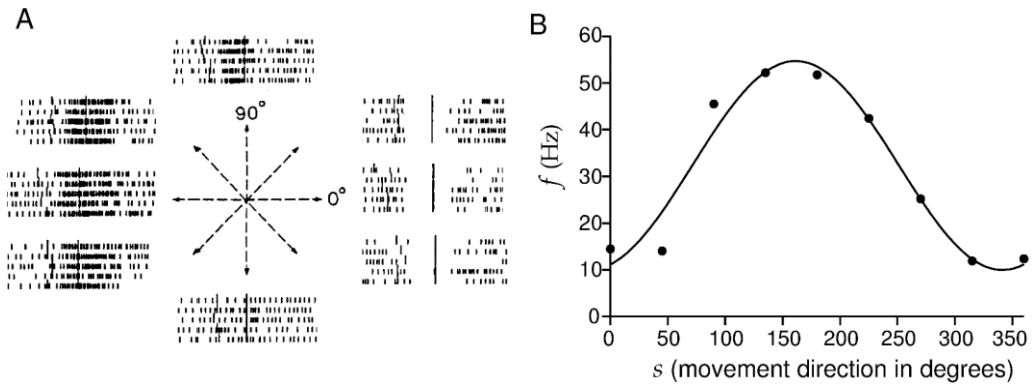
In the exceptional case that one or more of your answer require specific assumptions that were omitted in the question, you can add short comments at the end of each section. Start the optional comment with the number of the question it refers to. For example:

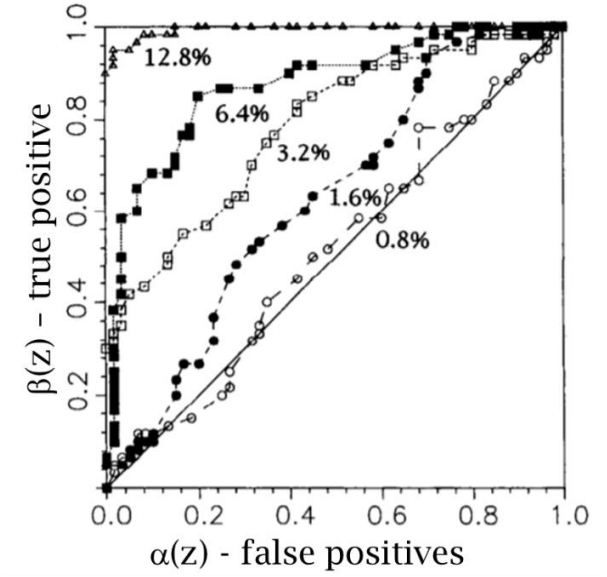
> …
>
> Comments
> 7. I assumed that the sinewave frequency is lower than the Nyquist frequency.

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.

The maximum total score for part I is 22.

#	Questions - Section A	Points (max)
1.	Given a spike train in output to a neuronal cell, which parameter is the most informative? A. The spikes amplitude B. The spatial position in which the spikes are generated C. The temporal distance between subsequent spikes Type the letter corresponding to the (only) correct answer.	1
2.	Put the following levels of cortical organization in a hierarchical order (from the smaller to the larger): A. Brodmann areas B. Cortical columns C. Brain lobes D. Brain circuits Type the ordered sequence of letters.	1
3.	For each of the following factors, indicate if it affects the amplitude of EEG signals: A. Open/closed field B. Neurons orientation C. Synchronicity of the neural activity D. Distance between the neurons and the electrodes Type the letter corresponding to each sentence, followed by Y or N.	2
4.	How is the post-synaptic membrane potential modified by an inhibitory synapse? Type a brief answer, max 1 line.	1
5.	In a Poisson process representing the generation of spike trains in a neuron, long inter-spike intervals (*isi*) have a probability that falls with their duration according to which mathematical law? Type a brief answer, max 1 line.	1
6.	Given the following tuning curve, is the neural response for a movement direction of 90 degrees greater than for a direction of 180 degrees?  Type Y/N.	1

#	Questions - Section A	Points (max)
7.	The ROC curves in the figure report the classification performances associated to different percentages of the stimulus coherence. Which of these curves indicate the best performances?  Type the percentage associated to the curve.	1
8.	Explain why testing causality as temporal precedence is more practical than testing the physical influence Type a brief answer, max 4 lines.	1
9.	List one advantage and one limitation of the multivariate approach Type a brief answer, max 3 lines.	2
	Total points for section A (max)	**11**

(Continues with section B on the next page)

#	Question – Section B For all answers: Type True/False unless otherwise specified	Points (max)
1.	What differentiates the mu rhythm from the alpha rhythm? Type a brief answer, max 2 lines	1
2.	The frequency of oscillation of the beta rhythm is around 10 Hz	0.5
3.	The CMRR of an EEG amplifier should be lower than 60 dB	0.5
4.	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
5.	The input impedance of a biosignal amplifier must be many orders of magnitude higher than the contact impedance of the electrodes	0.5
6.	An eyeblink produces an artifact which often interferes with the analysis of the beta band of the EEG.	0.5
7.	The eye is more positive in its frontal part than its posterior part, and thus its movements can generate large artifacts on the EEG.	0.5
8.	EMG artifacts on an 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 potential at the peak of the EP component P20 is lower than the potential at the peak of the N100 component	0.5
11.	The estimation of ERPs requires the acquisition of numerous repetitions of the stimulus or event which evoked or induced the potential.	0.5
12.	Event-Related Desynchronization/Synchronization (ERD/S) quantify the amount of coupling between signals on two EEG channels.	0.5
13.	In Analog to Digital Conversion, the Nyquist frequency equals half of the sampling frequency.	0.5
14.	Aliasing can be prevented by applying a digital low-pass filter with cutoff frequency lower than the Nyquist frequency.	0.5
15.	The RMS is the square root of the average of the squared value of the samples of a signal	0.5
16.	The frequency spectrum of a gaussian noise is flat, i.e. it has the same power at any frequency.	0.5
17.	The probability distribution of the average of N independent and identically distributed random variables is a normal distribution independently of the value of N	0.5

18.	The higher is the sampling frequency of a digital signal, the higher is the frequency resolution of its spectrum.	0.5
19.	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.	0.5
20.	For a signal sampled with sampling interval $\boldsymbol{\Delta T_s = 0.005s}$, the spectrum has a frequency range of: A. 200 Hz B. 100 Hz C. 0.005 kHz Type the letter corresponding to the correct answer	1
	Total points for Section B (max)	**11**

(End of the test)