Neuroengineering 2023-2024

Exam 3 July 2024 – Part I (even)

How to submit your answers.

Type your answers in the provided text file.

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. T
2. F
3. F
4. --
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
Q7: I assumed that the sinewave frequency is lower than the Nyquist frequency.
```

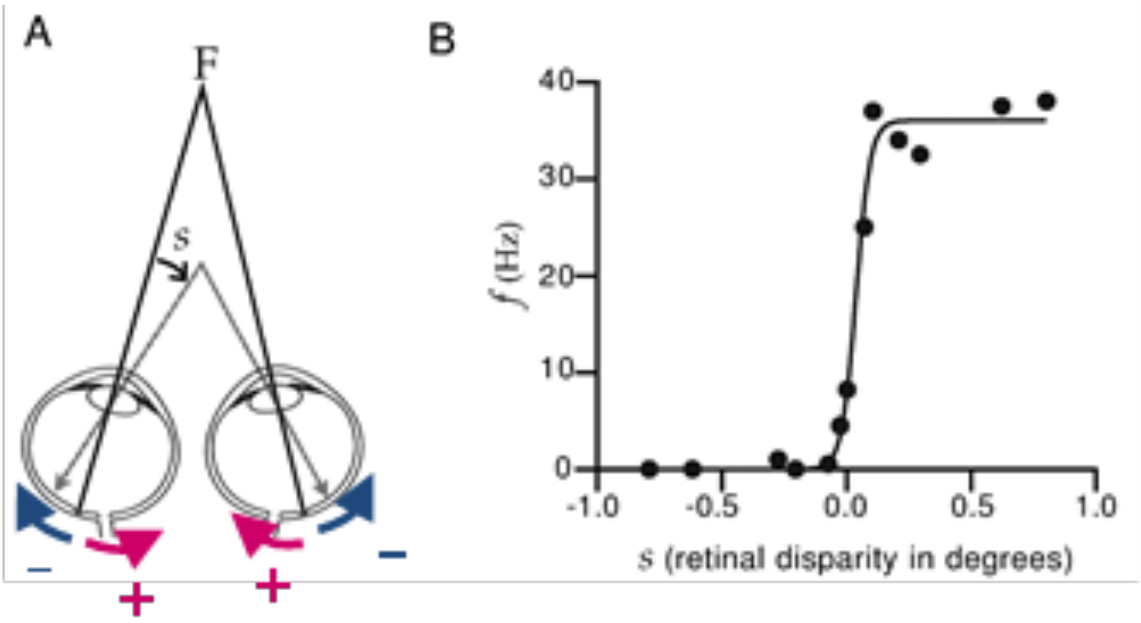
The total score will be computed summing the contribution of each answer, whose maximum partial score is shown on the right of each question, according to the following rules:

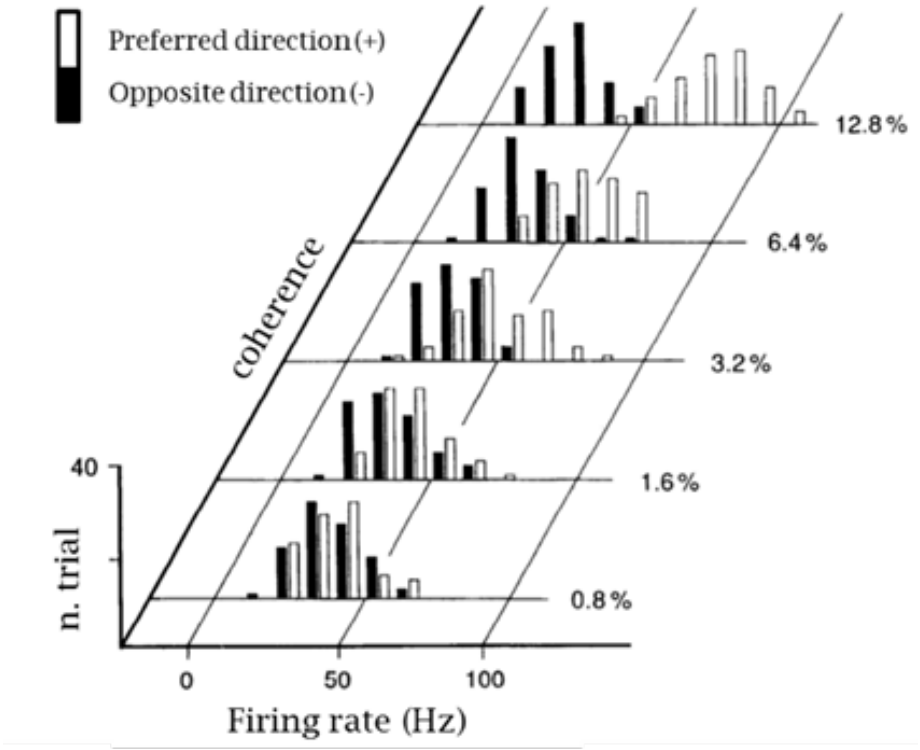
- a correct T/F answer contributes 0.5 points,
- a missing T/F answer contributes 0 points,
- a wrong T/F answer contributes -0.25 points.

The maximum total score for part I is 24.
A minimum score of 14 points in Part I is required to pass the exam.

Section A

Unless stated otherwise, each correct answer will contribute 0.5 points to the grade (yielding a maximum of 12 points for Section A). Wrong answers will receive a penalty of -0.25 points.

#	Question
1	An IPSP consists of a depolarization of the post-synaptic cell membrane.
2	The voltage-gated Na^+ channel is responsible for the absolute refractory period.
3	The most informative parameter of the spike train in output to a neuronal cell is the amplitude of the spikes.
4	The firing rate of the pre-synaptic neuron influences the temporal summation of the PSPs in the post-synaptic cell.
5	The frontal lobe houses the primary visual function.
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.
7	The short-term synaptic plasticity involves an irreversible change in the post-synaptic membrane.
8	To record in vivo measures of the membrane potential over the axon of a single neural cell, you will use extracellular measures.
9	The EEG signal is mainly generated by action potentials.
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).
11	In reference to the previous figure: from the curve, if the neuron firing rate is equal to 0 Hz I can exactly infer which retinal disparity produced that response

#	Question
12	To record in vitro measures of the membrane potential over the dendrites of a neural cell, you will use extracellular measures
13	The part of the pyramidal neuron that acts as a current dipole is the axon
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%
15	In reference to the previous figure, among the two distributions (r_+ or r_-), r_+ is the one affected by the coherence level
16	The normalized Partial Directed Coherence $\in[0, 1]$
17	The Granger Test is more suitable than the Ordinary Coherence to obtain a spectral measure
18	If Cxy(f) is the ordinary coherence between x and y, Cxy(f)=Cyx(f)
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
20	Regular networks have a smaller Global Efficiency than random networks
21	A regular network has fewer nodes than a random network.
22	Random networks have a smaller Local Efficiency than regular (lattice) networks.
23	In a graph, the minimum Divisibility is equal to zero.

#	Question
24	Divisibility and Modularity are measures of integration of a network.

(continues on the next page)

Section B

Unless stated otherwise, each correct answer will contribute 0.5 points to the grade (yielding a maximum of 12 points for Section B). Wrong answers will receive a penalty of -0.25 points.

#	Question
1	In a P300-based BCI, the user subjectively assigns saliency (relevance) to a stimulus so that their brain produces a P300 ERP every time the stimulus is administered
2	Event-Related Desynchronization/Synchronization (ERD/S) quantify phase-locked brain activity in response to an event
3	A FIR filter needs to be of a higher order to achieve the same quality specifications than a IIR filter.
4	The N20 component of an EP occurs before the stimulus (negative latency) while the P300 occurs after the stimulus (positive latency).
5	EEG signals recorded in monopolar configuration can be re-referenced to the Common Average Reference (CAR), by subtracting from each channel the instantaneous average of all channels. In ideal conditions, this would approximate taking the reference potential at infinity.
6	Evoked Potentials are deflection of the EEG signal following the presentation of a sensory input.
7	When recording EPs, the spontaneous EEG is to be considered a noise that completely masks the EPs on the recorded waveform.
8	In ERP analysis, ‘trials’ are portions of the continuous EEG recording that start exactly at the time when a sensory stimulus was delivered
9	Aliasing occurs when an artifact corrupts an otherwise healthy EEG recording.
10	The roll-off of a filter is the slope of its frequency response in the transition band. It is high when the transition band is narrow.
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.
12	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.
13	The CMRR of an EEG amplifier should be higher than 90 dB
14	Movements of the subject’s head produces artifacts only in the gamma band.

#	Question
15	The powerline noise affects a very narrow frequency band of the recorded signal around 50 Hz (in Europe) and odd multiples of (150 Hz, 250 Hz, …).
16	A 'run' is a portion of recording in an experimental protocol that contains no breaks, i.e. all samples contained therein have been acquired $1/f_s$ seconds after the previous (f_s being the sampling frequency)
17	$ARV_x = \sqrt{\frac{1}{N}\sum_i (x[i])^2}$, where the sum extends on the N samples of the signal x[i]
18	The frequency spectrum of white noise is flat, i.e. it has the same power at any frequency.
19	An EEG recording is said to be bipolar when it comprises exactly two channels
20	The RMS and the ARV of a zero-mean signal have the same value (assume that the number of samples $N \to \infty$).
21	Event-Related Desynchronization/ Synchronization (ERD/S) quantify the amount of coupling between signals on two EEG channels.
22	In an ADC, quantization introduces a noise whose amplitude is proportional to the width of the quantization interval (V_{LSB}): $\sigma_{quant} = \frac{1}{\sqrt{12}} \cdot V_{LSB}$
23	The Short Time Fourier Transform (STFT) is a simple method to estimate a spectrogram, i.e. the representation of the time-varying spectrum of a non-stationary signal.
24	The mu rhythm and the alpha rhythm are EEG components that differ for their fundamental frequency of oscillation

(end of Part I)