Neuroengineering 2019-2020

Exam Example – Part I

Solutions

Section A

1. C
2. B, A, C, D
3. A= Y, B= Y, C= Y, D= Y
4. An inhibitory synapse causes a hyperpolarization of the post-synaptic membrane
5. Exponential
   (note: $P[\tau] = P[t_i + \tau \leq t_{i+1} \leq t_i + \tau + \Delta t] = r\Delta t e^{(-r\tau)}$)
6. No
   (note: you need to compare the firing rate f for s = 90° and for s = 180°)
7. 12.8%
   (note: it's the curve with the highest AUC)
8. Because testing the physical influence requires physically acting upon brain activity to remove any other physical influence on the target node, while testing the temporal precedence is observational, as it is based on the statistical properties of the signals.
9. Advantages: Better accuracy in the network estimation, it allows the inclusion of all data sources in the model.
   Limitations: Limitation in the number of channels/signals that can be modeled, more data points required.

Section B

Question	Answer
What differentiates the mu rhythm from the alpha rhythm?	The mu rhythm originates in the motor cortex (central region), the alpha rhythm in the visual cortex (occipital region). The mu rhythm is arc shaped. [*Even though they both oscillate in the EEG alpha band*.]
The frequency of oscillation of the beta rhythm is around 10 Hz	F The minimum conventional oscillation frequency of the beta rhythm is 14 Hz
The CMRR of an EEG amplifier should be lower than 60 dB	F An instrumentation amplifier should have a high CMRR. Good values are 90 dB and up.
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.	F 10% and 20% are fractions of the total distance between craniometric points, used to establish electrode positions.
The input impedance of a biosignal amplifier must be many orders of magnitude higher than the contact impedance of the electrodes	T
An eyeblink produces an artifact which often interferes with the analysis of the beta band of the EEG.	F An eyeblink artifact is a slow wave lasting several tens of a second (i.e. well below 10 Hz)
The eye is more positive in its frontal part than its posterior part, and thus its movements can generate large artifacts on the EEG.	T
EMG artifacts on an EEG recording mainly affects the alpha band and specifically the mu rhythm.	F EMG artifacts has a spectral content starting at frequencies of 20 Hz and up, thus affecting the beta and gamma bands of the EEG signal
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.	T
The potential at the peak of the EP component P20 is lower than the potential at the peak of the N100 component	F P20 is a positive peak, N100 is a negative peak. The potential of the former is thus higher.
The estimation of ERPs requires the acquisition of numerous repetitions of the stimulus or event which evoked or induced the potential.	T

Event-Related Desynchronization/Synchronization (ERD/S) quantify the amount of coupling between signals on two EEG channels.	F ERD/S quantify changes of the power of EEG relative to a baseline period
In Analog to Digital Conversion, the Nyquist frequency equals half of the sampling frequency.	T
Aliasing can be prevented by applying a digital low-pass filter with cutoff frequency lower than the Nyquist frequency.	F Aliasing must be prevented by applying an analog filter before ADC. Digital filters can only be applied after the signal is sampled, and thus aliasing has occurred. No digital filter can remove it at that point.
The RMS is the square root of the average of the squared value of the samples of a signal	T
The frequency spectrum of a gaussian noise is flat, i.e. it has the same power at any frequency.	F A gaussian noise has normal distribution of amplitude of the samples. [*A white noise has a flat spectrum.*]
The probability distribution of the average of N independent and identically distributed random variables is a normal distribution independently of the value of N	T
The higher is the sampling frequency of a digital signal, the higher is the frequency resolution of its spectrum.	F The frequency resolution of a spectrum is only determined by the duration of the signal. A change of sampling frequency alone only affects its frequency range.
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.	T
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	A The frequency range of the spectrum equals the sampling frequency $\boldsymbol{f_s = 1/\Delta T_s = \frac{1}{0.005s} = 200Hz}$