

DEPARTMENT OF BIOTECHNOLOGY, IIT, MADRAS
CHENNAI – 36

BT 6220 Introduction to Computational Neuroscience

Class : Btech/MTech/PhD

Date : 27-11-2014

Time : 10-11 am

END SEMESTER Examination

Marks: 15 or 30

Instructions:

- 1) Students who opted for class project need to only answer Part B.
- 2) Some questions can have more than one choice!

Part A: Pre-midsem Portion (15 marks):

1. Which of the following are functions of glial cells?
a) release of neurotransmitter, b) responding to neurotransmitter, c) deliver energy molecules to neurons, d) clear neural debris, e) slow down neural conduction, f) generate action potentials
(A) c,d,e, (B) a,b,c,d,e, (C) d,e,f, (D) c,d,e, ☒
2. Which of the following is closest to the Nernst potential of potassium given, $[K^+]_0 = 20 \text{ mM}$, $[K^+]_i = 400 \text{ mM}$, (Use, $RT/F = 26 \text{ mV}$ at $T = 25^\circ\text{C}$. Assume $T = 25^\circ\text{C}$.)
(A) 55 mV, (B) 77 mV, (C) -55 mV, (D) -77 mV ☒
3. Shunting inhibition occurs when,
(A) When the Nernst potential of synaptic channel conductance equals resting membrane potential ☒
(B) When synapse is inhibitory ☒
(C) When the Nernst potential of synaptic channel conductance is much lesser than resting membrane potential
(D) When the Nernst potential of synaptic channel conductance is much greater than resting membrane potential
4. Which of the following is NOT one of the 4 components of signaling in a neuron:
(A) Dendritic processing, (B) spatio-temporal summation, (C) axon remodeling, (D) neurotransmission ☒
5. Propagation velocity in an unmyelinated axon depends on its diameter, d , as,
(A) d , (B) $d^{1/2}$, (C) d^2 , (D) $d^{3/2}$. ☒

Part B: Post-midsem Portion (15 marks):

1. The dynamics of quadratic-integrate-and-fire neuron is described as follows:

$$\frac{dV}{dt} = V^2 + I$$

Resetting mechanism: if $(V \geq V_{peak}) V = V_{reset}$.

- i) If, $I < 0$ and $V_{reset} < -\sqrt{-I} < \sqrt{-I} < V_{peak}$, the neuron exhibits the following kinds of dynamics:

(A) Oscillations, ~~(B)~~ excitability, ~~(C)~~ two stable nodes, (D) none of the above

- ii) If, $I < 0$ and $\sqrt{-I} < V_{reset} < V_{peak}$, the neuron exhibits the following kinds of dynamics:

~~(A)~~ Oscillations, (B) resting state, (C) one saddle and 2 spiral nodes, (D) none of the above

2. Consider the multilayer perceptron defined as $y = g(w_1*V_1 + w_2*V_2 - b)$; $V_1 = g(w_{11}*x_1 + w_{12}*x_2 - b_1)$; $V_2 = g(w_{21}*x_1 + w_{22}*x_2 - b_2)$, where x_1 and x_2 are inputs and y is the output. For which of the following weight patterns does the network simulate an EXOR gate? ($g()$ = step function).

~~(A)~~ $w_{11} = w_{12} = 1$; $b_1 = 0.4$; $w_{21} = w_{22} = 1$; $b_2 = 1.6$; $w_1 = 1 = -w_2$; $b = 0.1$.

(B) $w_{11} = w_{12} = -1$; $b_1 = 0.4$; $w_{21} = w_{22} = 1$; $b_2 = -1.6$; $w_1 = -1 = -w_2$; $b = 0.1$.

(C) $w_{11} = w_{12} = 1$; $b_1 = -0.4$; $w_{21} = w_{22} = -1$; $b_2 = 1.6$; $w_1 = -1 = -w_2$; $b = 0.1$.

~~(D)~~ $w_{11} = w_{12} = 1$; $b_1 = 0.6$; $w_{21} = w_{22} = 1$; $b_2 = 1.4$; $w_1 = 1 = -w_2$; $b = 0.9$.

3. The two stages of training of a self-organizing map are called:

(A) Early phase and late phase, ~~(B)~~ topological phase and metric phase, (C) stable phase and unstable phase, ~~(D)~~ ordering phase and settling phase

4. Which of the following is NOT a merit of a multilayer perceptron?

~~(A)~~ Local minima, (B) parallelizable training, (C) universal approximation, ~~(D)~~ non-unique solutions