Resting Potential and the Nerve Impulse

version 19 May 2016

ECE 5730 Foundations of Neural Networks

Part One

1. Carefully read Section I.3 of [1].
2. Make an 'electrical engineering' observation about equations (I.3-9) to (I-3.13) of [1] given Figure I.3-1(b). Discuss. Assume that V_m is defined with a polarity such that for a positive V_m the cell interior is at a higher electric potential than the cell exterior.
3. Complete the "***NeuroDynamix II* Modeling: *Soma* Lessons**" of [1, pp. 43-50]: "Nernst Potential"; "Resting Potential"; "Conductances"; and "Electrogenic Sodium Pump".

Part Two

Download the dissertation *Exploration of Stimulus Current Energy Reduction and Bifurcation Dynamics in Conductance-Based Neuron Models Using Optimal Control Theory* by Michael Ellinger. Page 144 of that document provides the classic four-dimensional Hodgkin-Huxley neuron model. Using the parameter values of Table 5, duplicate the result of Figures 89-91 using a MATLAB® simulation of the differential equations. Use functions to implement $\alpha_n(V)$ etc.

Part Three

1. Carefully read Section I.4 of [1].
2. Complete the "***NeuroDynamix II* Modeling: *Axon* Lessons**" of [1, pp. 68-81]: "Impulse: Dynamics"; "Voltage Clamp: Ionic Currents"; "Voltage Clamp: Sodium Current Inactivation"; "Voltage Clamp: Sodium and Potassium Conductances"; "Impulse: Conductances"; "Impulse: Threshold"; "Impulse: Refractory Period"; and "Impulse: Anodal Break Excitation".

References

[1] W. Otto Friesen and J. A. Friesen, *NeuroDynamix II: Concepts of Neurophysiology Illustrated by Computer Simulations*, Oxford University Press, 2010.

