EE3BB3 Tutorial #1 (2014)

Question 1 (Exercise 8 of Chapter 3 from Plonsey & Barr, 2nd Edition)

8. The major external and internal ion concentrations for the *Aplysia* giant nerve cell are approximately:

K_e^+	10 mM	Cl_e^-	485 mM
K_i^+	280 mM	Cl_i^-	51 mM
Na_e^+	485 mM		
Na_i^+	61 mM		

a. Determine the Nernst equilibrium potential for sodium, potassium, and chloride. (Express as potential inside *i* minus outside *e*.) Assume T = 20°C.

b. Is there a transmembrane potential for which all ions are in equilibrium?

c. The resting potential for the cell is −49 mV (inside minus outside). Which ions are in equilibrium and which are not? For the latter, in what direction do the ions move? What must be true of the net ion movement? Why?

Question 2 (Exercise 28 and 29a of Chapter 3 from Plonsey & Barr, 2nd Edition)

28. Suppose a cardiac cell has the shape of a brick, with edges of 10, 20, and 100 μm. Suppose it is modelled satisfactorily using a parallel-conductance model with three paths, one for capacitance, *C*, one for sodium, Na, and one for all other membrane currents, or "leakage," *L*. (The famous cardiac investigators Ebihara and Johnson used this kind of model.) Suppose the cell is isolated (so that there are no cell-to-cell connections), and that its transmembrane potential V_m may therefore vary temporally but not spatially. Suppose that the cell has $E_{Na} = +40$ and $E_L = -90$ mV. Suppose g_L is constant and equal to 0.90 mS/cm^2, while g_{Na} is 0.10 mS/cm^2 at rest but may vary as specified. Suppose transmembrane stimulus currents may be injected with a rectangular pulse-shaped wave form but are otherwise zero. What is:

a. The cell's surface area, *A*, excluding the ends of the brick?

b. The cell's membrane capacitance, *C* (in farads), if $C_m = 1.0\ \mu F/cm^2$?

c. The cell's membrane resistance at rest, R_r (in ohms)?

d. The magnitude of charge, *Q* (in coulombs), that must be added to the membrane capacitance to shift V_m from the resting potential V_r to $V_m = V_r + 10$ mV?

e. dV_m/dt, if V_m is $V_r + 10$.

29. We continue with questions about the cardiac cell. What is:

a. The resting potential, V_r (in mV)?