Problem 1: Write matlab code to simulate squid action potential On the homework page, you will find a partial solution in matlab called hh_squid_stub.m. Around line 90 is where you will have to fill in code to solve the differential equation for the membrane voltage labeled INSERT CODE HERE.

The rest of this code is a stub which sets up the units, provides the alpha and beta functions, and initializes all the variable. Line 86 initializes the membrane voltage at time click 1 – this will be helpful since this is the form you need to wrap in an ODE solver to complete the assignment. You can use Euler's method to solve the HH ode(s).

I gave you this stub because it is somewhat tricky to get the units to work out correctly and can be a big time sink to get the basic structure of the code correct. So this structure will save you that problem.

Here, I am using SI units, but you might want to plot in "milliSI" units by making using of the scale factor sf=1e-3 given in the code.

Problem 2: Derive Cable Equation Derive the cable equation for practice.

$$\frac{1}{r_i}\frac{\partial^2 V_m}{\partial x^2} = \frac{V_m}{r_m} + c_m\frac{\partial V_m}{\partial t} \tag{0.1}$$

Using the definitions of r_m and r_i (in Chapter 5 of Genesis) or in the note I put on the class web site about "Units of Compartmental Modeling", show that this can be written in the dimensionless form:

$$\frac{\partial^2 V_m}{\partial X^2} = V_m + \frac{\partial V_m}{\partial T} \tag{0.2}$$

where $\lambda = \sqrt{\frac{r_m}{r_i}}$ and $\tau = r_m c_m$ and $X = \frac{x}{\lambda}\ and\ T = \frac{t}{\tau}$.

Show that λ has dimensions of length and τ has dimensions of time .

The space constant λ and time constant τ are fundamental characterizations of neuronal processes.

Problem 3: Cable Unit Geometry Derive the dependence of geometry of the lumped membrane resistance R_m and the lumped axial Resistance R_a (with reference to Chapter 5 of The Book of Genesis, or the notes on the wiki on "Units of Compartmental Modeling)