MATH 3375 - Hodgkin Huxley HW

All of these problems are based on the Hodgkin Huxley equations whose equations are given in Dayan & Abbott, equations (5.22), (5.24), and (5.25). (Please note that they give conductances in $mS/mm^2$. The capacitance is thus, $0.01\mu F/mm^2$.)

In case you don't want to type in the code, I think you can cut and paste from pdfs, so here are the equations:

$$am(v) = 0.1(v+40)/(1-\exp(-(v+40)/10))$$
$$bm(v) = 4*\exp(-(v+65)/18)$$
$$ah(v) = 0.07*\exp(-(v+65)/20)$$
$$bh(v) = 1/(1+\exp(-(v+35)/10))$$
$$an(v) = 0.01*(v+55)/(1-\exp(-(v+55)/10))$$
$$bn(v) = 0.125*\exp(-(v+65)/80)$$

$$v' = (I_0 + iS(t) - gna(h)*(v-vna)*m^3 - gk*(v-vk)*n^4 - gl*(v-vl))/c$$
$$m' = am(v)*(1-m) - bm(v)*m$$
$$h' = ah(v)*(1-h) - bh(v)*h$$
$$n' = an(v)*(1-n) - bn(v)*n$$

1. Set all currents to zero and find the rest state of the equations by letting the membrane come to equilibrium.

2. Apply a square wave of current lasting 5 msec at a magnitude of 0.05 $\mu A/mm^2$; do the same for $-0.05\mu A/mm^2$. In both protocols vary the amplitude of the stimulus until an action potential appears or fails to appear.

3. Apply a ramp of current that goes from 0 to .2 $\mu A/mm^2$ and back to 0, 200 msec up and 200 msec down. At what value of current does it begin to spike and when does it stop?

4. Compute the firing rate current curve in the following manner: Step from 0 to 0.2 $\mu A/mm^2$ in 50 steps and wait for steady state to be reached; if it is oscillator, compute the interspike interval. Plot the reciprocal of this as a function of current. Note that if you use a bifurcation package (such as AUTO, which is part of XPPAUT), you can do this rather easily.