Fall 2015 * Math 430 * Math 635 * Prof. Victor Matveev
Homework 10 * Due date: November 19

1. Finish your code for the 2D reduction of the Hodgkin-Huxley model:

$$CV' = I_{app}(t) - g_K n^4 (V - V_K) - g_{Na} m_\infty^3 (0.89 - 1.1n)(V - V_{Na}) - g_L (V - V_L)$$

   Set capacitance to C=5, and I_{app} =0. Plot the phase-plane trajectory corresponding to a single spike, plot the flow field, and the nullclines. See email for the V-nullcline code.

2. Examine the resonance in the 2D HH model by studying the amplitude of the V(t) as a function of the frequency *k* of the oscillatory applied current Iapp = @(t) Imax * sin(k*t) (choose Imax = 4.5). Note that you can do this automatically, by using a for-loop over frequencies, and extracting the maximum of potential in the solution using command “max”. Make sure to pick the initial condition near the rest state. Pick a sufficiently long integration time, and to avoid the initial transient, use “Vmax = max(Y(round(end/2):end,1))” to extract the maximal potential from the second half of simulation.

3. For the case of constant applied current, find the critical value of I_{app} for which the Hodgkin-Huxley model transitions to periodic spiking. Does this look like class-1 or class-2 excitability? What type of bifurcation describes the transition from rest to spiking?

4. Examine the following bifurcation diagram of some 2D model (the parameter is on the horizontal axis). Name all bifurcations, and label them on this plot. Make a rough sketch of the flow in the 2D plane consistent with each bistability region in this bifurcation diagram.