**Computational Neuroscience**

**Project 2**

**Group 2**

1. Units chosen:

Current/area -> microamps/cm2

Voltage ->millivolts

Time -> milliseconds

Conductance/area -> millisiemens/cm2

Capacitance/area -> microfarads/cm2

To verify ohms law with respect to dimension,

Current = conductance x voltage

Millisiemens/cm2\*millivolts = 10^-3 siemens/cm2 x 10^-3 volts = 10^-6 amps/cm2= 1 microamps/cm2

Units are consistent.

If conductance was microsiemens/cm2, voltage could be in volts and current in microamps/cm2 OR voltage in millivolts and current in nanoamps/cm2

The solution is not unique as any common factor in units involved in the Ohm’s law will get cancelled.

1. Morris Lecar equations –

dv/dt = -gCa x m\_inf(V) x (V-VCa) / C - gK x w x (V-VK) /C – gL x (V-VL)/C + I/C ----- (1)

dw/dt = phi x (w\_inf(V) – w)/ tau\_w(V) ------ (2)

At equilibrium,

dv/dt=dw/dt=0

Solving the equation in Matlab, we get equilibrium at v=-60.8554 mV and w=0.01491

Iext is taken as 93.85 microamps/cm2 for quiver plot

1. Eigenvalues from Jacobian matrix are (- 0.09146 + 0.0258i)

and (- 0.09146 - 0.0258i). Stable equilibrium.

1. Several options are available for MATLAB’s ode45 solver, giving you limited control over the algorithm. Two important options are relative and absolute tolerance, respectively RelTol and AbsTol in MATLAB. At each step of the ode45 algorithm, an error is approximated for that step. If yk is the approximation of y(xk) at step k, and ek is the approximate error at this step, then MATLAB chooses its partition to ensure ek ≤ max(RelTol · |yk|, AbsTol), where the default values are RelTol = 10−3 = 0.001 and AbsTol = 10−6 = 0.000001. Notice that with this convention, if the magnitude of the solution |yk| gets large then the error can be quite large and RelTol should be reduced. On the other hand, if the magnitude of the solution is smaller than 10−6 then AbsTol must be reduced. (Source: <https://www.math.tamu.edu/~glahodny/Math442/Solving%20ODEs.pdf>)
2. Somewhere between Iext = 84 microamps/cm2 and Iext = 85 microamps/cm2, there is an action potential (spike). On maintaining a higher value of Iext, the spiking occurs periodically as observed from V vs t plot. For Iext= 85 microamps/cm2, action potentials occur. But maintaining this Iext, if phi set to 0.04, there is no action potential but for phi = 0.01 there is still action potential. The change in phi in the differential equations leads to change in the solution and therefore a new (higher) minimum Iext value at which action potential occurs. Physically phi is a temperature factor and this shows that the required current impulse magnitude for spiking changes with temperature. Also, from phase plane plots, limit cycle occurs only when the action potentials occur (no limit cycle for phi=0.04).
3. At around -15 mV of initial conditions, we find there is a threshold and above this, spiking occurs as seen by a huge jump in peak voltage.