Assignment 1 (BT6270)

1. Threshold values for the external applied currents I 1, I 2, and I 3 in which shift of dynamical behavior from one to another is seen, such as no AP, a finite number of APs, Continuous firing, and then followed by distortion resulting in no more APs.

Assumptions Made:

- For some constant value of current (Iext), we have plotted the Voltage vs Time graph. And we observe the behavior of the graph as the current changes.
- If the peak value of the Membrane Potential (Vm) is less than 0 than we do not consider it as an Action Potential.
- I = Current, V = Voltage

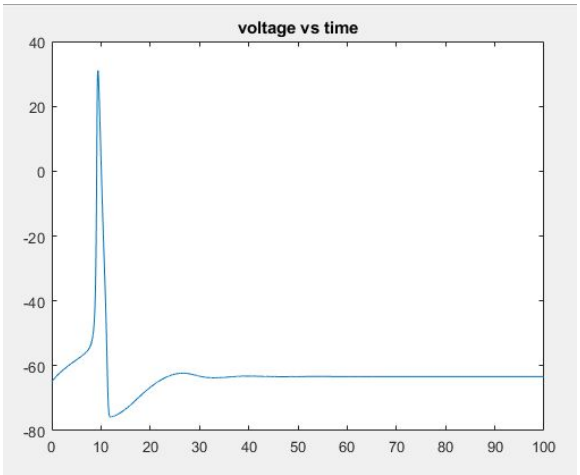
Values Asked for:

- $I_1 = 0.0224$ (Bifurcation)
- $I_2 = 0.06215$
- $I_3 = 0.8$

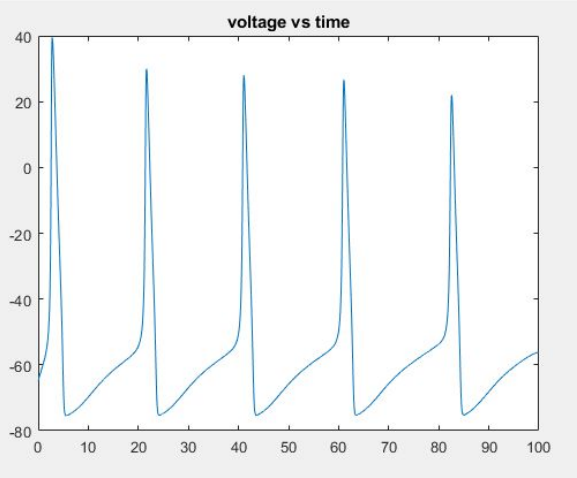
Observations:

- For I <= 0.0223, no action potentials are observed.
- At I = 0.0224 (I_1), one Action Potential is observed. This is an example of Bifurcation.
- Between I = 0.0224 (I_1) and I = 0.06215 (I_2), finite number of Action Potentials are observed.
- Between I = 0.06215 (I_2) and I = 0.8 (I_3), a continuous number of Action potentials are seen, this is known as the Limit Cycle behavior. As the current increases the firing rate increases by a little amount but the max voltage to which the Action Potential goes starts decreasing.
- After 'I_3' no Action potentials are seen because the Peak Voltage is really low so that we can hardly consider it as an Action Potential.

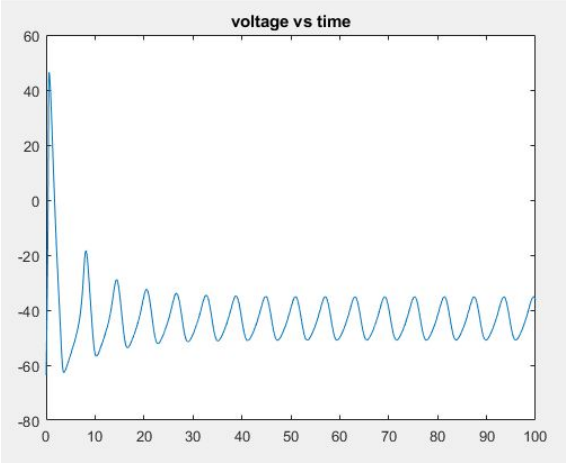
Plots:



1 Action Potential



Multiple Action Potentials



No Action Potentials

2. A graph that depicts the firing rate (frequency) as you change the applied external current (i.e. I ext vs. Firing rate (f), as explained by sir in the class). You can make this plot either in Matlab or Python.

Assumptions Made:

- For different values of current (Iext), we have plotted the "No. of spikes per second (f) vs Iext" graph. And we observe the behavior of the graph as we change Iext.
- If the peak value of the Membrane Potential (Vm) is less than 0 than we do not consider it as an Action Potential.
- Iext = Applied external Current

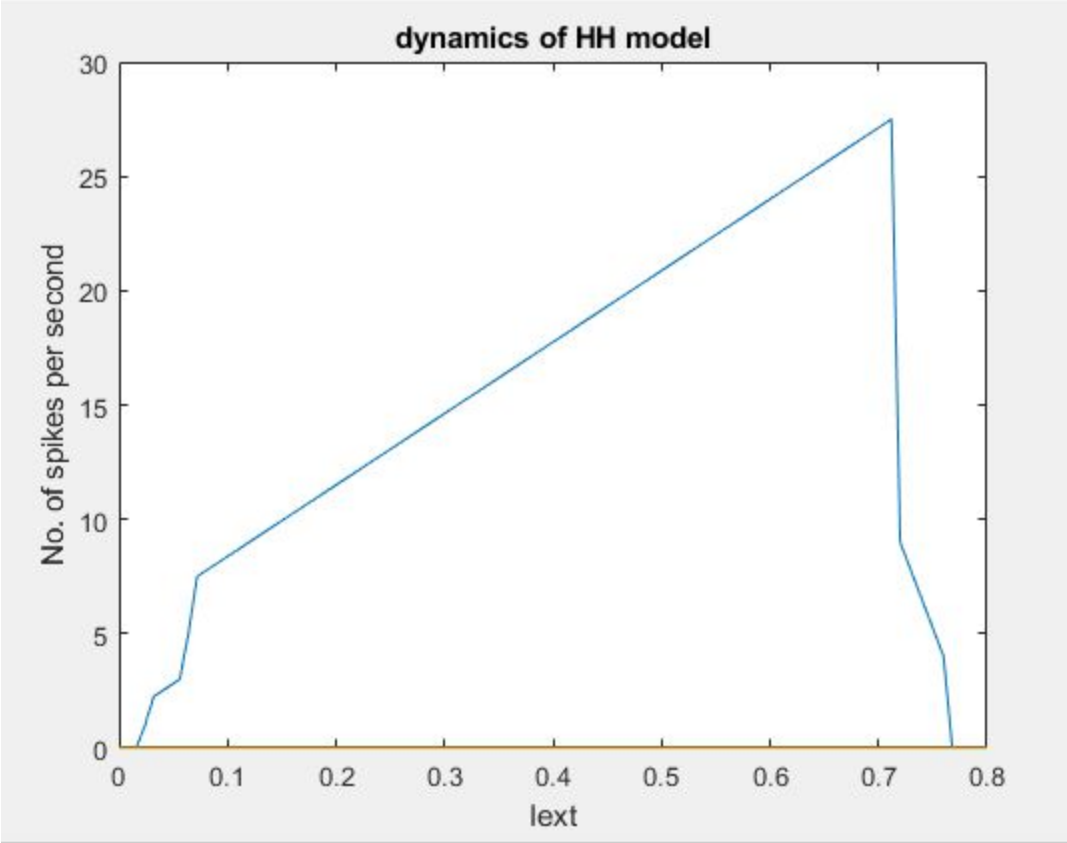
Values Asked for:

- NA

Observations:

- For Iext <= 0.0223, no Action Potentials were seen after plotting the "f vs Iext" graph.
- When Iext = 0.0224, the first Action Potential is seen. Below this threshold, no action potential is observed. This sudden change in the behavior by changing the threshold is known as Bifurcation.
- Between Iext = 0.0224 and Iext = 0.06215 region, a finite number of Action Potentials are seen as the Iext increases.
- Between Iext = 0.06215 and Iext = 0.8, a continuous firing of Action Potentials were seen which can be termed as the Limit Cycle behavior. As the current increases the firing rate increases by a little amount but the max voltage to which the Action Potential goes starts decreasing.
- After Iext = 0.8, the firing rate (the number of Action Potential spikes) decreases significantly, which can be seen as distortion followed by no Action Potential.

Plots:


dynamics of HH model
No. of spikes per second
lext
0
5
10
15
20
25
30
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8