BT6270 : Computational Neuroscience
Assignment 2

General Instructions:

- ✓ The goal of this assignment is simulating and Understanding FitzHugh-Nagumo neuron model taught in the class.
- ✓ This is an individual assignment.
- ✓ You may use MATLAB or PYTHON for your implementation.
- ✓ You have to turn in the well commented code along with a detailed report of the study.
- ✓ Your report should contain answers for all of the questions/cases asked below.
- ✓ Look at the end of the assignment for submission instructions.
- ✓ **Submission deadline: 12th October, 2021 (23:59).**

Simulate the two variable FitzHugh-Nagumo neuron model using the following equations :

$$\frac{dv}{dt} = f(v) - w + I_m$$

where $f(v) = v(a - v)(v - 1)$

$$\frac{dw}{dt} = bv - rw$$

where a=0.5; choose b, r = 0.1)

Use single forward Euler Integration

dv/dt = Δv/ Δt

Δv(t) = v(t+1) - v(t) = [fv(t) - w(t) + I_{ext}(t)]* Δt given v(0) --> v(Δt) --> v(2* Δt) -->....

Case 1: I_{ext} = 0

(a) Draw a Phase Plot superimposed (use hold on command in MATLAB)

(b) Plot V(t) vs t and W(t) vs t and also show the trajectory on the phase plane for the both cases

(i) V(0) < a and W (0)= 0

(ii) V(0) > a and W (0)= 0

Case 2: Choose some current value $I_1 < I_{ext} < I_2$ where it exhibit oscillations. Find the values of I_1 and I_2.

(a) Draw a Phase Plot for some sample value of I_{ext}

(b) Show that the fixed point is unstable i.e., for a small perturbation there is a no return to the fixed point (show the trajectory on the phase plane) – also show limit cycle on the phase plane

(c) Plot V(t) vs t and W(t) vs t

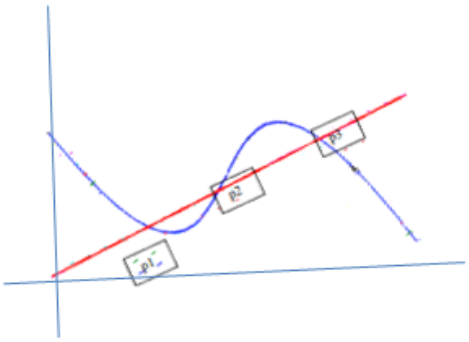
Case 3: Choose some $I_{ext} > I_2$

(a) Draw a Phase Plot for some sample value of I_{ext}

(b) Show that the fixed point is stable i.e., for a small perturbation there is a return to the fixed point (show the trajectory on the phase plane)

(c) Plot V(t) vs t and W(t) vs t

Case 4: Find suitable values of I_{ext} and (b/r) such that the graph looks as phase plot shown as below.



(a) Redraw the Phase plot

(b) Show stability of P1, P2, P3

(c) Plot V(t) vs t and W(t) vs t

Submission Instructions

Enclose all your programs, plots and report in a single zip folder

Please submit a compressed zip or tar file named as <ROLLNO>_A2.zip by uploading it to the moodle. Report should be very clear and all assumptions should be clearly highlighted.