

BT6270: Computational Neuroscience

The details of Assignment-2 are given below

Assignment description:

The goal of this assignment is to simulate and understand the FitzHugh-Nagumo neuron model taught in the class. You must submit 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: 21st October, 2025 (23:59).

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

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

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

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

Choose $a = 0.5$, $b = 0.1$, $r = 0.1$

Use euler's method to solve the ODE's

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 exhibits oscillations. Find the values of I_1 and I_2

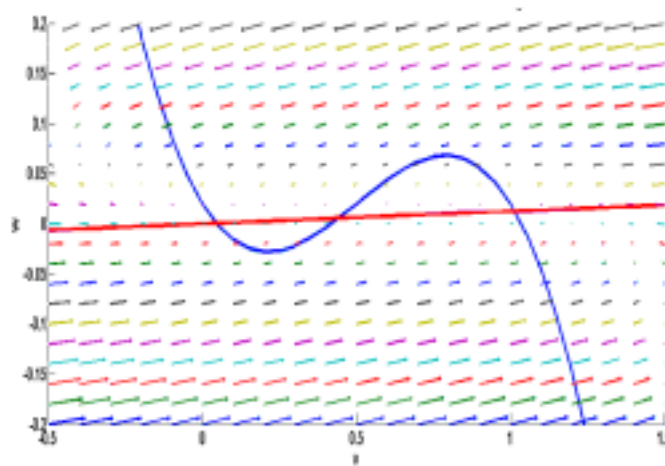
- a. Draw a Phase Plot for some sample value of I_{ext}

- 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 $I_{\text{ext}} > I_2$

- 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 (Bistability).



- a. Redraw the Phase plot
- b. Show stability of of three points P_1, P_2, P_3
- c. Plot $V(t)$ vs t and $W(t)$ vs t

Submission link:

<https://forms.gle/TYRrA1KYHdRcHJ7o8> #Update link

General Instructions:

- Submit a pdf file containing a detailed report showing all the plots mentioned above. Label the figures clearly and label the axis of the plots properly with required units. Write

brief comments regarding the observations made for each case. Please be very crisp and clear in the comments.

Kindly name your report as follows: ROLLNO_A2.zip, **Eg:** BT22D109_A2.pdf

- A code file containing the code to simulate above graphs (either matlab or python). Note that the code file should be clearly annotated and you would also be graded accordingly.

Kindly name your code as follows: ROLLNO_A.ipynb or ROLLNO_A2.m Eg:
BT22D109_A2.ipynb, BT22D109_A2.m

Mention any reference codes you have used to simulate the assignment.

- Please email the TAs for any clarifications

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Please note this is an individual assignment. Please do not share your assignment with other students. Any form of plagiarism found, the assignment will be considered null and the assignment score will be set to zero.

The deadline for Assignment-2 is 21/10/2025, 23:59. The form link gets disabled beyond the deadline.

Delay in submitting the assignment will only be accepted if found valid reason, and should be informed to both the TAs at least 3 days before the due date via email.