

Assignment 6:

Please create a single notebook for submission. Note that this assignment will not be graded. The questions and the corresponding credits only serve as examples.

1. Create a model for the Izhikevich neuron. Note that you have to use Forward Euler's Method to solve the differential equations.

(a) Create a function to generate the spikes in membrane potential. Pass input current and the parameters  $a$ ,  $b$ ,  $c$  and  $d$  as input parameters. The function should return membrane potential and the input current as the outputs.

You should also define the total simulation time, time-step, spike value and the input pulse within the function.

5 marks

**\*\* If the membrane potential is less than the spike value, solve the set of ODEs. \*\***

**\*\* Else assign the spike value to membrane potential followed by a reset. \*\***

(b) Run the simulation for 1000 ms with a step size of 0.5 ms. Use an input current pulse of 10 nA.

The pulse should be activated at 100 ms and deactivated at 900 ms.

Plot the membrane potential and input current in a single figure for the entire length of the simulation.

Demonstrate regular spiking (type II) by choosing appropriate values for  $a$ ,  $b$ ,  $c$  and  $d$ .

5 marks

(c) Change the values of the parameters  $c$  and  $d$  to demonstrate regular bursting behavior in the neuron. What is the relationship between these two parameters for maintaining bursting behavior? For example, if you increase  $d$ , how will you change the value of  $c$  to keep the neuron in bursting mode?

3 marks

(d) Which parameter will you modify to change the behavior from regular bursting to phasic bursting? Demonstrate phasic bursting by changing the value of this parameter.

2 marks