EECE6036 HW2

Problem 1

Problem Statement

Implement a simulation of a regular spiking (RS) neuron, utilizing the model described by Izhikevich (2003, 2004). The primary independent variable is the step-function I(t).

Results

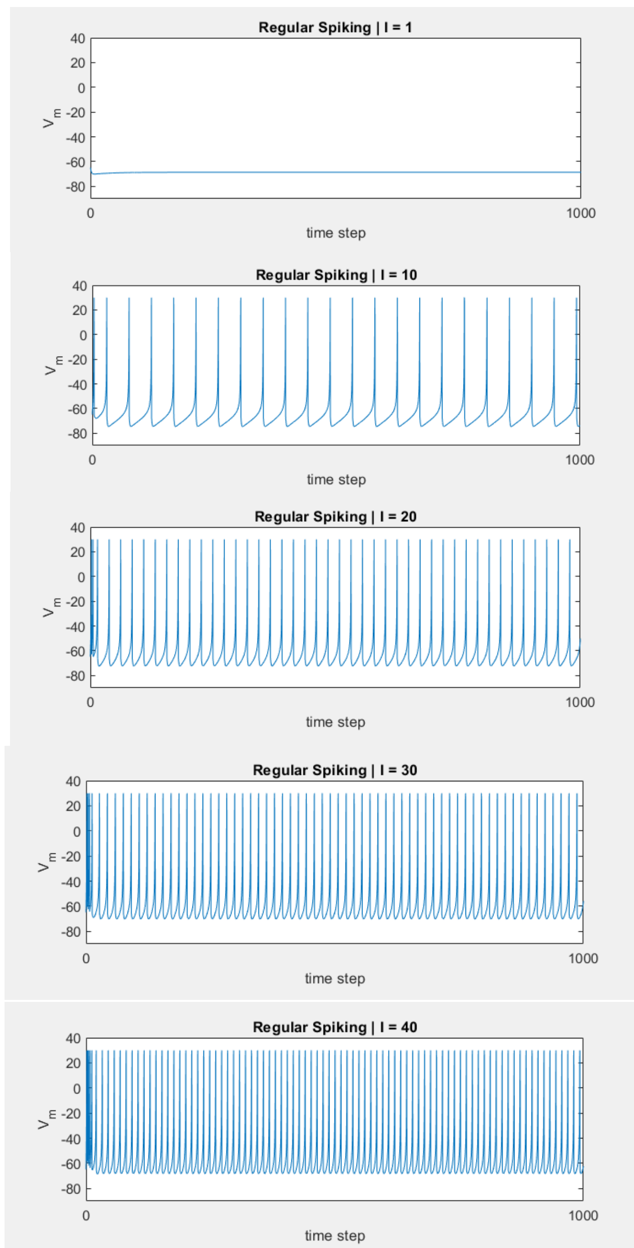

Figure 1 : VV vs time-step for regular spiking neuron

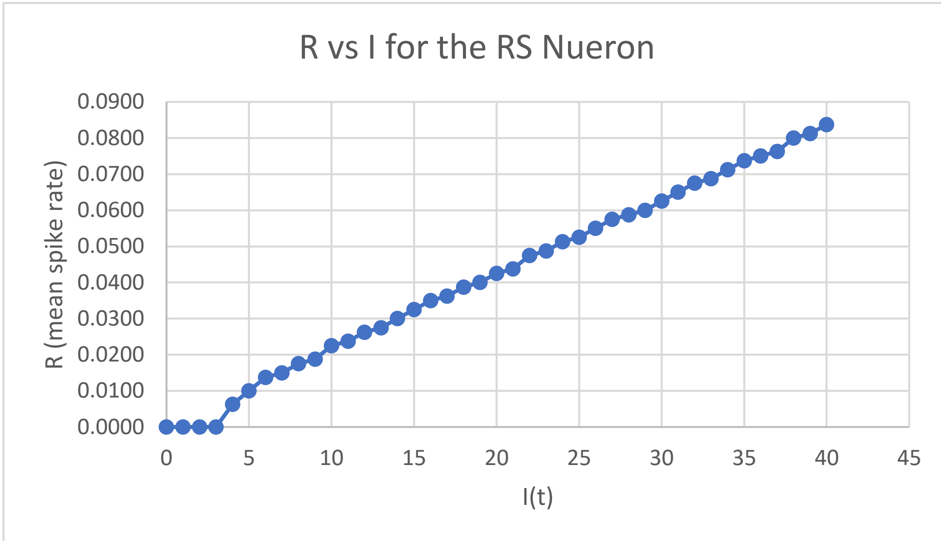

Figure 2 : Mean Spike Rate vs Current (I) of a MATLAB simulated Regular Spiking Neuron

Discussion

A pattern we can observe as the current increases is the frequency in which the neuron spikes increase for the same amount of time steps. As the I(t) value increases we see that the neuron is more active in the simulation. This is because as we increase the current, the membrane is more susceptible to inputs and has a lower threshold to make it spike. A useful function that we see from this (at least in systems like our brains) is when there are lots of input and more "thinking" is needed to accomplish a task.

Problem 2

Problem Statement

Implement a simulation of a fast spiking (FS) neuron, utilizing the model described by Izhikevich (2003, 2004). The primary independent variable is the step-function I(t).

Results

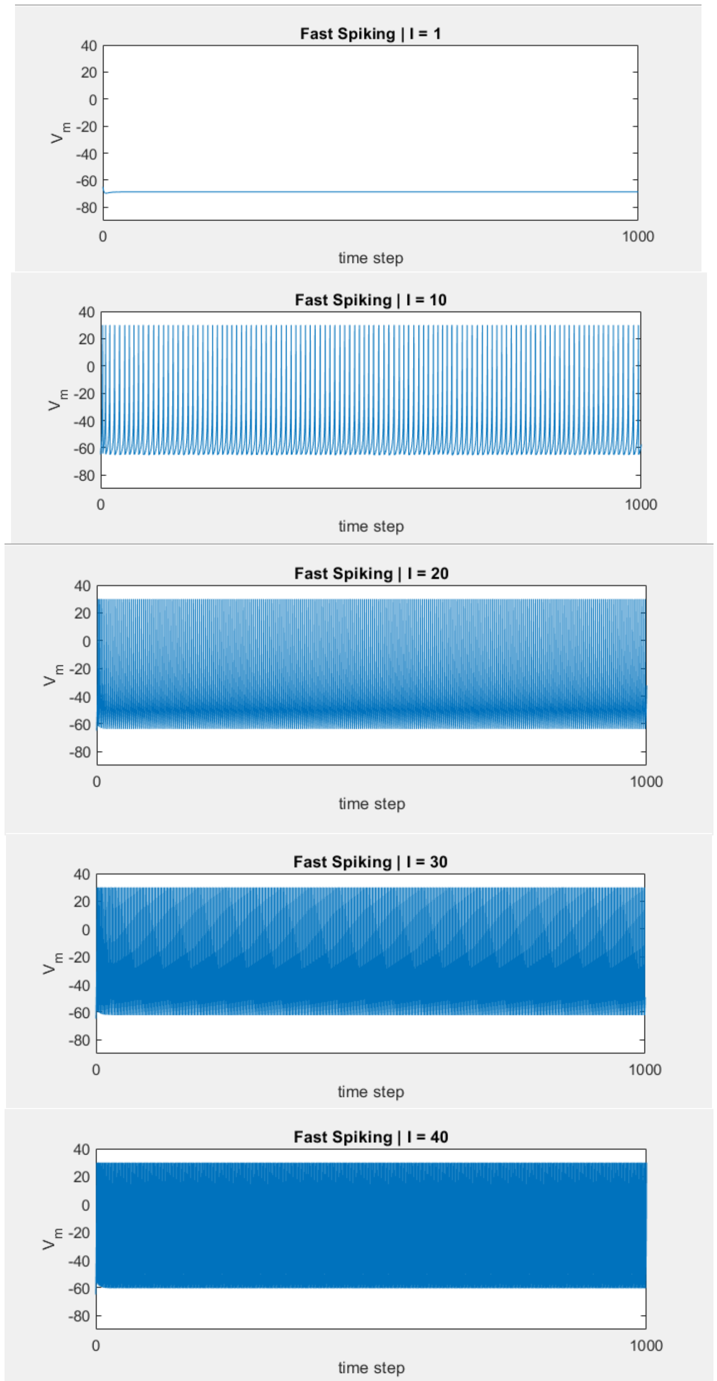

Figure 4 : VV vs time step for a fast-spiking neuron

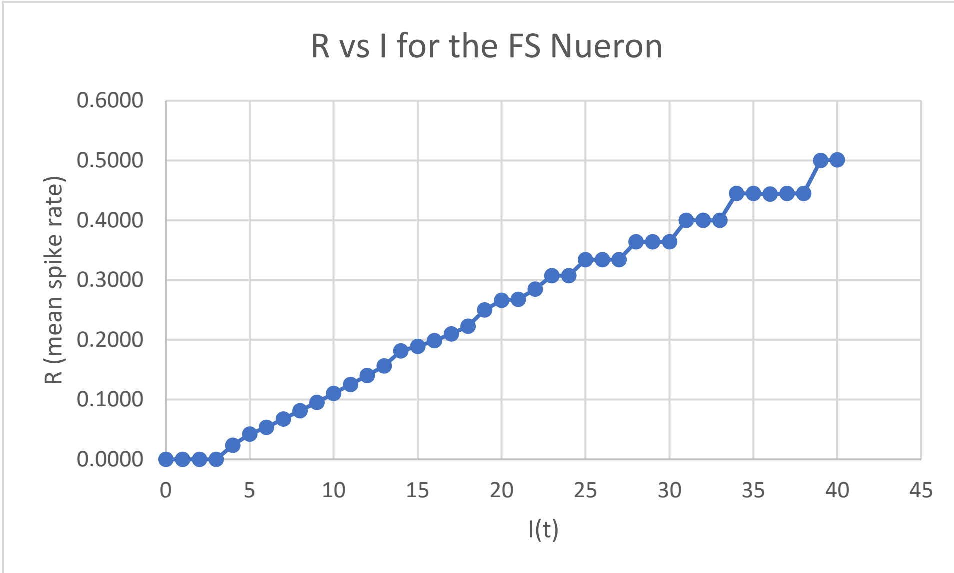

Figure 5 : Mean Spike Rate vs Current (I) of a MATLAB simulated Fast Spiking Neuron

Discussion

We can see that the mean spike rate changes positive and linear as the Current I(t) increases. Compared to the regular spiking neuron, the fast-spiking neuron has more activations for the same amount of time steps. This is because the simulated membrane equation has a lower threshold, and the neuron is more easily activated. A difference we can also see is at around I(t) = 23 the mean spike rate begins to plateau for a few I values and then steps up to the next mean spike rate. The maximum R we see for the fast-spiking neuron is 0.5013 when I(t) = 40. A similarity we see between the regular-spiking and fast-spiking graphs is an upward linear trend and the first spikes occur at I(t) = 4.

Problem 3

Methods

For this experiment I used ChatGPT-3.5 August 3 Version. The prompt I started with to get code that would generate the desired model was, “Create code that will simulate a Izhikevich regular spiking neuron that will run for 1000 time-steps for each input of I. I should start at 0 and end at 40 in steps of 1. Then plot the mean spiking rate of each I versus I using only the last 800 time-step of each trial.”

Results

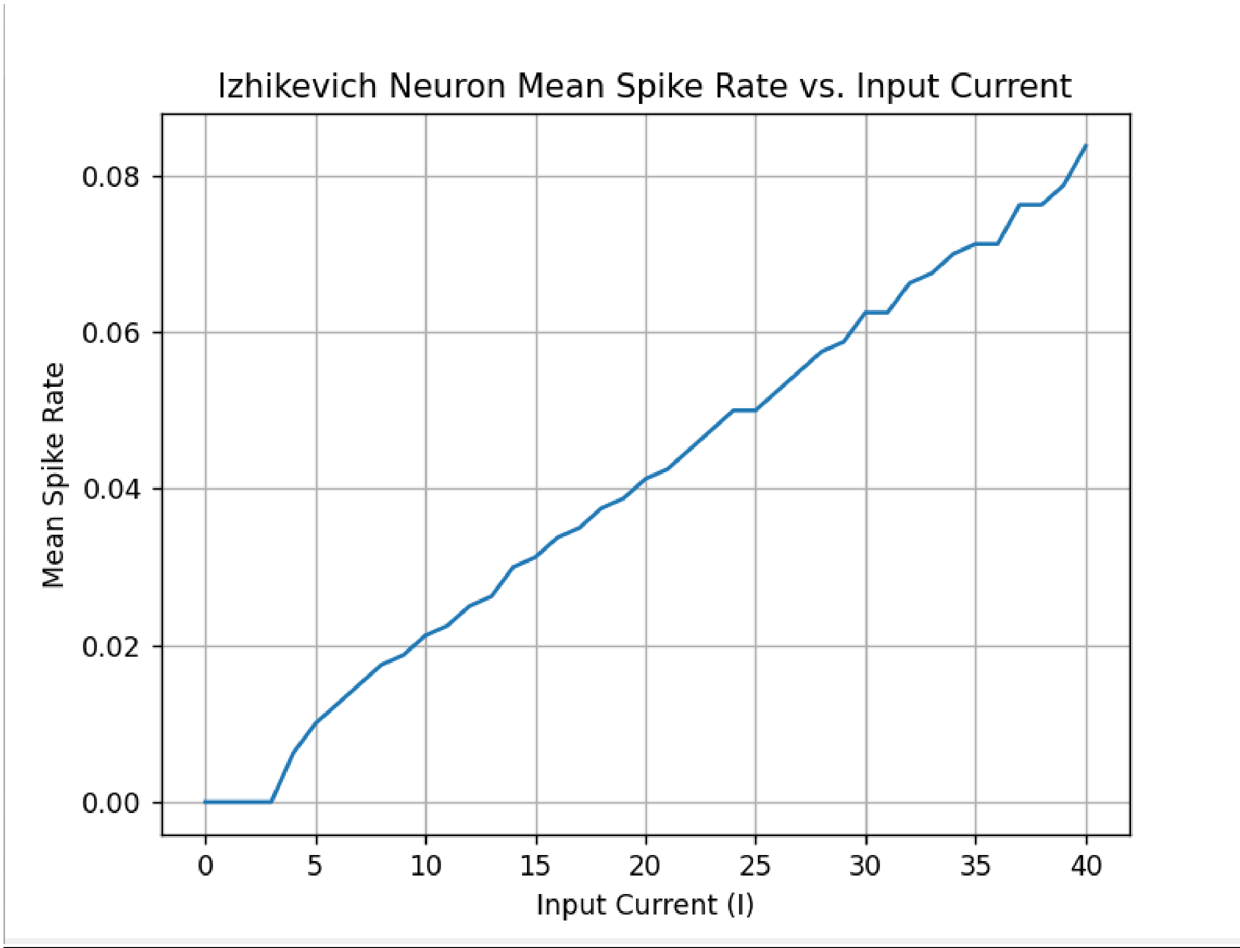

Figure 6 : ChatGPT generated R vs I(t)

Discussion

The result of the graph was very similar to the result of Problem 1. There is a positive linear trend for the Mean Spike Rate (R) vs Input Current (I). It looks like the first spikes don’t occur until I = 4 which is what we would expect from Figure 2 and Figure 5.

An error produced by ChatGPT was it was recording a spike every time the algorithm went through its loop which should not be the case. After giving it this prompt, “The spike count in the code is counting for every loop when it should be counting for every spike (which is located under the if condition)", the code was corrected and ran as expected.

Transcript

https://chat.openai.com/share/ded10f78-6752-44e8-b917-40c1accd30fc