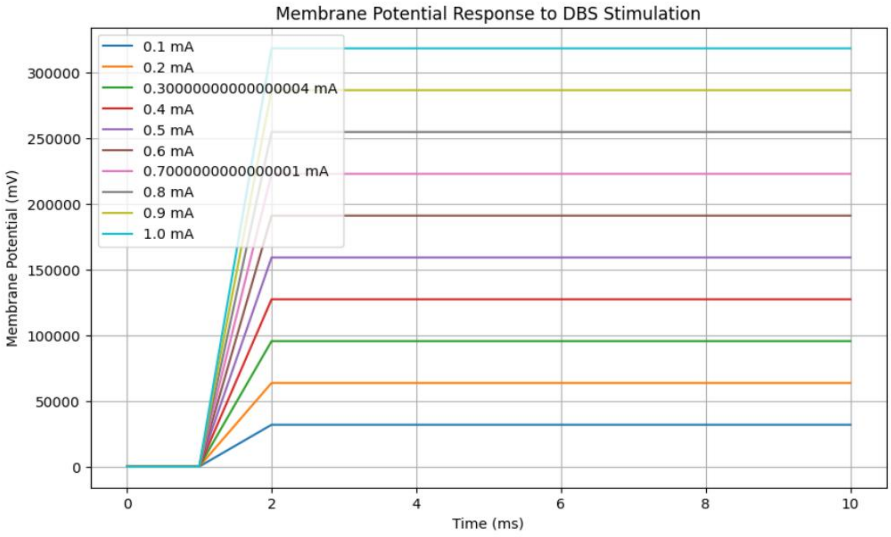
- **PART 1-**

• **This is the original document for : A computational model of a Deep Brain Stimulation (DBS) electrode implanted in the superior cerebellar peduncle**	ORIGINAL NEURO.pdf

- **After running the code given in the above file I ran the code and the output was this :**

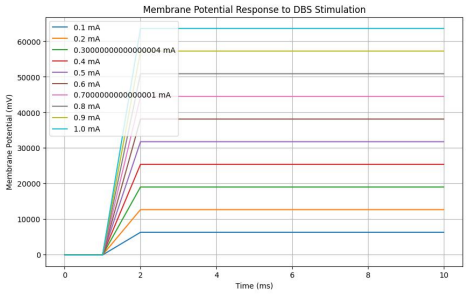
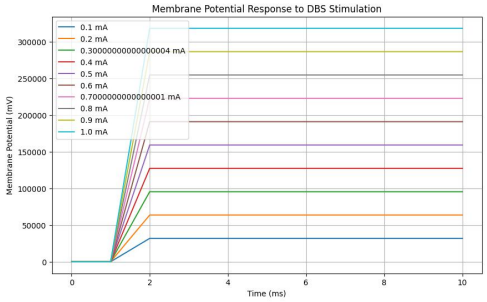
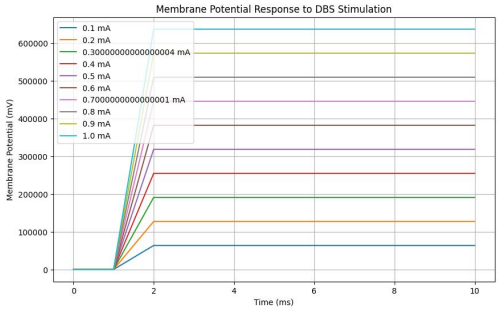
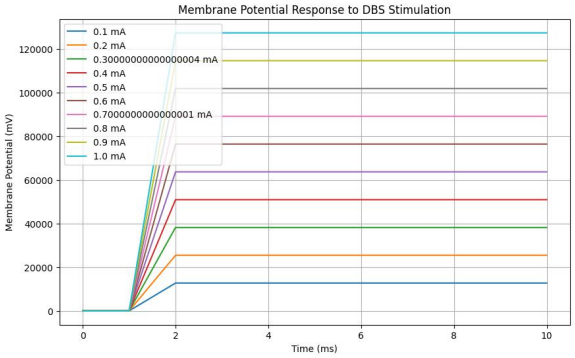
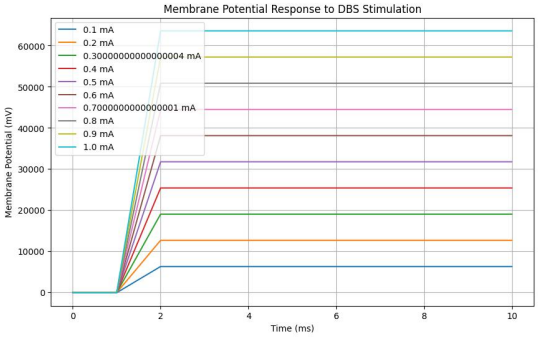


- **Then I modified the code according to following instructions:**

Change in Diameter:	Change in Length :
1. **0.5 mm Diameter** 2. **0.1 mm Diameter** 3. **0.05 mm Diameter**	1. **0.5 mm L**

- **Down below I am sharing the output of the above cases after modifications in a table format :**

- **I have also attached a extra case with Diameter =1 mm and Length = 0.5 mm**

Output when change in Diameter:	Output when change in Length:
1. 0.5 mm Diameter  **2. 0.1 mm Diameter**  **3. 0.05 mm Diameter**  	**1. 0.5 mm L**  *** This output below is for Diameter = 1 mm and Length = 0.5 mm** 

- **Now , I am attaching the Code part of every output above:**

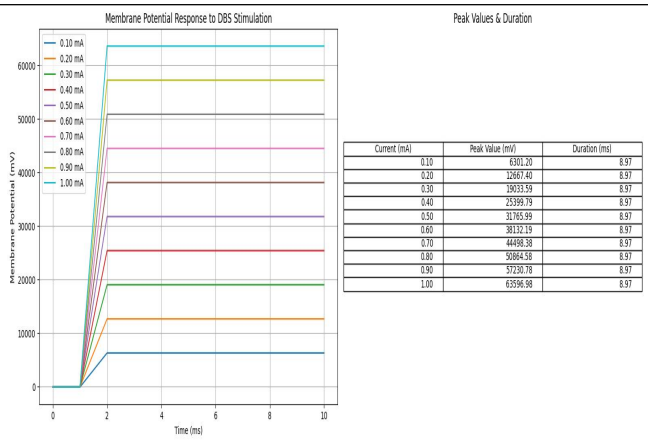
Original Code	ORIGINAL CODE.txt
0.5 mm Diameter	0.5 mm Diameter CODE.txt

0.1 mm Diameter	0.5 mm Diameter CODE.txt
0.05 mm DIameter	0.05 mm Diameter CODE.txt
0.5 mm L	0.5 mm Length CODE.txt
Diameter = 1 mm and Length = 0.5 mm	EXTRA CODE.txt

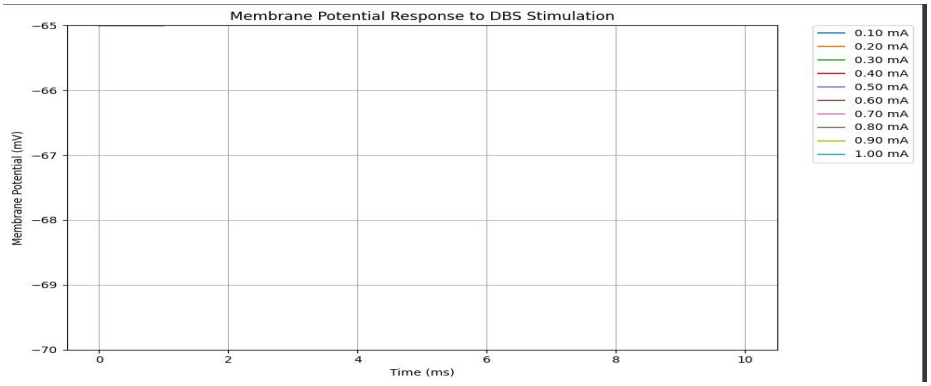
- **So , there were 4 problems with these codes:**

1. **The table of current and the graph where overwritten each other.**
2. **Quantification of Y axis. It should be between -65mV to -70mV.**
3. **Peak Membrane potential (y-value) for each Current.**
4. **How long the membrane potential response persists.**

- **Tackling the 1.>, 3.> & 4.> part -**

Updated part of the code - I just added a code in the existing codes above to get the required solutions **Reference CODE:(only 1 case taken here)** **//JUST CHANGE THE VALUE OF DIAMETER AND LENGTH TO GET DIFFERENT RESULTS.** MODIFIED_FINAL CODE-1.txt	 Current (mA) | Peak Value (mV) | Duration (ms) 0.10 | 6301.20 | 8.97 0.20 | 12667.40 | 8.97 0.30 | 19033.59 | 8.97 0.40 | 25399.79 | 8.97 0.50 | 31765.99 | 8.97 0.60 | 38132.19 | 8.97 0.70 | 44498.38 | 8.97 0.80 | 50864.58 | 8.97 0.90 | 57230.78 | 8.97 1.00 | 63596.98 | 8.97

- **Last problem remains is the 2.> Quantification of Y axis. It should be between -65mV to -70mV. The output I found is the following :**



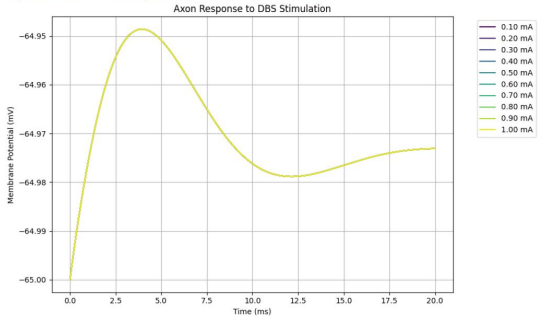
- **The reason mentioned was :**

Warning: Non-physiological value detected for current 0.01 mA
Warning: Non-physiological value detected for current 0.02 mA
Warning: Non-physiological value detected for current 0.03 mA
Warning: Non-physiological value detected for current 0.04 mA
Warning: Non-physiological value detected for current 0.05 mA
Warning: Non-physiological value detected for current 0.06 mA
Warning: Non-physiological value detected for current 0.07 mA
Warning: Non-physiological value detected for current 0.08 mA
Warning: Non-physiological value detected for current 0.09 mA
Warning: Non-physiological value detected for current 0.10 mA

- **So, there is no possible membrane potential response in this range.**

- **PART 2 -**

// Changes are mentioned at last page of the document in form of a table , please check..

Code with modifications like adding axions etc.	**Output for it-**
CODE 2 ORIGINAL.txt	**Optimum current (safe ≤30.0 mV): 1.00 mA** 

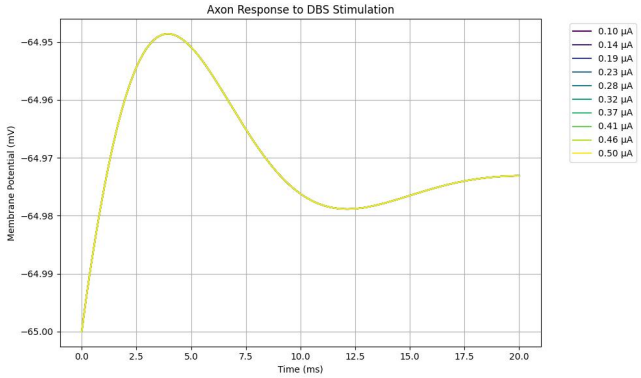
- **After this modifications, I was instructed to show that there should be a current around 100 micro-A to 500 micro-A which should be able to give membrane potential -65 mV to -70 mV. The followint are the 2 outputs and following code for them int the form of table:**

Changes in current :

//currents = np.linspace(0.1, 0.5, 10)
 # Convert µA to mA (100 µA → 0.1 mA) and other changes

CODE-

CODE-2 _ PART-1.txt



More Changes donw like:

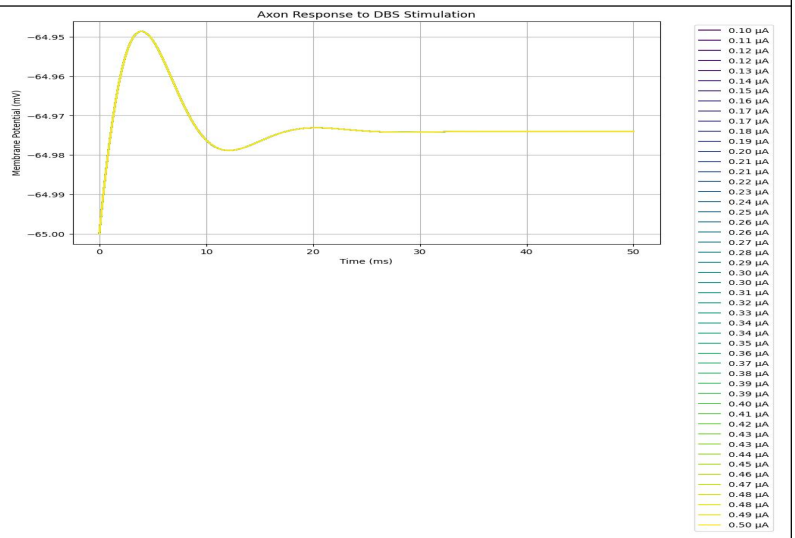
#axon.diam = 2.0 # Increased from 1.0 µm to 2.0 µm
#currents = np.linspace(0.1, 0.5, 50) # Increased steps for finer granularity
#sim_time = 50 # Increased from 20 ms to 50 ms

#[steady_state_voltage = voltage[-10:] # Last 10 time points
#if np.all(steady_state_voltage >= safe_range[0]) and np.all(steady_state_voltage <= safe_range[1]):
#optimum_current = current if optimum_current is None else min(optimum_current, current)]

#h.finitialize(-65)

CODE-

CODE-2 PART 2.txt



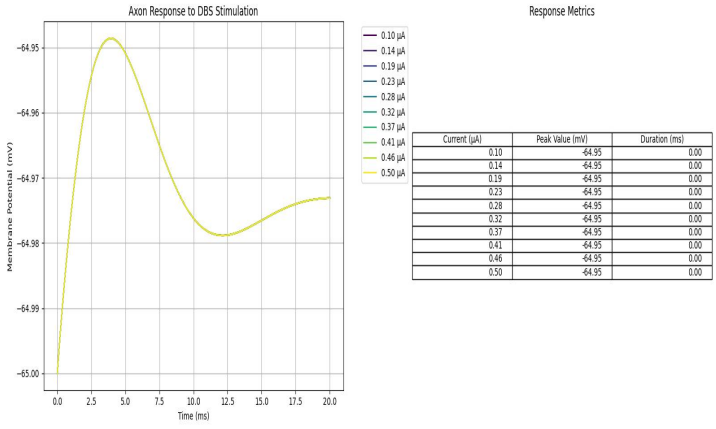
- **I was then instructed to find the Peak Membrane potential (y-value) for each Current and how long the membrane potential response persists.**

- **Final Code for Part 2 with Peak Membrane potential (y-value) for each Current and how long the membrane potential response persists.**

CODE-

CODE 2- Final.txt

Output for it-

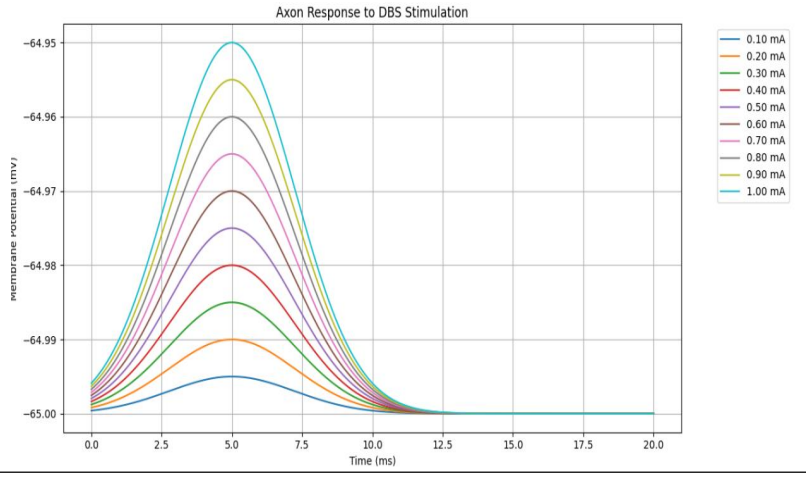


Current (µA)	Peak Value (mV)	Duration (ms)
0.10	-64.95	0.00
0.14	-64.95	0.00
0.19	-64.95	0.00
0.23	-64.95	0.00
0.28	-64.95	0.00
0.32	-64.95	0.00
0.37	-64.95	0.00
0.41	-64.95	0.00
0.46	-64.95	0.00
0.50	-64.95	0.00

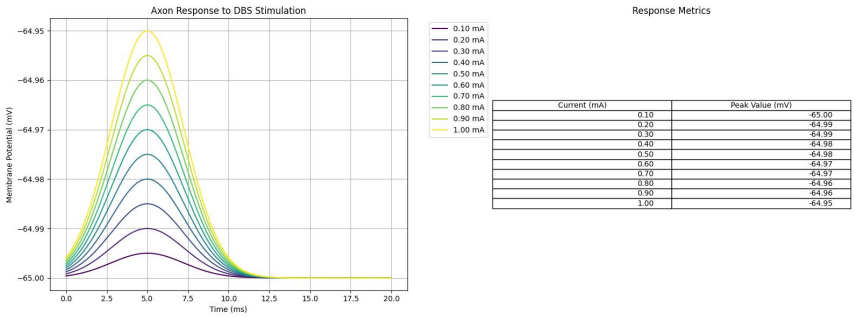
- **PART 3-**

// SOME MORE CHANGES WERE DONE -> PLEASE VISIT LAST PAGE OF THIS DOCUMENT TO CHECK THE CHANGES.

- **This part's code were good and acceptable . Here is the attached code and the output .**

CODE-3:	**OUTPUT-**
CODE-3.txt	

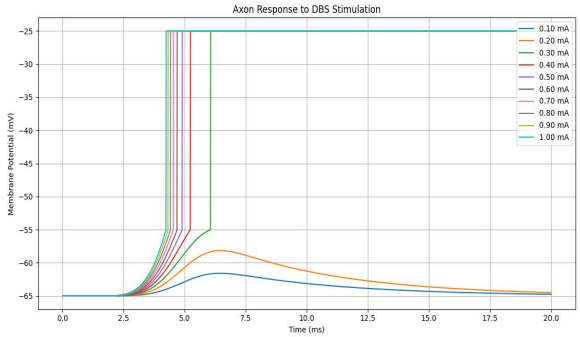
- **So for this piece of code , I was instructed to play with values and to find the Peak Membrane potential (y-value) for each Current.**

CODE-3 FINAL	**OUTPUT-**
CODE3 FINAL.txt	

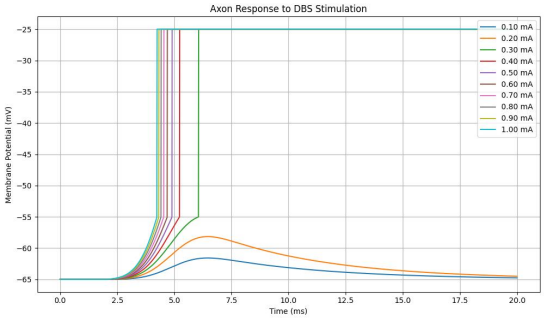
- **CODE-4**

// ALL THE CHANGES ARE MENTIONED AT LAST PAGE.

- **This Code output was also good and was asked to add the difference of response time of different membranes (latency)**

CODE -4	OUTPUT-
CODE-4.txt	 Current (mA) | Latency (ms) 0.10 mA | No response 0.20 mA | No response 0.30 mA | 3.56 ms 0.40 mA | 2.73 ms 0.50 mA | 2.40 ms 0.60 mA | 2.19 ms 0.70 mA | 2.04 ms 0.80 mA | 1.92 ms 0.90 mA | 1.82 ms 1.00 mA | 1.74 ms

- **I then added Peak Membrane potential (y-value) for each Current.**

CODE4-FINAL	OUTPUT-
CODE 4 FINAL.txt	 Current (mA) | Peak Value (mV) | Persistence Time (ms) 0.10 mA | -61.58 mV | 2.52 ms 0.20 mA | -58.15 mV | 1.60 ms 0.30 mA | -25.00 mV | 13.94 ms 0.40 mA | -25.00 mV | 14.77 ms 0.50 mA | -25.00 mV | 15.10 ms 0.60 mA | -25.00 mV | 15.31 ms 0.70 mA | -25.00 mV | 15.46 ms 0.80 mA | -25.00 mV | 15.58 ms 0.90 mA | -25.00 mV | 15.68 ms 1.00 mA | -25.00 mV | 15.76 ms

- **With this I have shown the codes and their outputs with changes and requirements. Now, down below is the differences in 4 codes-**

- **DIFFERNCES-**

Feature/Aspect	Code 1	Code 2	Code 3	Code 4
Purpose	Simulates DBS stimulation and plots membrane potential responses.	Adds safe range analysis for axon response and displays results in a table.	Adds peak value and persistence time metrics to the table.	Adds realistic neural response simulation with latency, peak, and persistence.
Simulation Type	Simple DBS stimulation with NEURON.	NEURON simulation with axon response analysis.	NEURON simulation with peak and persistence time analysis.	Realistic neural response simulation including action potentials.
Metrics in Table	None	Safe range compliance for axon response.	Peak value (mV) and persistence time (ms).	Peak value (mV), persistence time (ms), and latency (ms).
Graph Features	Membrane	Same as Code 1 but	Same as Code 1 but	Realistic action

	potential vs. time for various currents.	with safe range indication.	includes peak and persistence data in the table.	potential dynamics with latency analysis.
Key Additions/Updates	Basic plot of membrane potential responses for different currents.	Safe range analysis added to determine optimal current for axon response.	Added peak value calculation and persistence time around the peak.	Added realistic action potentials, latency calculation, and dynamic table.
Table Columns	None	Current (mA), Safe Range Compliance	Current (mA), Peak Value (mV), Persistence Time (ms)	Current (mA), Peak Value (mV), Persistence Time (ms), Latency (ms)
Realism in Simulation	Basic DBS stimulation without action potentials or refractory periods.	Same as Code 1 with safe range check for axon response.	Same as Code 1 but includes detailed metrics like peak and persistence time.	Includes action potentials, refractory periods, and realistic neural dynamics.

- **I HAVE ATTACHED THE CODE FILES WITH PROPER NAMES IN ZIP FOLDER.PLEASE CHECK IT.**