Biol635/Math635/Biol432/Math430
Fall 2020
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Homework 5

Answer the following questions.

- Justify your answers.
- Explain your results.
- Provide the necessary calculations in a clear way.
- Provide the necessary supporting graphs and codes.
- Make sure the graphs are properly labeled and include the information (title and parameter values) necessary to understand your explanations.
- You may write your own code or adapt the template code provided in the course website.

Question 1

(a) Calculate the time and length constants (τ and λ respectively) for an infinite cable with the following parameters: $\rho = 2.5\,\mu m$ (radius), $R_a = 200\,\Omega cm$, $R_m = 20000\,\Omega cm^2$, and $C_m = 1\,\mu F/cm^2$.

(b) Plot the stationary solution $V_s(x)$ for an infinite cable with the following parameters: $d = 4\,\mu m$ (diameter) $R_a = 100\,\Omega cm$, $R_m = 10000\,\Omega cm^2$, $I_{app}(t) = 0.25nA$ and $V_{rest} = -65mV$. For what values of x will $V_s(x) - V_{rest}$ decrease by 63 % of its maximum value?

Question 2

Consider a cable neuron model with the following parameters: $C_m = 1\mu F/cm^2$, $R_m = 3333\Omega cm^2$, $R_a = 100\Omega cm$, and $E_L = -65\, mV$.

(a) Calculate the time constant τ.

(b) Calculate the product $Area \times C_m$ for an isolated (single) compartment with $\rho = 1\,\mu m$ (radius), $L = 0.159\, cm$ (length of the compartment). What reasonable units for the applied (injected) current I_{app} would be?

(c) Consider a multicompartmental model with the parameters given above, calculate D_{jk}/C_m between two equal compartments.

(d) Build a Matlab code of a multicompartmental model with 5 compartments for the parameters given above. What amount of current do you need to give to the first compartment to get a voltage output in the last one. If you can't, can you change the cable geometry to achieve this goal?