Biol698/Math635/Math430
Fall 2018
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Homework 5

Answer the following questions. Justify your answers, explain your results, and provide the necessary supporting graphs and Matlab codes. Make sure the graphs are properly labeled and include the information (title and parameter values) necessary to understand your explanations.

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?