

Biol635/Math635/Biol432/Math430  
Fall 2022

Assignment 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 ( $\tau$  and  $\lambda$  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)  $R_a = 100 \Omega cm$ ,  $R_m = 10000 \Omega cm^2$ ,  $I_{app}(t) = 0.25 nA$  and  $V_{rest} = -65 mV$ . 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  $\tau$ .

(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?