Homework 1.4: Synaptic current pulse

Synaptic current pulse

1/1 point (graded)

Synaptic inputs can be approximated by an exponential current

$$I(t) = q\frac{1}{\tau_s}\exp\left[-(t-t_f)/\tau_s\right].$$

where t_f is the moment when the spike arrives at the synapse. Use the equation below to calculate the response of a passive membrane with time constant τ_m for $t \geq t_f$ to an input spike arriving at time t_f. Assume the membrane potential is at rest before spike arrives.

$$\tau_m \frac{d}{dt}u = -(u-u_{rest}) + RI(t).$$

for $t \geq t_f, u(t) =$?

这里猜的，我不会求微分方程的解

- $u(t) = u_{rest} + \frac{Rq}{\tau_s - \tau}\left[\exp\left(-\frac{t-t_f}{\tau}\right) - \exp\left(-\frac{t-t_f}{\tau_s}\right)\right]$
- ✔ $u(t) = u_{rest} + \frac{Rq}{\tau - \tau_s}\left[\exp\left(-\frac{t-t_f}{\tau}\right) - \exp\left(-\frac{t-t_f}{\tau_s}\right)\right]$
- $u(t) = u_{rest} + \frac{Rq}{\tau}\left[\exp\left(-\frac{t-t_f}{\tau}\right) - \exp\left(-\frac{t-t_f}{\tau_s}\right)\right]$
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- $u(t) = u_{rest} + \frac{Rq}{\tau_s}\left[\exp\left(-\frac{t-t_f}{\tau_s}\right) - \exp\left(-\frac{t-t_f}{\tau}\right)\right]$

✔

Submit You have used 1 of 1 attempt

✔ Correct (1/1 point)

Chain of linear equations

0 points possible (ungraded)

Suppose that the arrival of a spike at time t_f releases neurotransmitter into the synaptic cleft. The amount of available neurotransmitter at time t is

$$\tau_x \frac{d}{dt}x = -x + \delta(t-t_f)$$

The neurotransmitter binds to the postsynaptic membrane and opens channels that enable a synaptic current

$$\tau_s \frac{d}{dt}I = -I + I_0 x(t)$$

Finally, the current charges the postsynaptic membrane according to

$$\tau_m \frac{d}{dt}u = -u + RI(t)$$

好的呢，我不会求。上面的不会下面的更不会了。

Write the voltage response to a single current pulse as an integral. (no point for this question)

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Discussion

Topic: Week 1 / Homework 1.4: Synaptic current pulse

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