

# Exercise 02: Single-compartment model

Theoretical Neuroscience I

Johannes Gätjen

October 17, 2015

## Question:

Compute and plot the dependent variables of a neuron with the single-compartment model for a constant input current, an oscillating input current with low frequency (10Hz), an oscillating input current with medium frequency (100Hz) and a high frequency random input current. Use the following values for the independent variables:  $r_m = 0.9\text{M}\Omega\text{ mm}^2$ ,  $c_m = 12\text{nF mm}^{-2}$ ,  $V_0 = 0\text{mV}$  and  $i_0 = 25\text{nA mm}^{-2}$ .

## Answer:

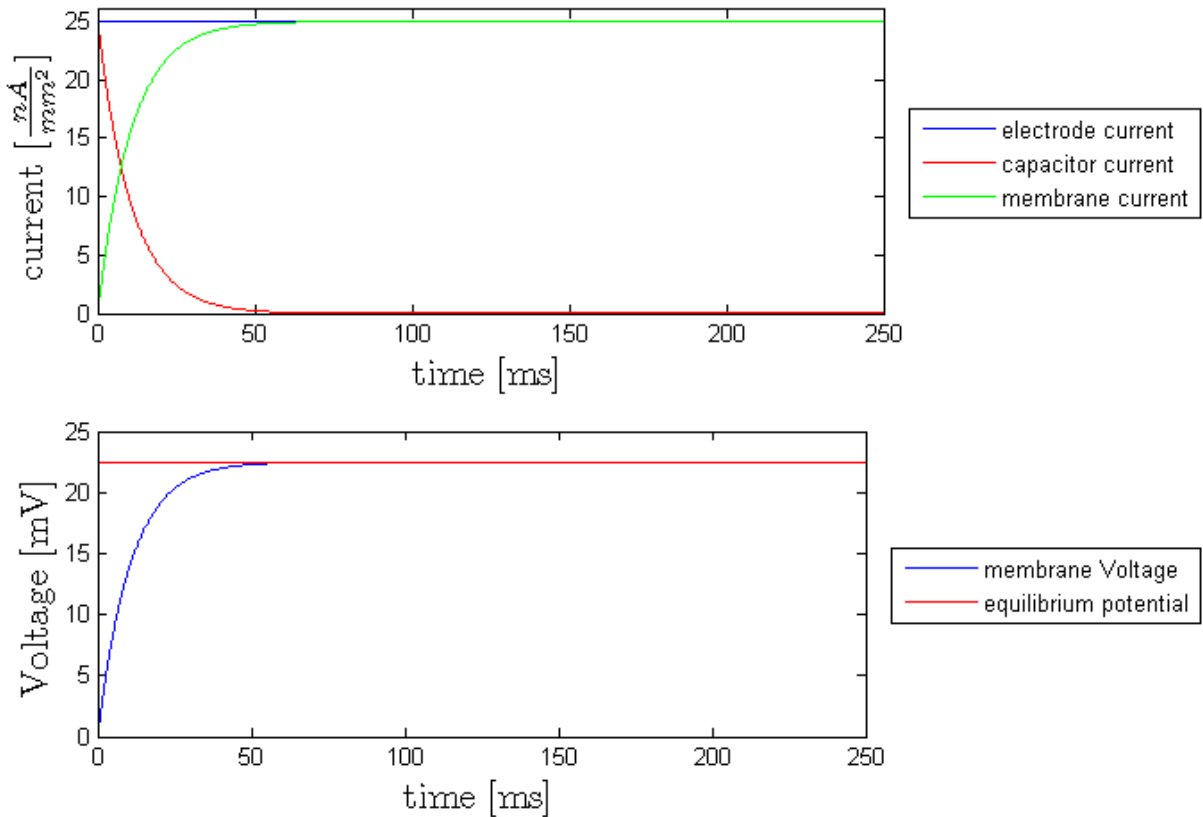


Figure 1: Constant input current:  $i_e(t) = i_0$  Top: The electrode current( $i_e$ , blue), the capacitor current( $i_c$ , red) and the membrane current ( $i_r$ , green) over time. Bottom: The membrane voltage ( $V_m$ , blue) and the equilibrium potential ( $V_\infty$ , red) over time.

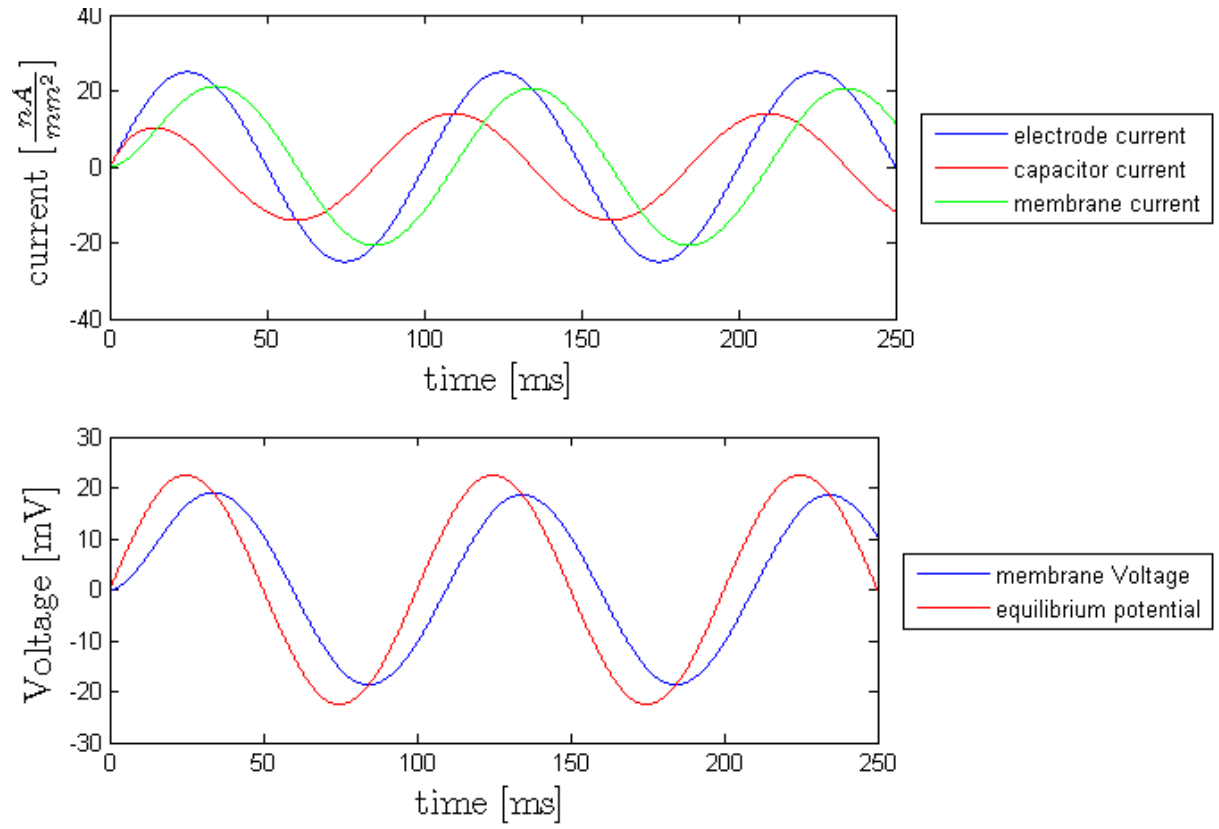


Figure 2: Low frequency input current:  $i_e(t) = i_0 \cdot \sin 2\pi f t$ ,  $f = 10\text{Hz}$  Same variables shown as in Figure 1.

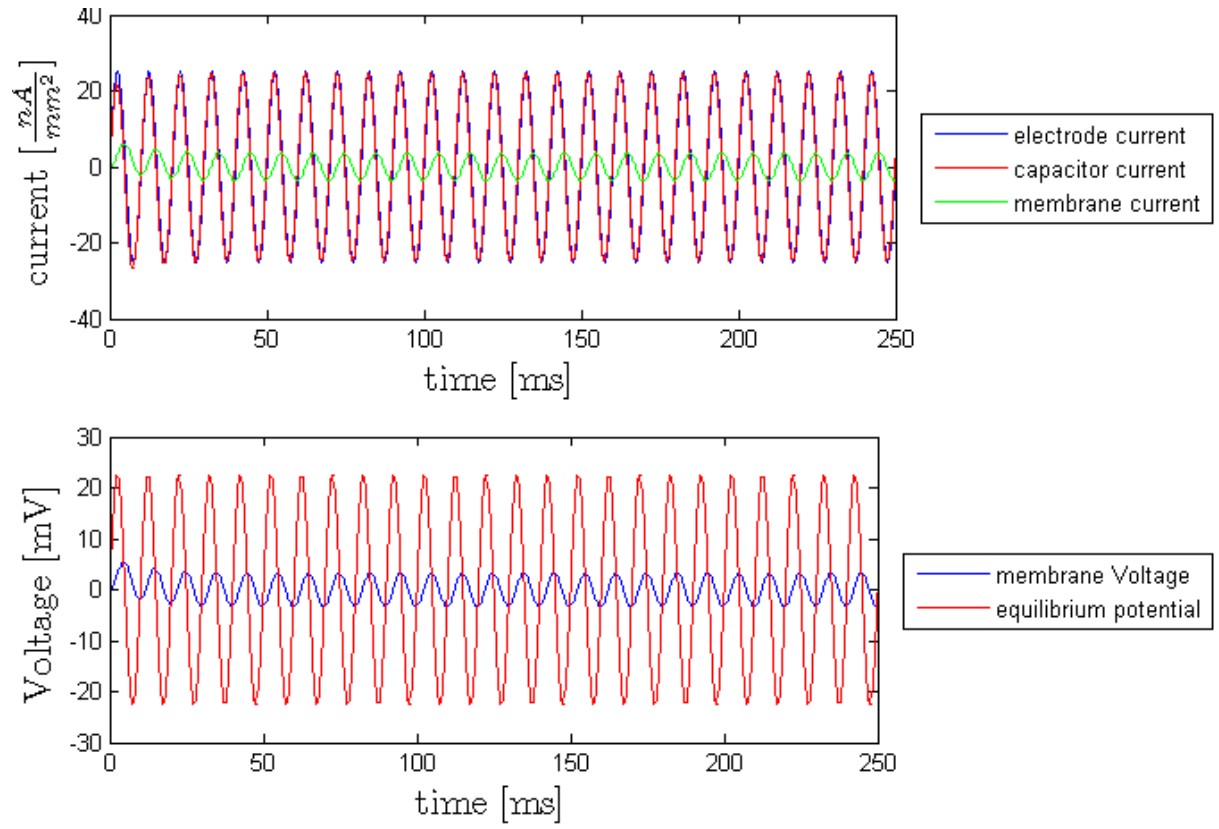


Figure 3: Medium frequency input current:  $i_e(t) = i_0 \cdot \sin 2\pi f t$ ,  $f = 100\text{Hz}$  Same variables shown as in Figure 1.

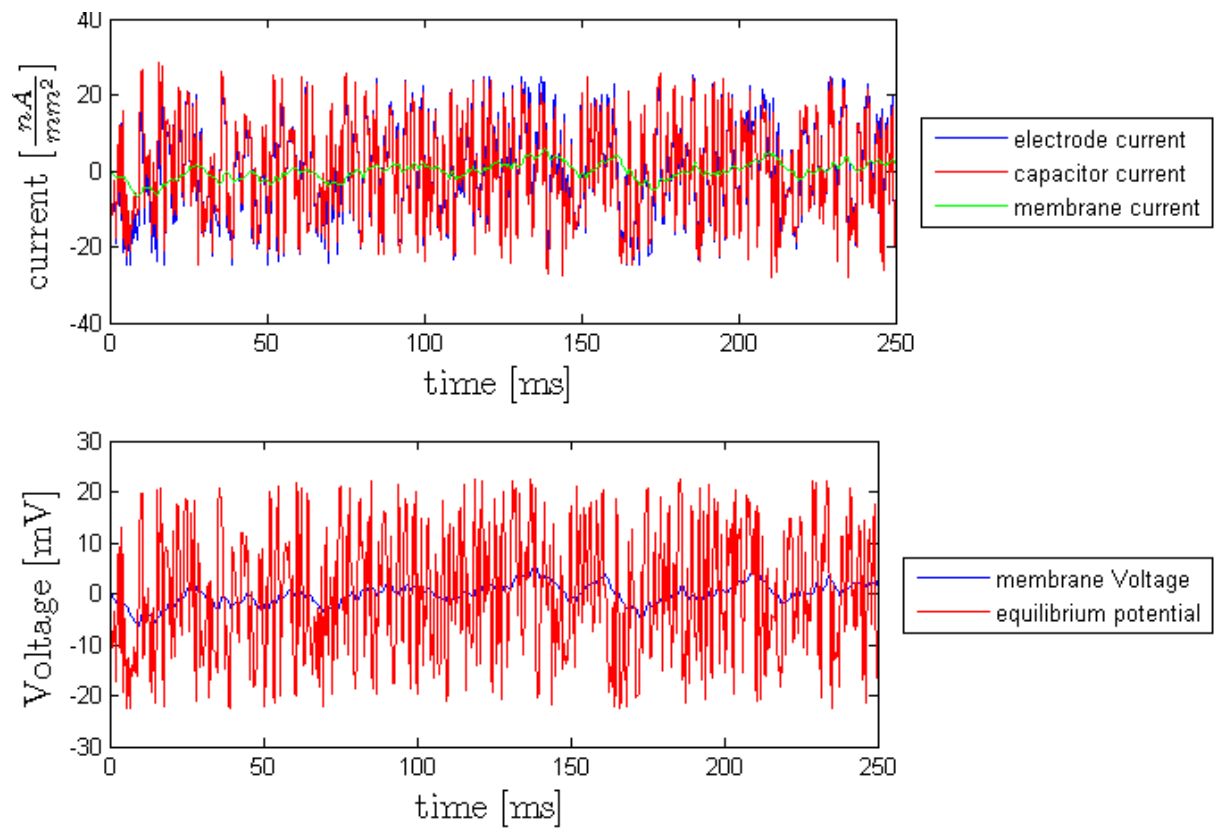


Figure 4: High frequency random input current. Same variables shown as in Figure 1.