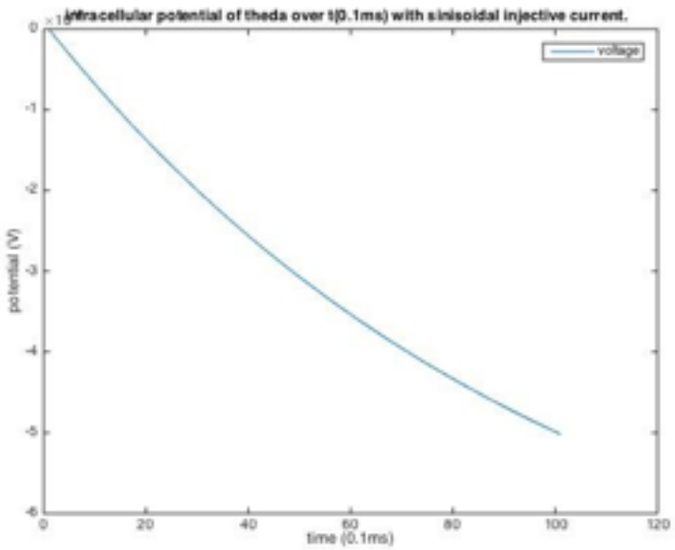
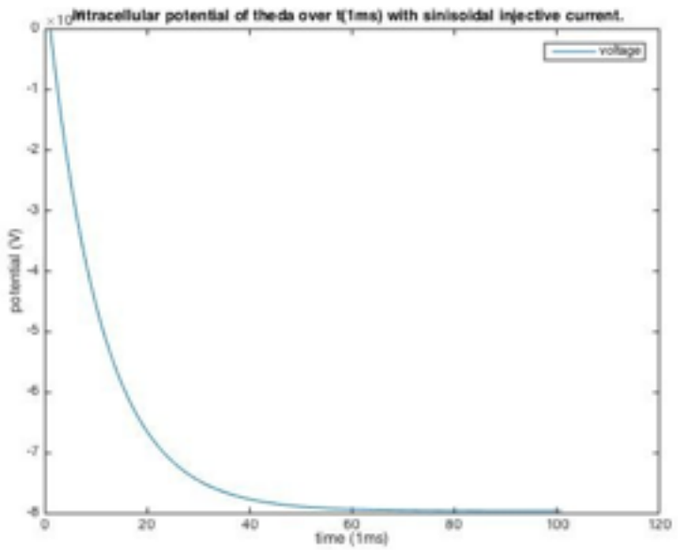
Neural Dynamics
Exercise II

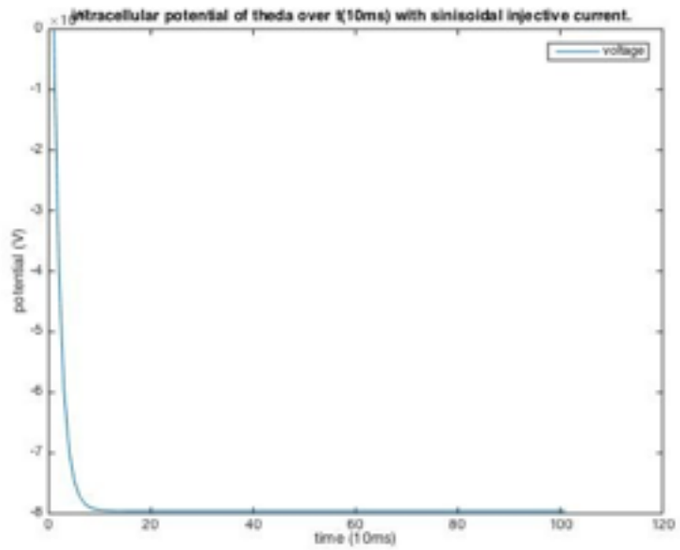
Question 3

Po-Hsuan Huang

Q3.2 Set Δt to the values 1ms, 10ms. What changes in the simulation?





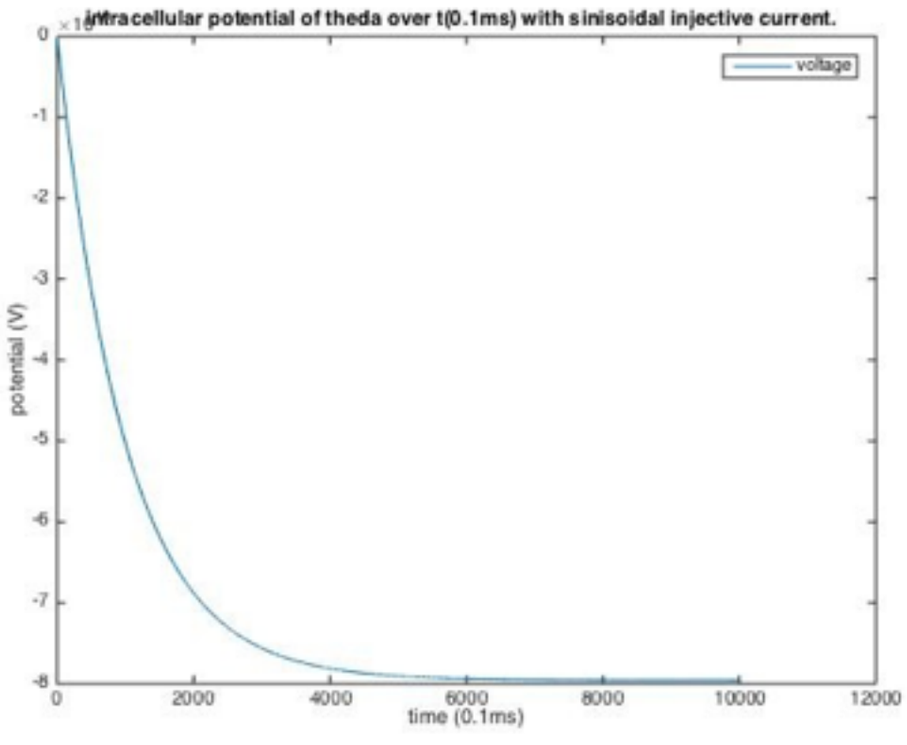


100x0.1ms/step 100x1ms/step 100x10ms/step

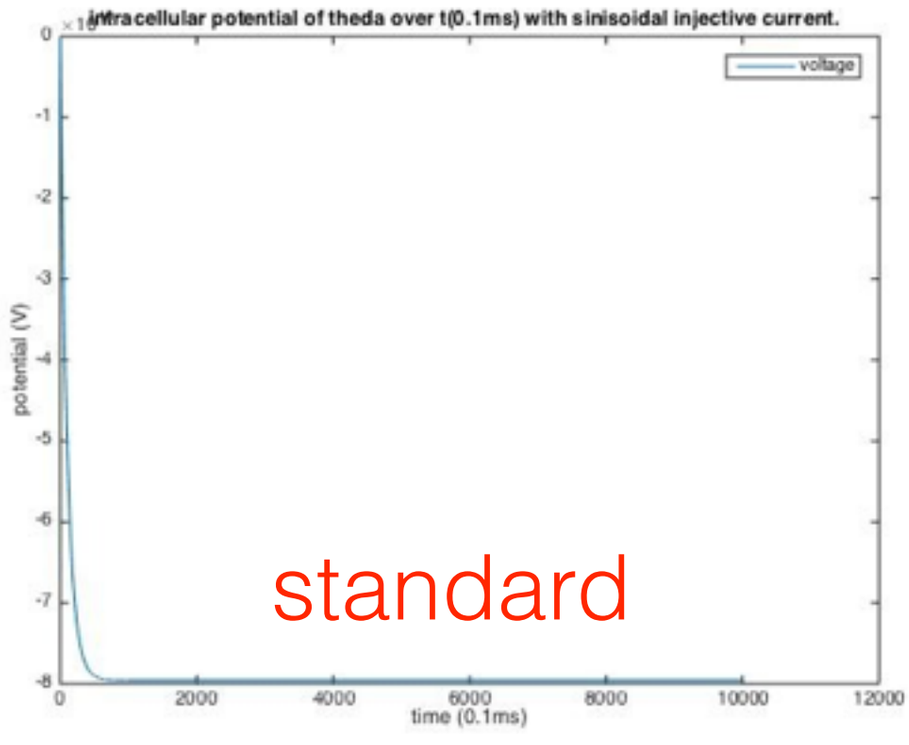
Because the step is amplified by 10 times, the error of the simulation is enlarged by 10 times,which can be deduced from the analytical solution.
Also, the scale is enlarged the same amount of steps.

Q3.3

$R\tilde{}_m = 1\ \Omega m^2$ $c\tilde{}_m = 10^{-1} F\ m^{-2}$

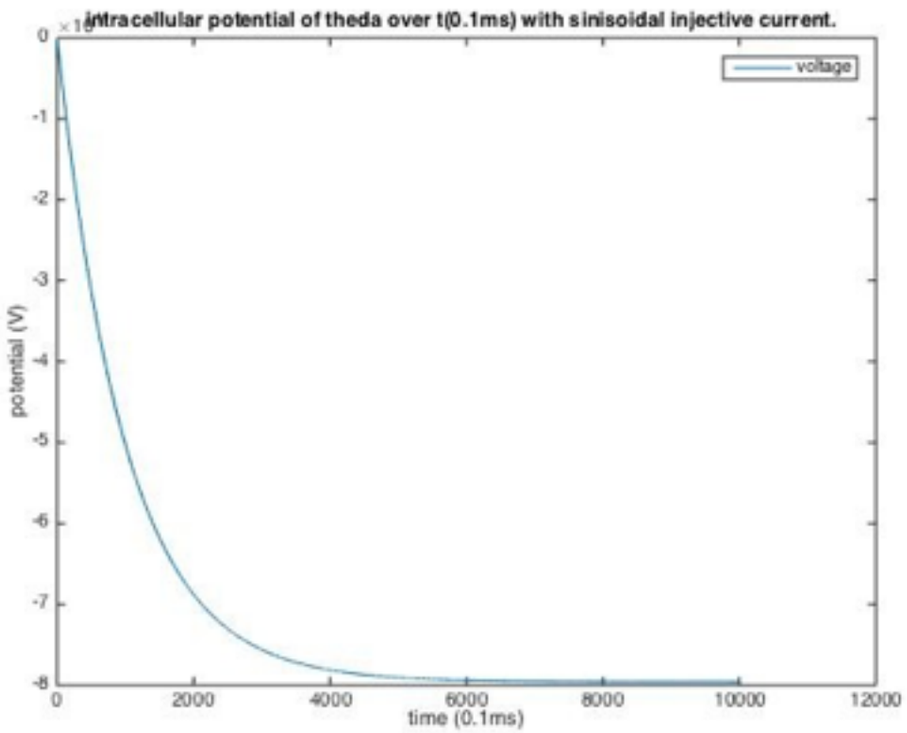


$R\tilde{}_m = 1\ \Omega m^2$ $c\tilde{}_m = 10^{-2} F\ m^{-2}$



standard

$R\tilde{}_m = 10\ \Omega m^2$ $c\tilde{}_m = 10^{-2} F\ m^{-2}$



characteristic time constant= RmCm

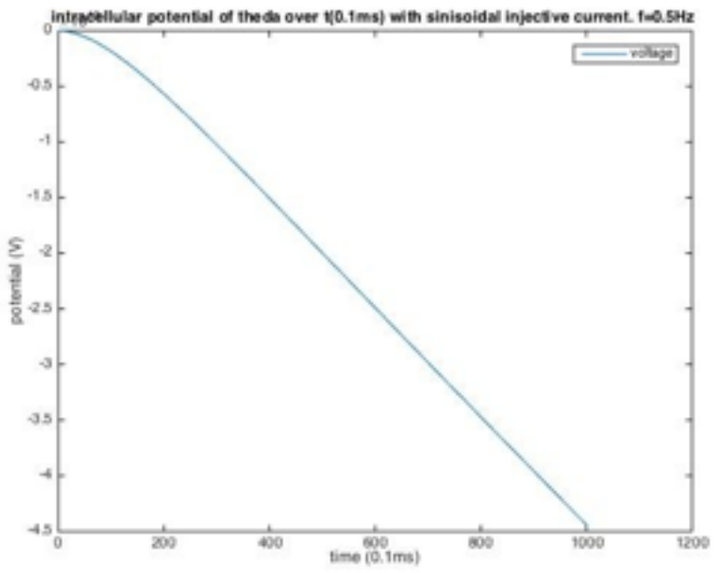
Characteristic time constant describes how fast the function decayed to 1/e times of its initial value. Analytically, both case should decay 10 times slower, but due to the simulation error, they look different.

Q3.4

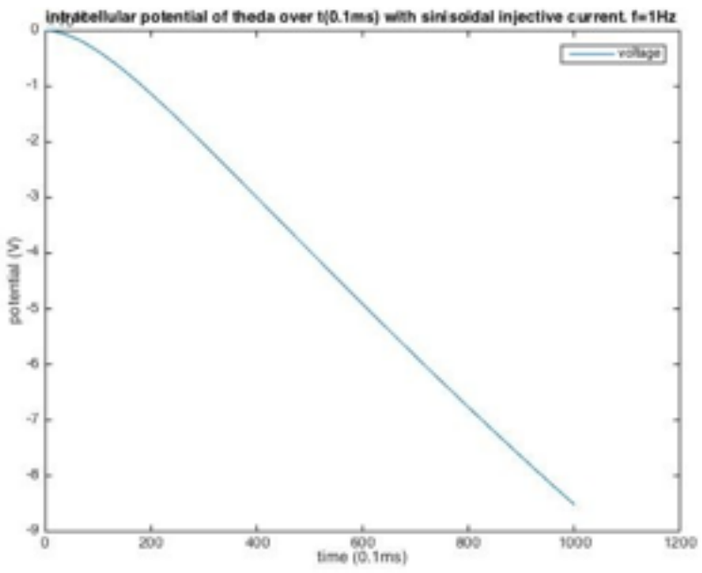
I_e (t) = 100pA sin (2πf t)

time step = 0.1 ms 1000 steps

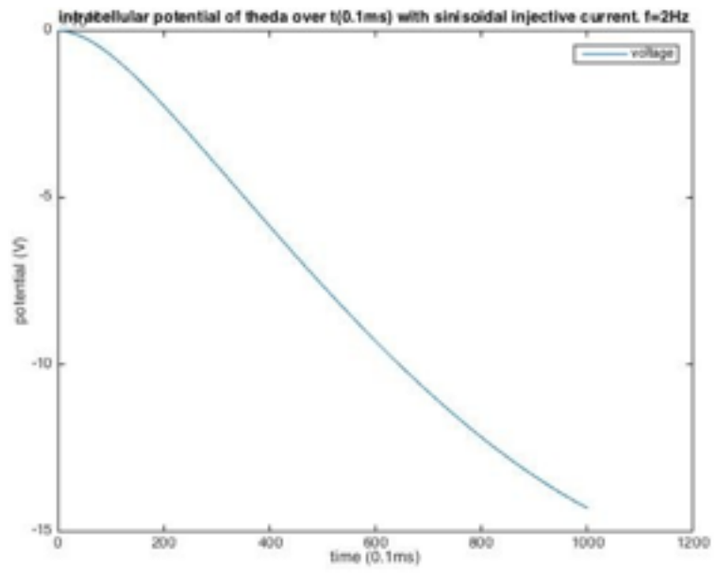
f_1 = 0.5Hz



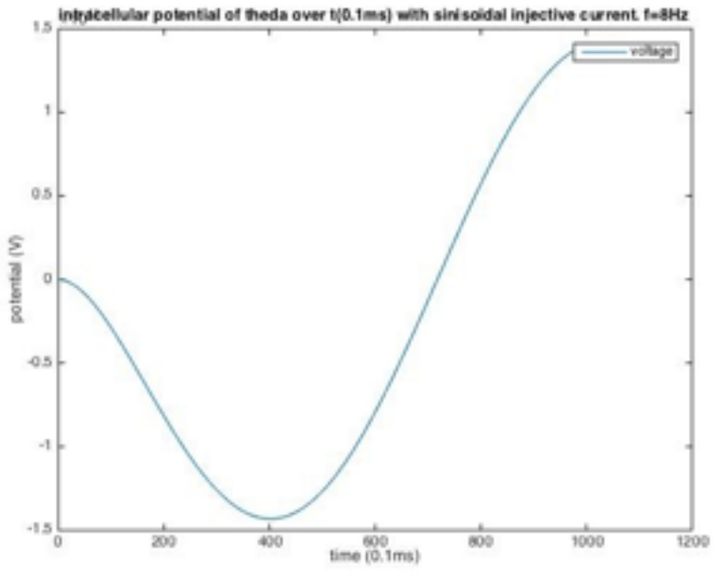
f2 = 1Hz



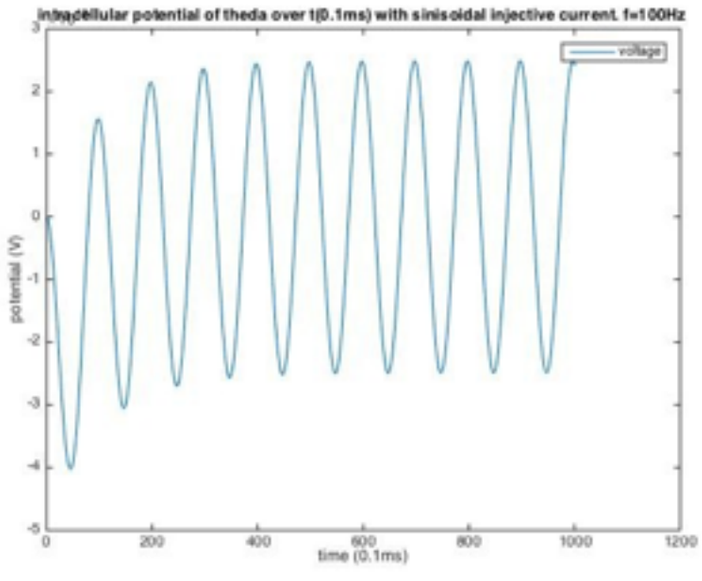
f_3= 2Hz



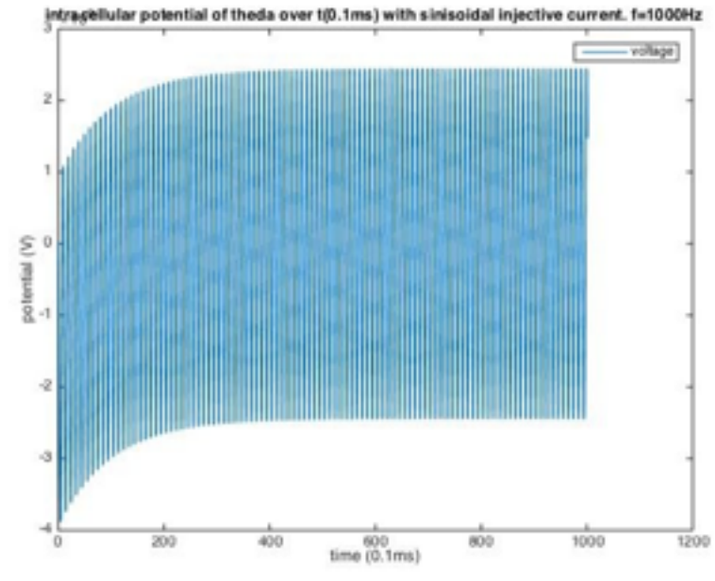
f_4= 8Hz



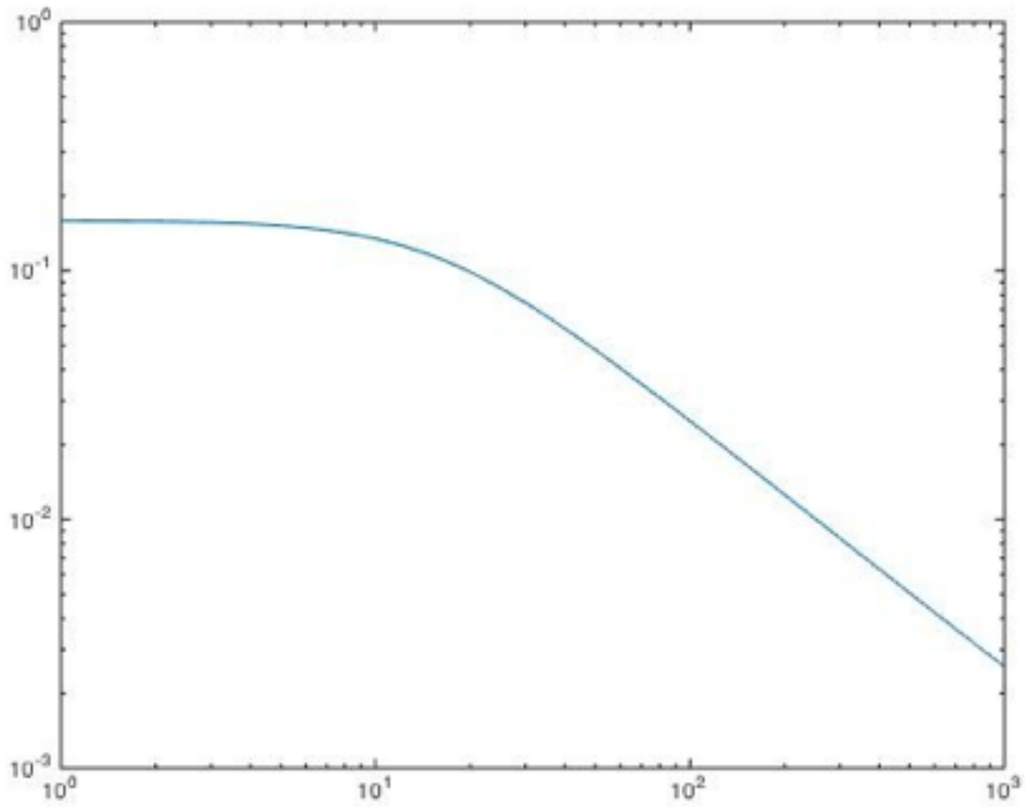
f5 = 100Hz



f6 = 1000Hz



Q3.4 For the converged state, plot the log of the amplitude of the voltage V (t) against the log of the frequency (Bode diagram). Explain the result.



Take logarithm to analytical solution of V(t), and let t = N*period, where N is a positive integer. We can show function logV(log w) is a straight line with slope =-1 when angular frequency >> (1/CmRm). Detailed derivation please check the paper version.