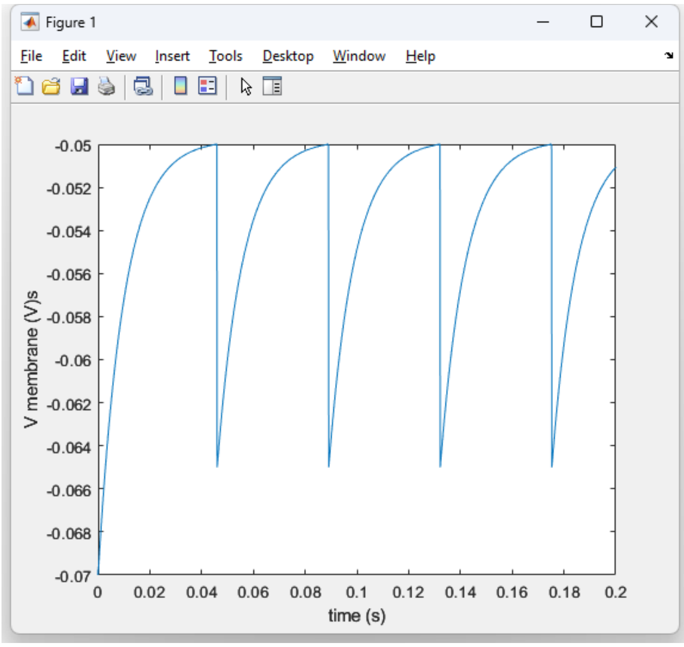
Question 1

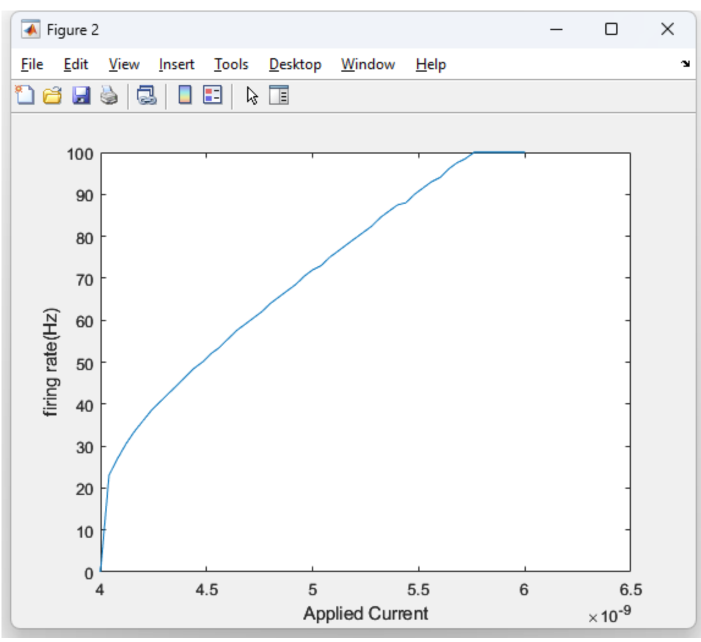
(a), (b)



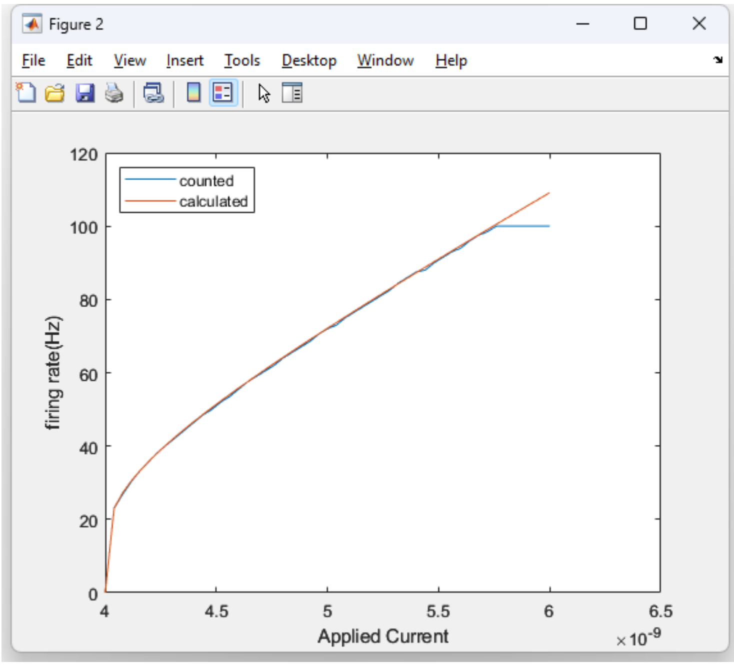
The minimum applied current is 4nA (not inclusive)

Figure above has 4.04nA applied current.

(c).

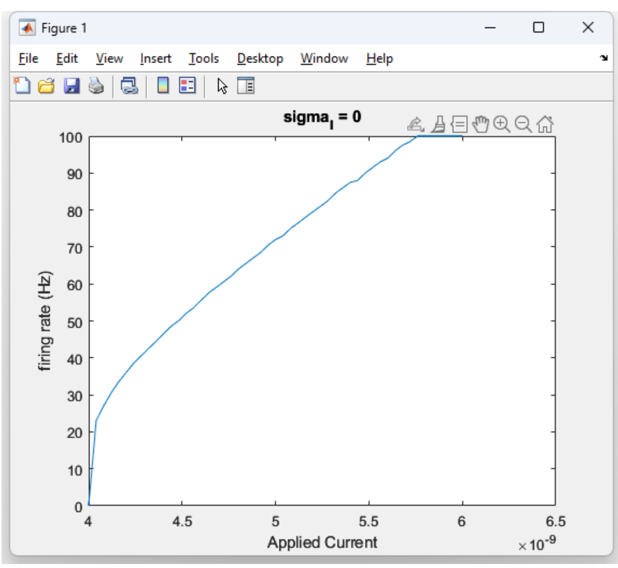


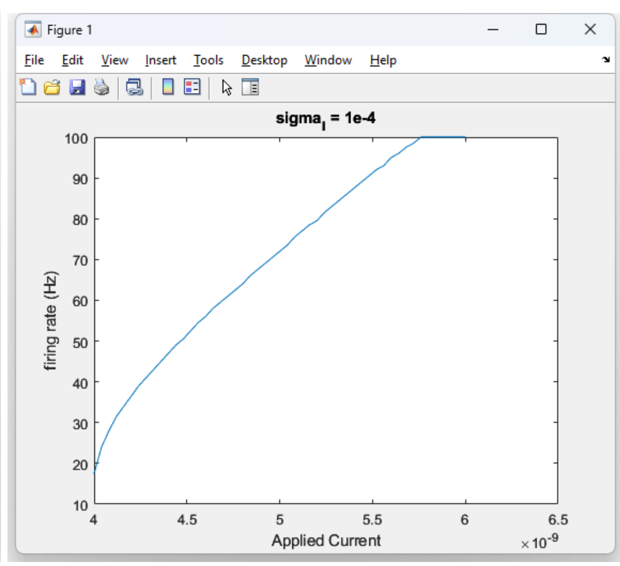
(d).

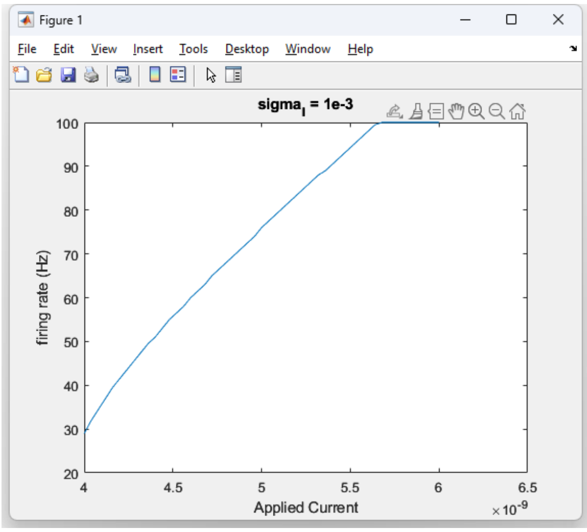


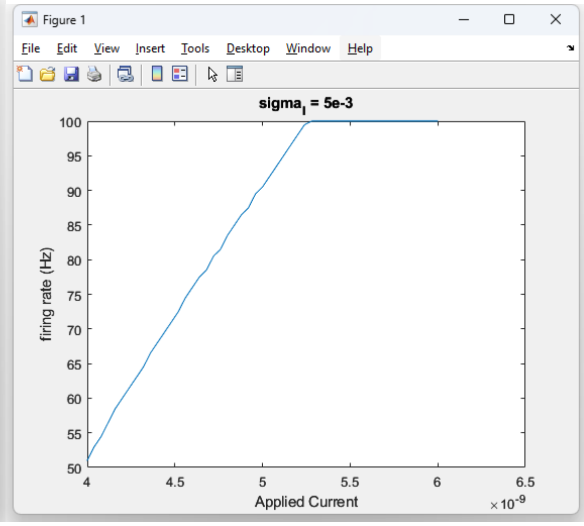
Question 2.

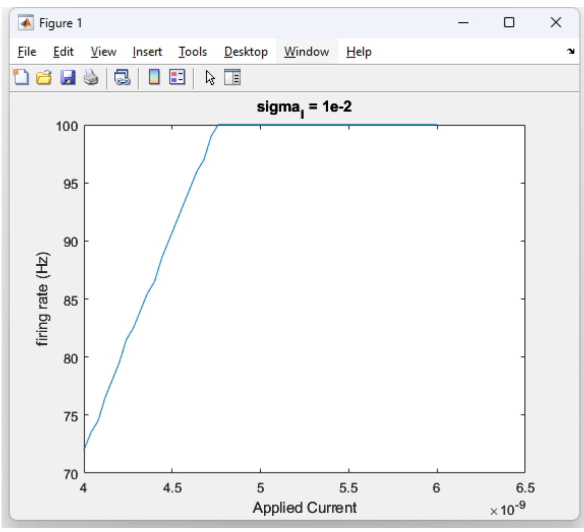
(a), (b) The increase of sigma_I would increase dV, making its speed for reaching threshold faster, the firing time would be shorter. Because the firing rate is inversely proportional to firing time, the firing rate would therefore be higher as noise (sigma_I) increases. The curve become a complete straight line when sigma_I value is around 1.74e-2. The curve for multiple sigma values are drew below.

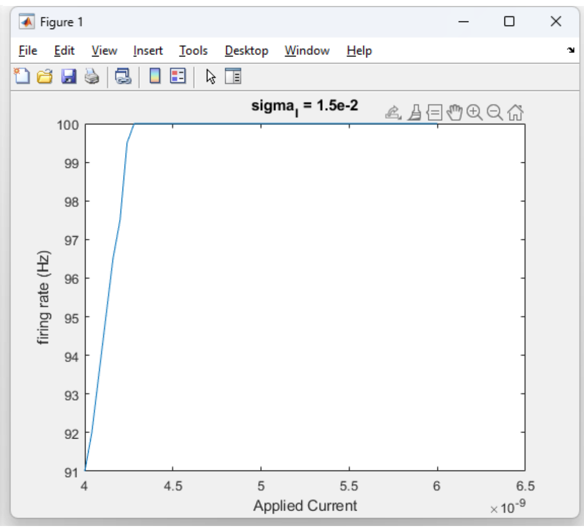












(c). Yes, the results are different. This is because the white noise function has units of the square-root of inverse-time ($s^{-0.5}$). Because the dV function is dependent on time scale of dt, the f-I curve would be different due to the altering of dt scale.

$$dV_m = \left(\frac{E_l - V_m}{R} + I_{app}\right) * \left(\frac{dt}{C_m}\right) + \sigma_I * rand * \sqrt{\boldsymbol{dt}}$$

$$C_m \frac{dV_m}{dt} = \left(\frac{E_l - V_m}{R} + I_{app}\right) + \frac{\sigma_I * rand * \sqrt{dt}}{dt} * C_m$$

$$= \frac{E_l - V_m}{R} + I_{app} + \frac{\sigma_I * rand * C_m}{\sqrt{\boldsymbol{dt}}}$$

The (dVm/dt) function would increase when dt decreases to smaller time scale, but this would not cause big differences in the graph shape. The graph is moving upward when dt decreases by 10 times scale. The graph would be horizontal line on 100-Hz when y-axis intersection is above 100 due to the decrease in time scale.