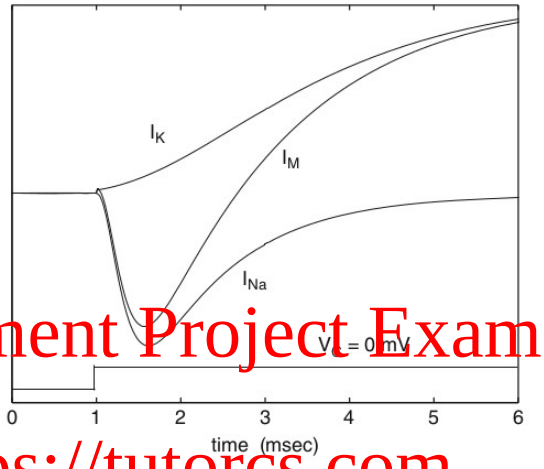
Assignment#1. Cog132. Due Wed. March15th at 11:59PM. 200 Points

Please submit an ipynb working file. This is a group assignment.

1. Replicate figure 1.8 below in Ermentrout and Terman. This is called a voltage-clamp experiment, where the voltage is held at rest and then stepped up to a testing voltage. Step the voltage to 0,+30,+60 mV, and show all the Na currents in one plot and the K currents together in another plot. Submit an ipynb file. From your simulation explain the flow of Na ions (in or out of the cell) in all traces. Notice that our HH model is slightly different than the one used by Ermentrout and Terman.

Fig. 1.8 Numerically computed voltage-clamp experiment. The membrane potential is stepped from rest to 0 mV. This results in an inward current followed by an outward current. The separate K^+ and Na^+ currents are also shown



#2. Create a plot where you show all the activation and inactivation curves. In a separate plot, show the time constants.

#3. Solve the HH equations with a brief pulse of current that produces an action potential. In this case, the voltage is not clamped anymore. Try to figure out how to determine the scale of time exactly. Use a current stimulation that is sin(wt) where w is the frequency of the stimulation. Use frequencies between 10 and 1000 hz (wT=2pi and T=1/f) to show how the action potential is modulated. Change the amplitude of the sine wave so that you can see an effect. because of the time scale, you also have to figure how to scale the frequency. Explain what you see. Use the Euler integration and compare with the RK methods.

#4 Compare the accuracy of the Euler integration with the RK second order. Use the RK4 as the gold standard. Calculate an approximate error and use it to monitor the error as the action potential is generated. How does the error change in the Euler scheme in the different phases of the action potential?