DEPARTMENT OF ELECTRONIC

AND

TELECOMMUNICATION ENGINEERING

UNIVERSITY OF MORATUWA

BM2102 - Modelling and Analysis of Physiological Systems

Assignment 3

Properties of the Hodgkin-Huxley equations

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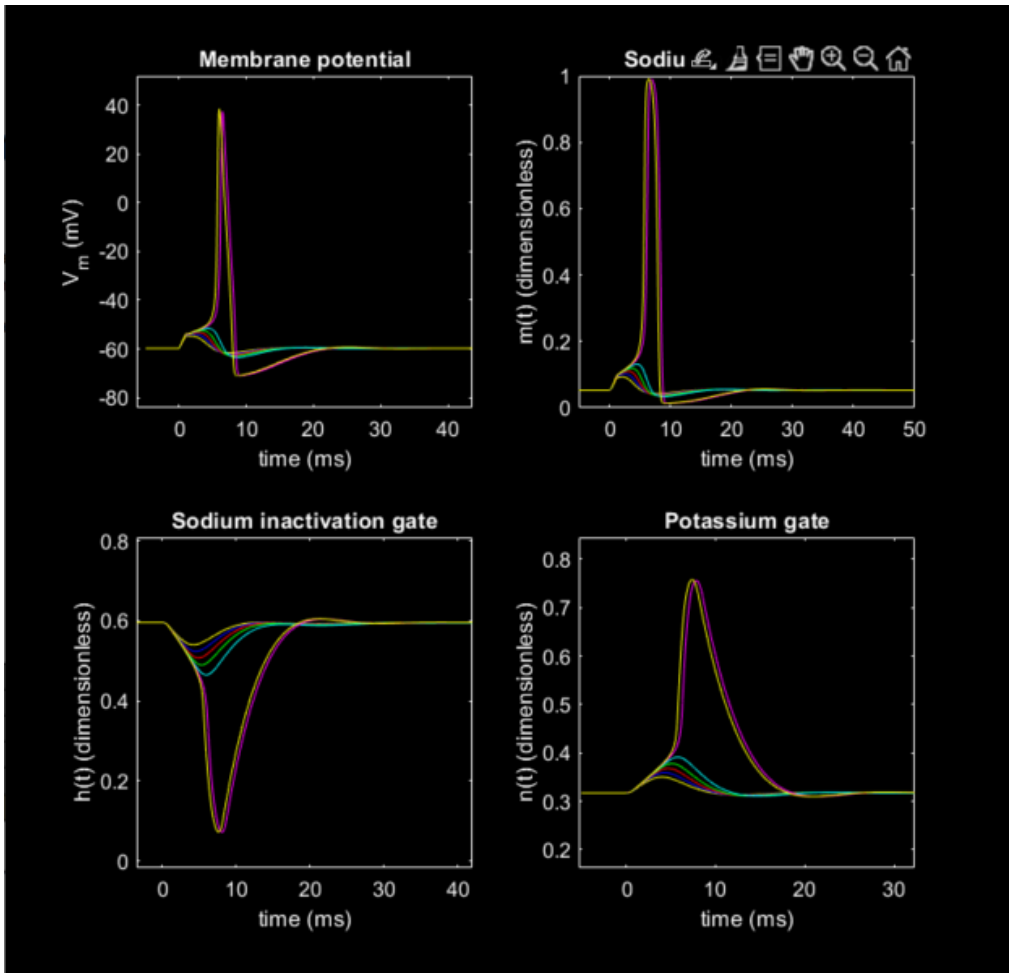
200003P

Question 1

Continue to bisect the amplitude interval for sub-threshold and supra-threshold stimulating currents and obtain an estimate of the threshold stimulating current amplitude to two decimal places.



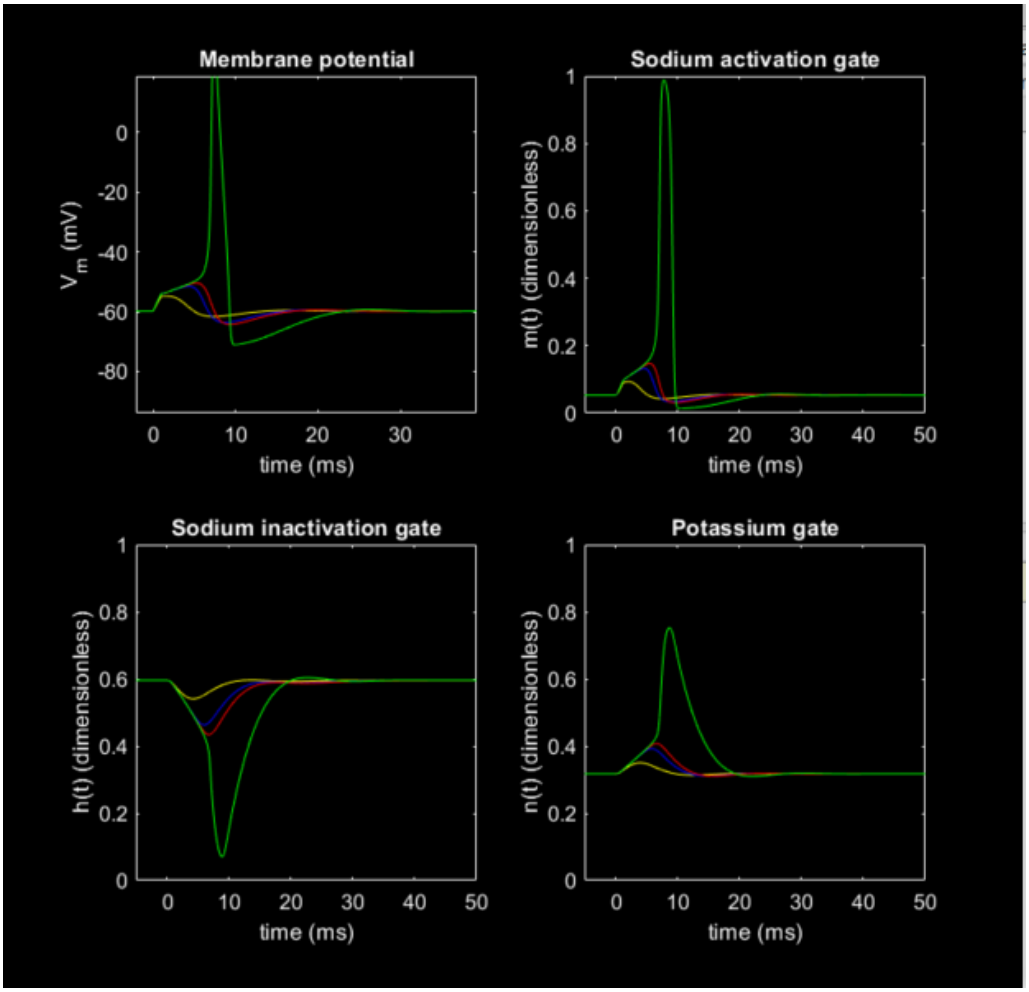
Amplitudes used.

- 6.5000 - no AP
- 6.7500 - no AP
- 6.8750 - no AP
- 6.9375 - no AP
- 6.9688 - AP generated
- 6.9844 - AP generated

Maximum amplitude that could pass the threshold is **6.9688**

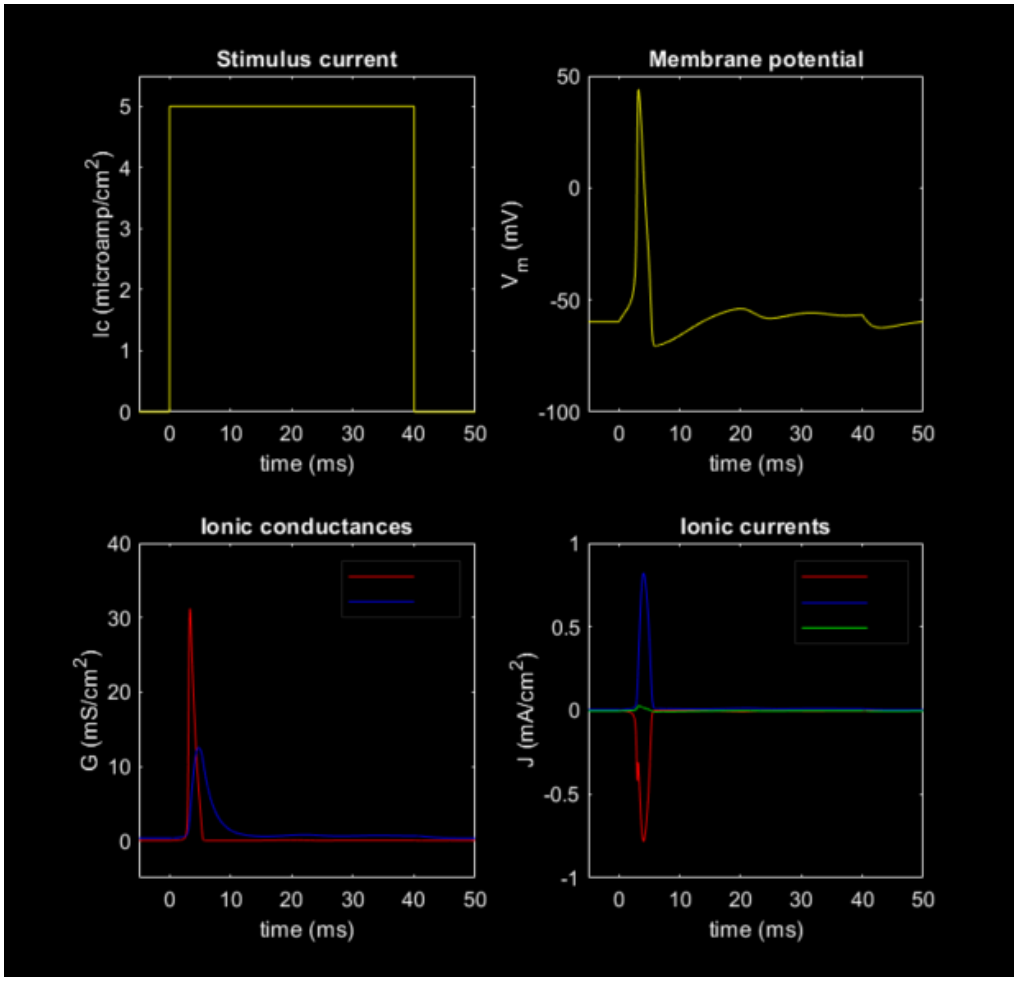
Considering values between 6.9688 and 6.9375 following graphs were plotted.

- 6.9400 - no AP
- 6.9550 - no AP
- 6.9600 - AP generated



According to above graph threshold amplitude is 6.96.

Question 2



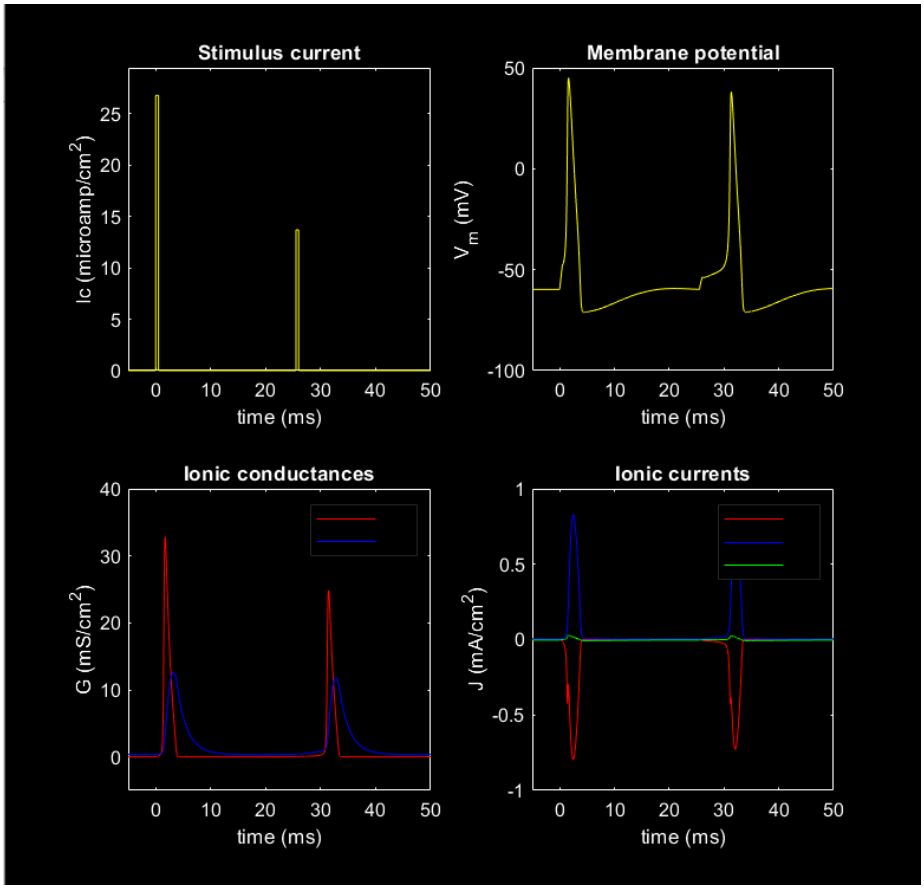
Total current densities = qna + qk + ql = 199.9645

Jei sum is 200

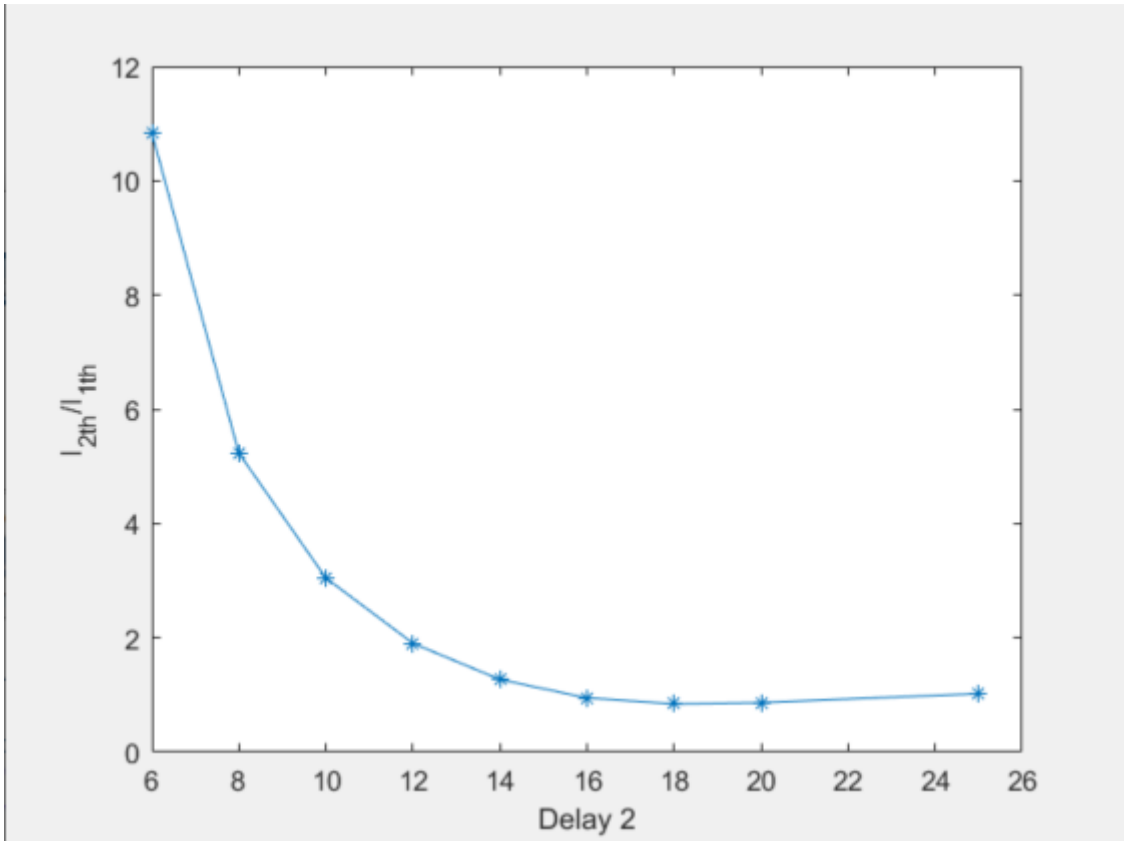
it shows that **sum of j_{ei} = total current density**

Question 3

- Delay = 25 , amp2 = 13.7
- Delay = 20 , amp2 = 11.6
- Delay = 18 , amp2 = 11.3
- Delay = 16, amp2 = 12.7
- Delay = 14 , amp2 = 17
- Delay = 12 , amp2 = 25.5
- Delay = 10, amp2 = 40.8
- Delay = 8 , amp2 = 70.1
- Delay = 6, amp2 = 145.2


Stimulus current
Ic (microamp/cm2)
time (ms)
Membrane potential
Vm (mV)
time (ms)
Ionic conductances
G (mS/cm2)
time (ms)
Ionic currents
J (mA/cm2)
time (ms)

Question 4

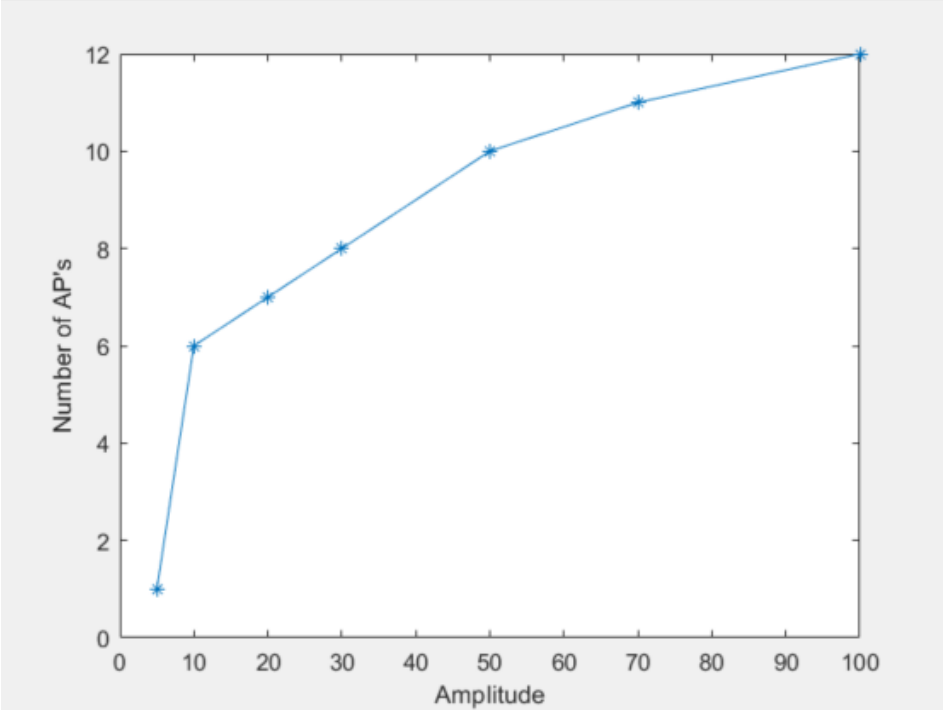

I2th/I1th
Delay 2

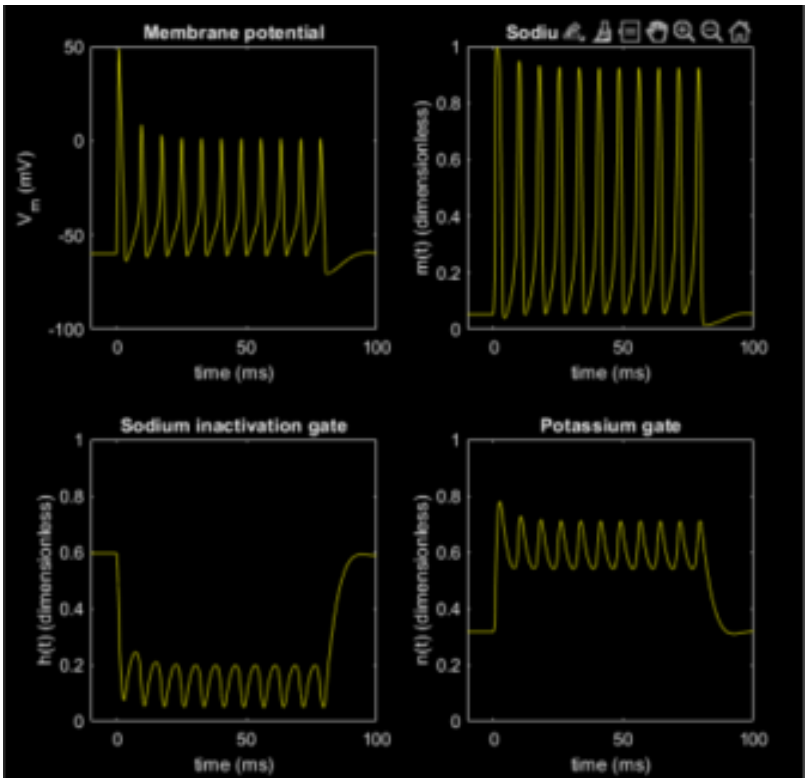
According to the graph,

Absolute refractory period = **0- 6ms**

Relative refractory period = **6-16ms**

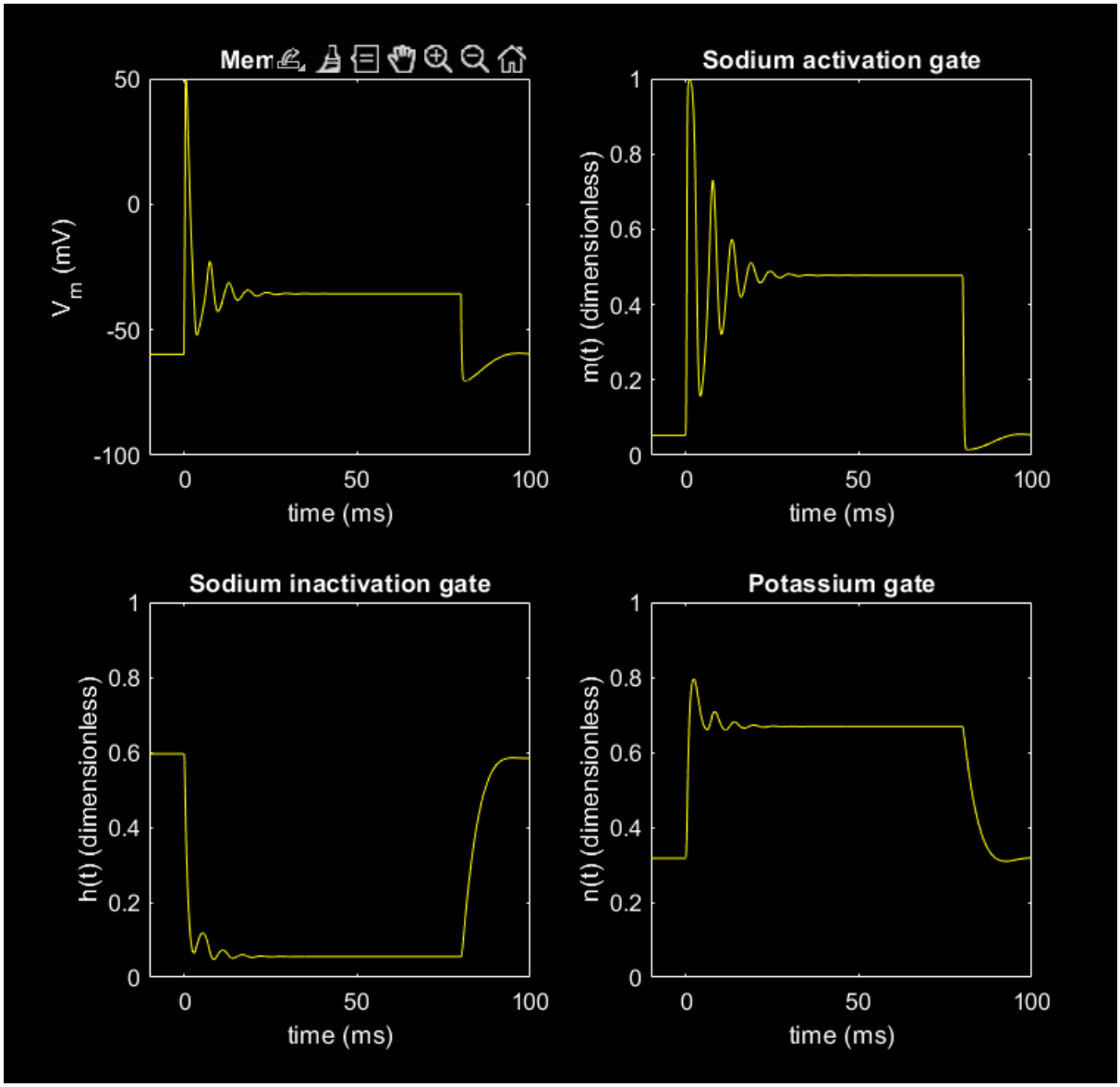
Question 5





When the stimulating current amplitude is increased, amplitude of Ap is decreased and frequency is increased.

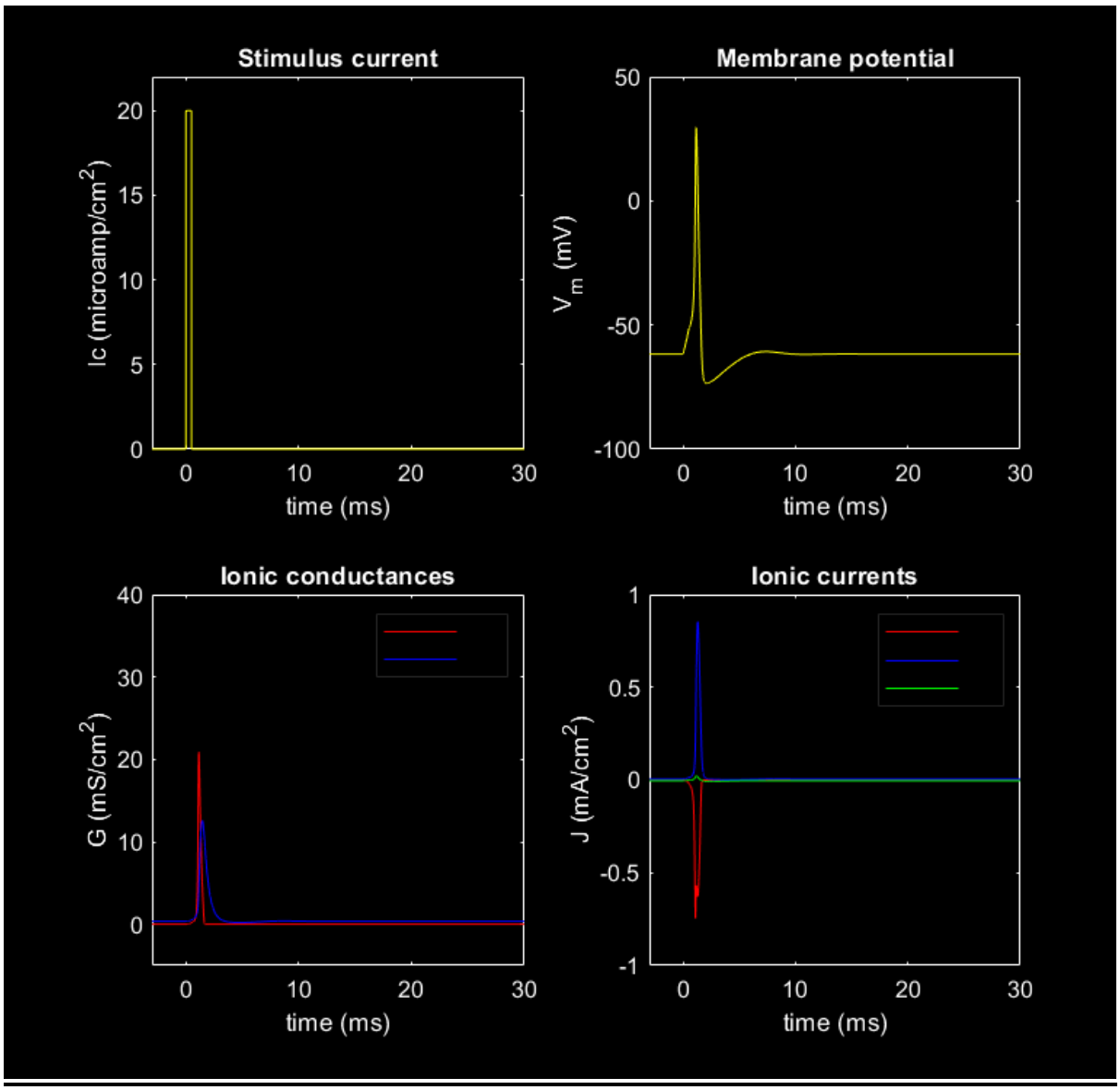
Question 6



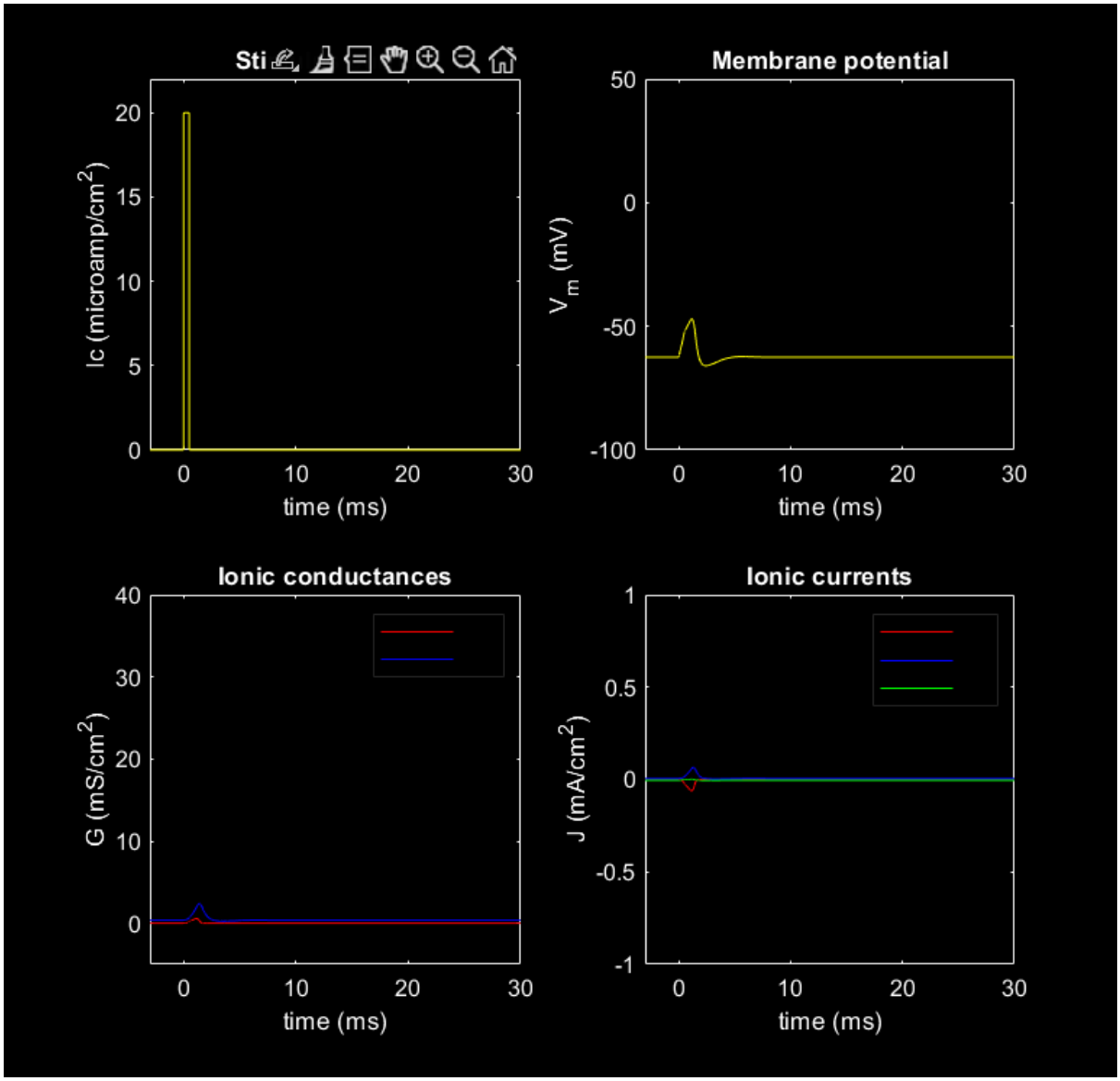
when the stimulating current amplitude is increased, the neuron's membrane potential depolarizes more rapidly. This leads to the activation of sodium channels and the influx of sodium ions, initiating an action potential. However, the increased depolarization also causes the inactivation of some sodium channels, resulting in a decreased amplitude of the action potential. Additionally, at very high levels of

depolarization, the activation of potassium channels responsible for repolarization is hindered, prolonging the depolarized state of the membrane.

Question 7



Temp = 20°C



Temp = 26ºC

- Action potential duration

  higher temperatures have the tendency to shorten the duration of the action potential. This occurs because elevated temperatures accelerate the kinetics of ion channels, causing faster activation and inactivation processes. Consequently, the repolarization phase of the action potential is expedited, leading to a decrease in the overall duration of the action potential.

- Threshold

  Higher temperatures have the effect of decreasing the threshold for

neuron activation. This is because elevated temperatures increase the excitability of neurons, making them more responsive to depolarizing stimuli. As a result, neurons require less depolarization to reach the threshold and generate an action potential. This lowered threshold facilitates the initiation of action potentials, leading to increased neuronal activity.