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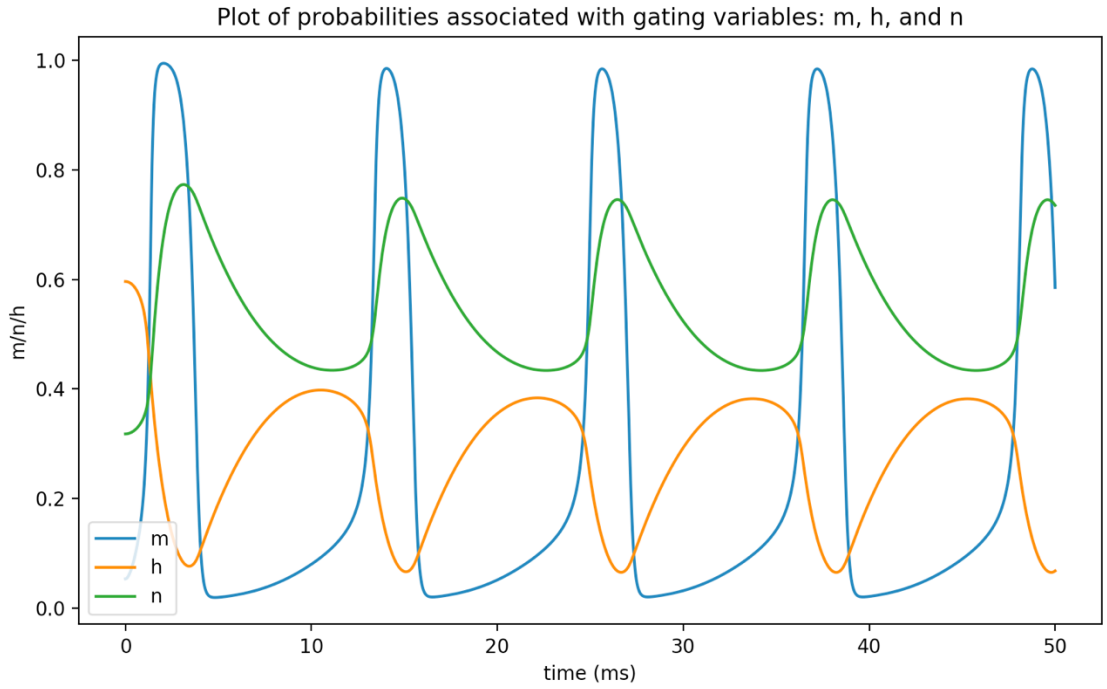
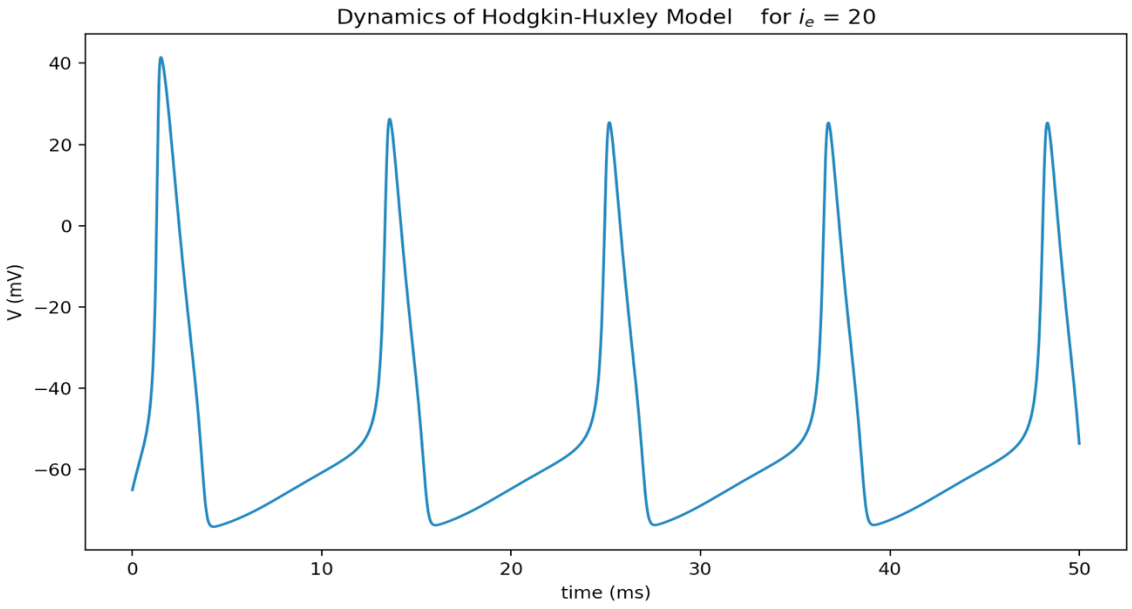
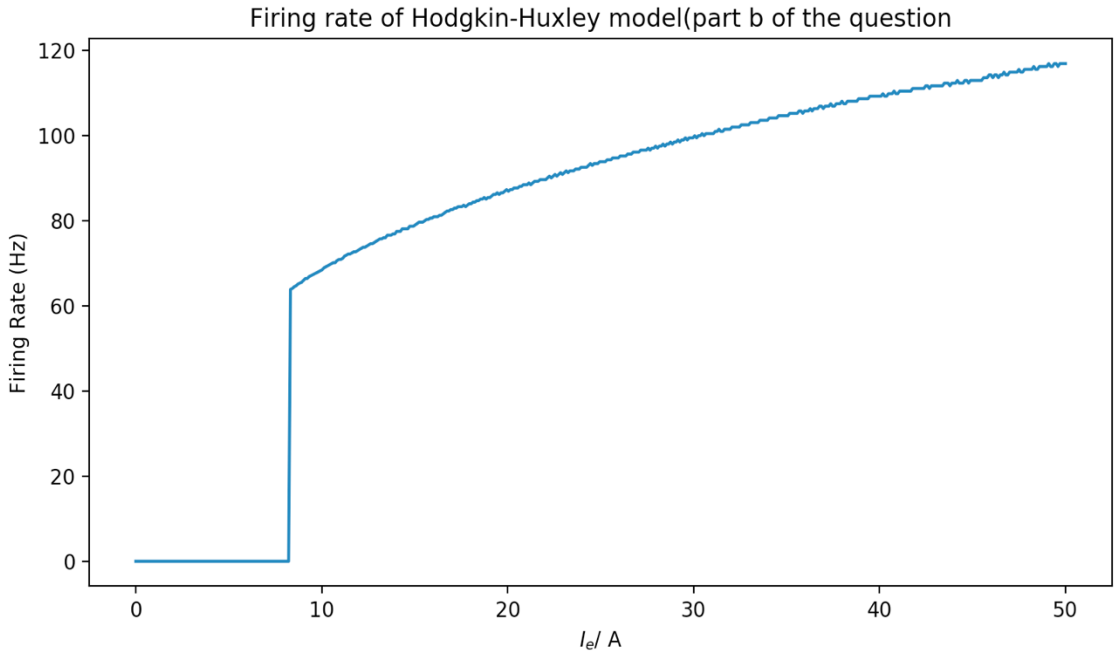
Question 1.

I used Euler method to solve the system of ODE's.
a)

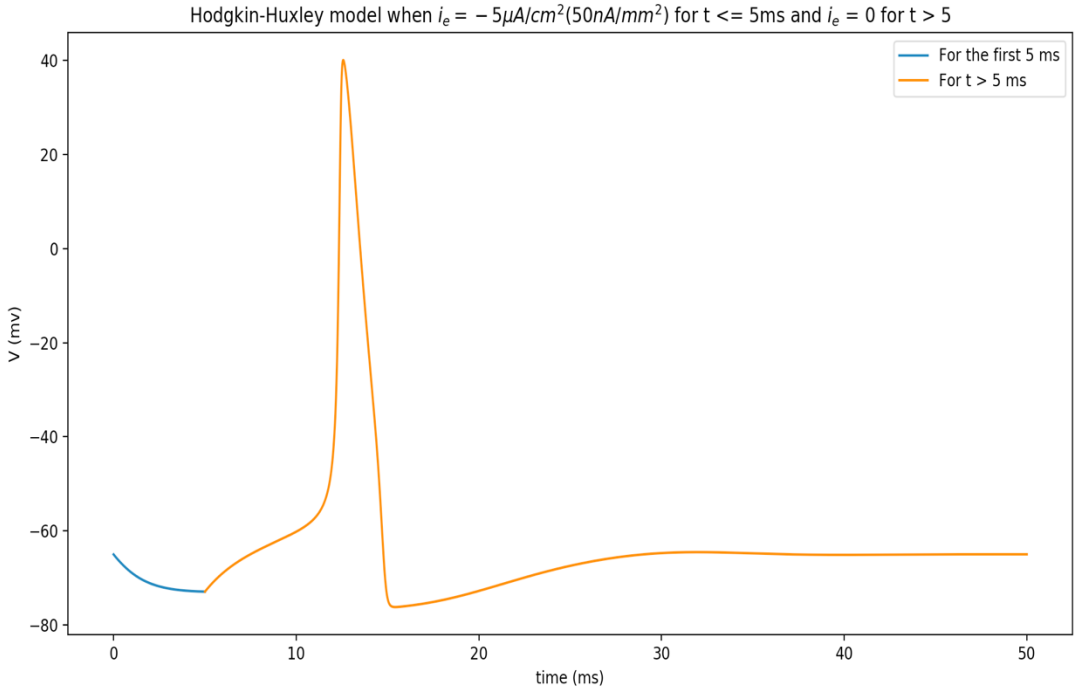


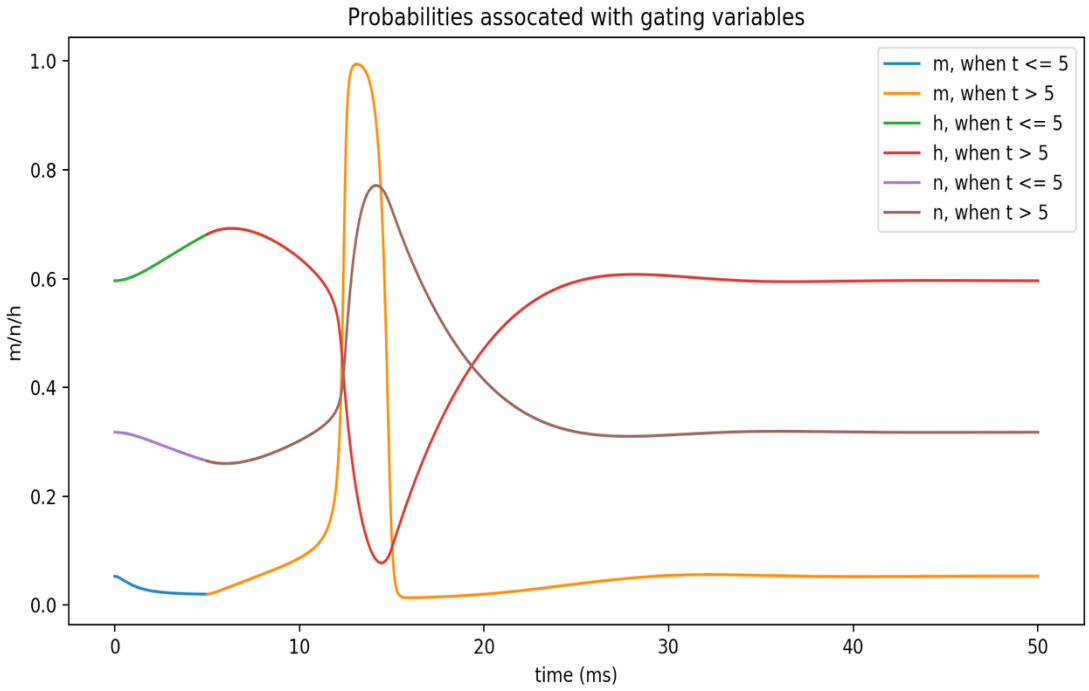


Part b)


Firing rate of Hodgkin-Huxley model(part b of the question
Firing Rate (Hz)
120
100
80
60
40
20
0
0
10
20
30
40
50
I_e/ A

Part c


Hodgkin-Huxley model when $i_e = -5\mu A/cm^2(50nA/mm^2)$ for t <= 5ms and i_e = 0 for t > 5
For the first 5 ms
For t > 5 ms
V (mv)
40
20
0
−20
−40
−60
−80
0
10
20
30
40
50
time (ms)



When a negative pulse of current is applied, I_e is negative. And since, $c_m \frac{dV}{dt} = -i_m + \frac{I_e}{A}, \frac{dV}{dt}$ can take negative values. It will be positive if $i_m < 0 \; and \; |i_m| > |i_e|$. But in our case, it is not. Hence, $\frac{dV}{dt} < 0$. Since, the derivative is less that 0, the membrane potential decreases. But the potential will not decrease forever. It will stop changing once m, n, and h reach their asymptotes.

Once we stop supplying current, the system will revert to where it started i.e. V, m, n, h will be equal to the initial values.