Question 2

Question 3

Question 4

*% From Question*

Vrest = -70E-3;

R\_m = 10E6;

tao = 10E-3;

Vm = -70E-3;

Vth = -54E-3;

Vreset = -80E-3;

time = 0.5;

*% Chosen values*

Vspike = 0;

dt = 1E-3;

I\_max = 2E-9;

iterations = time/dt;

I = zeros(iterations, 1);

*% Apply step function current for middle 300ms*

I(0.2\* iterations + 1 : 0.8 \* iterations) = I\_max;

*% iterate through phase timesteps*

**for** n= 1:iterations

*% Manual Spikes*

**if** Vm >= Vth

V(n, 1) = Vspike;

Vm = Vreset;

*% Use the membrane equation*

**else**

dv = (1/tao) \* ((-1\* Vm) + Vrest + R\_m\*I(n,1)) \* dt

Vm = Vm + dv;

V(n, 1) = Vm;

**end**

**end**

plot(V);

xlabel('Time, (ms)')

ylabel('Membrane Volage (V)')

title('Membrane Volage (V) vs Time (ms)')

Question 5

*% 0 to 10 ns in 100 increments*

Iinj = 0:(10E-9/100):10E-9;

*% Apply the simulated and expected spike rates*

spike\_rate\_actual = arrayfun(@ass\_1\_q5\_actual, Iinj);

spike\_rate\_expected = arrayfun(@ass\_1\_q5\_expect, Iinj);

hold on

plot(Iinj, spike\_rate\_actual);

plot(Iinj, spike\_rate\_expected);

xlabel('Injection current, (A)')

ylabel('firing rate (/s)')

title('Firing Rate (/s) vs Injection current (A)')

hold off

with functions defined:

**function** firing\_rate = ass\_1\_q5\_actual( I\_inj)

*% From Question*

Vrest = -70E-3;

R\_m = 10E6;

tao = 10E-3;

Vm = -70E-3;

Vth = -54E-3;

Vreset = -80E-3;

time = 0.5;

*% Chosen values*

Vspike = 0;

dt = 1E-4;

iterations = time/dt;

I = zeros(iterations, 1);

*% Apply step function current for middle 300ms*

I(0.2\* iterations + 1 : 0.8 \* iterations) = I\_inj;

*% iterate through phase timesteps*

**for** n= 1:iterations

*% Manual Spikes*

**if** Vm >= Vth

V(n, 1) = Vspike;

Vm = Vreset;

*% Use the membrane equation*

**else**

dv = (1/tao) \* ((-1\* Vm) + Vrest + R\_m\*I(n,1)) \* dt

Vm = Vm + dv;

V(n, 1) = Vm;

**end**

**end**

firing\_rate = spikes / (0.6 \* time);

**end**

and

**function** firing\_rate = ass\_1\_q5\_expect( Iinj )

*% From Question*

Vrest = -70E-3;

R\_m = 10E6;

tao = 10E-3;

Vth = -54E-3;

Vreset = -80E-3;

time = 0.5;

*% Chosen values*

Vspike = 0;

dt = 1E-4;

firing\_rate = 1 /(tao \* log( (R\_m \* Iinj + Vrest - Vreset) / (R\_m \* Iinj + Vrest - Vth)) );

**end**

Question 6

*% From Question*

Vrest = -70E-3;

R\_m = 10E6;

tao = 10E-3;

Vm = -70E-3;

Vth = -54E-3;

Vreset = -80E-3;

time = 0.5;

*% Chosen values*

Vspike = 0;

dt = 1E-3;

I\_max = 2E-9;

*% rsa value from question*

tao\_sra = 100E-3;

dg\_sra = 0.3;

V\_k = -70E-3;

r\_sra = 1;

g\_sra\_init = 0;

g\_sra = g\_sra\_init;

iterations = time/dt;

I = zeros(iterations, 1);

I(0.2\* iterations + 1 : 0.8 \* iterations) = I\_max;

*% iterate through phase timesteps*

**for** n= 1:iterations

*% Manual Spikes*

**if** Vm >= Vth

V(n, 1) = Vspike;

Vm = Vreset;

g\_sra += dg\_sra;

*% Use the membrane equation*

**else**

dv = (1/tao) \* ((-1\* Vm) + Vrest + R\_m\*I(n,1) - g\_sra \* r\_sra \* (Vm - V\_k) ) \* dt

Vm = Vm + dv;

*% Spike rate adaptation variable updates*

dg = (-1 \* g\_sra/tao\_sra) \* dt

g\_sra = g\_sra + dg;

V(n, 1) = Vm;

**end**

**end**

hold on

xlabel('Time (ms)')

ylabel('Membrane Voltage (V) ')

title('Membrane Voltage with spike rate adaptation(V) vs Time (ms)')

plot(V);

hold off