Q2 Izhikevich Model

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Q2 part-a steady state values

solving for steady state for RS neurons

```
[C,kz,Er,Et,a,b,c,d,v_peak]=neuron_data(1);
polynom = [kz/c,-1-((Er+Et)*kz/b),Er+Er*Et*kz/b];
root_temp=roots(polynom);
V_steady_state=root_temp(2);
U_steady_state= (root_temp(2)-Er)*b;
display('for RS neurons');
display(strcat('steady state V= ',num2str(V_steady_state)));
display(strcat('steady state U= ',num2str(U_steady_state)));

% for IB neurons
[C,kz,Er,Et,a,b,c,d,v_peak]=neuron_data(2);
polynom = [kz/c,-1-((Er+Et)*kz/b),Er+Er*Et*kz/b];
root_temp=roots(polynom);
V_steady_state=root_temp(2);
U_steady_state= (root_temp(2)-Er)*b;
display('for IB neurons');
display(strcat('steady state V= ',num2str(V_steady_state)));
display(strcat('steady state U= ',num2str(U_steady_state)));

% for CH neurons
[C,kz,Er,Et,a,b,c,d,v_peak]=neuron_data(3);
polynom = [kz/c,-1-((Er+Et)*kz/b),Er+Er*Et*kz/b];
root_temp=roots(polynom);
V_steady_state=root_temp(2);
U_steady_state= (root_temp(2)-Er)*b;
display('for CH neurons');
display(strcat('steady state V= ',num2str(V_steady_state)));
display(strcat('steady state U= ',num2str(U_steady_state)));
```

```
for RS neurons
steady state V=-0.025
steady state U=-7e-11
for IB neurons
steady state V=-0.026439
```

```
steady state U=2.4281e-10
for CH neurons
steady state V=-0.023758
steady state U=3.6242e-11
```

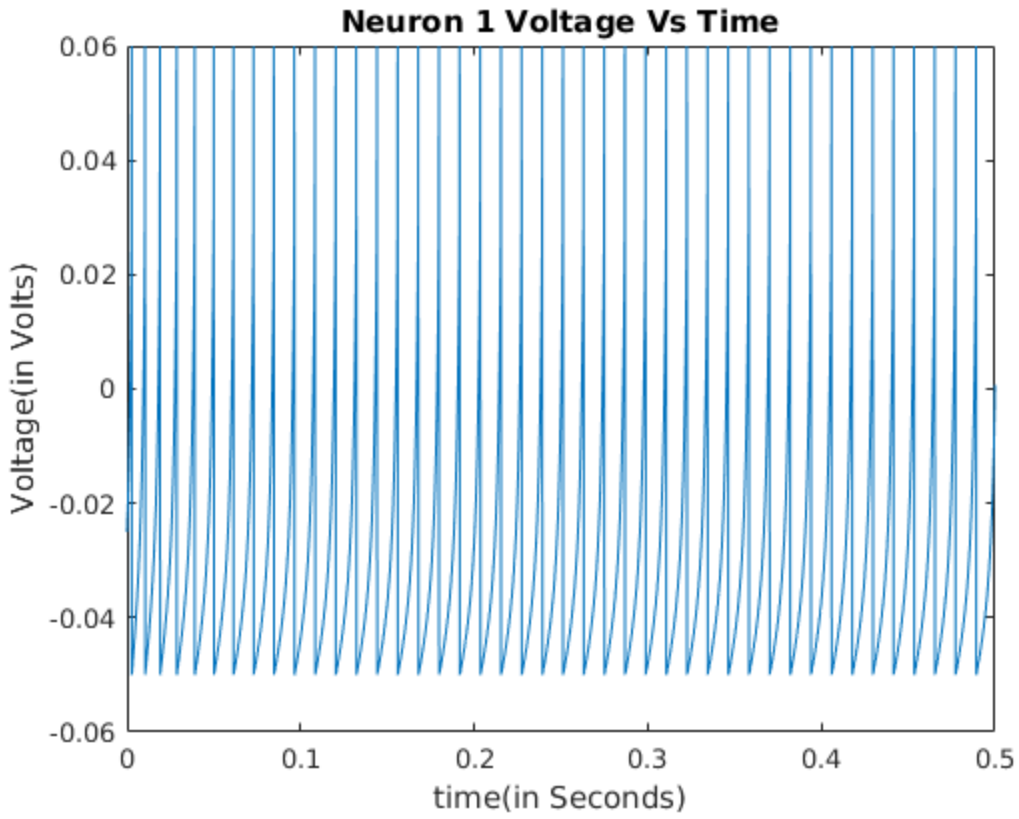
Q2 part-b Writing Difference equations

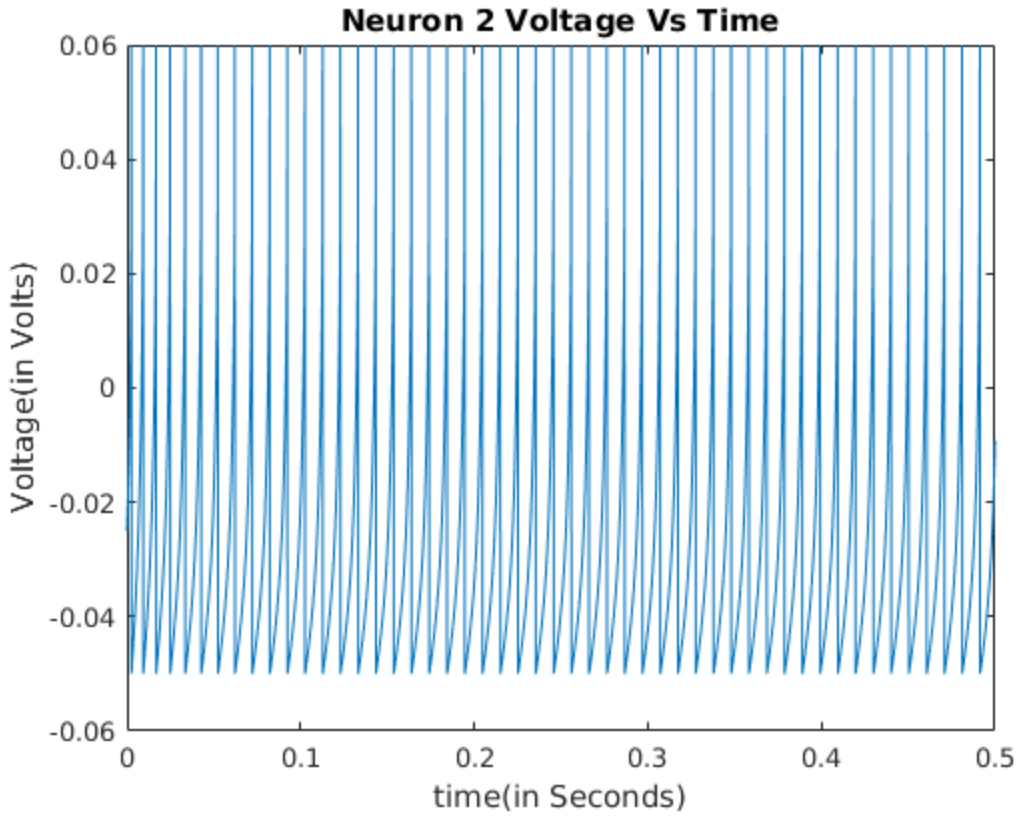
```
display('difference equation for Izhikevich Model');
display('V(n+1)=1/C(kz(V(n)#Er)(V(n)#Et)#U(n)+I app(n)+V(n)');
display('and');
display('U(n+1)=a[b(V(n)#Er) # U (n)]+U(n)');

difference equation for Izhikevich Model
V(n+1)=1/C(kz(V(n)#Er)(V(n)#Et)#U(n)+I app(n)+V(n)
and
U(n+1)=a[b(V(n)#Er) # U (n)]+U(n)
```

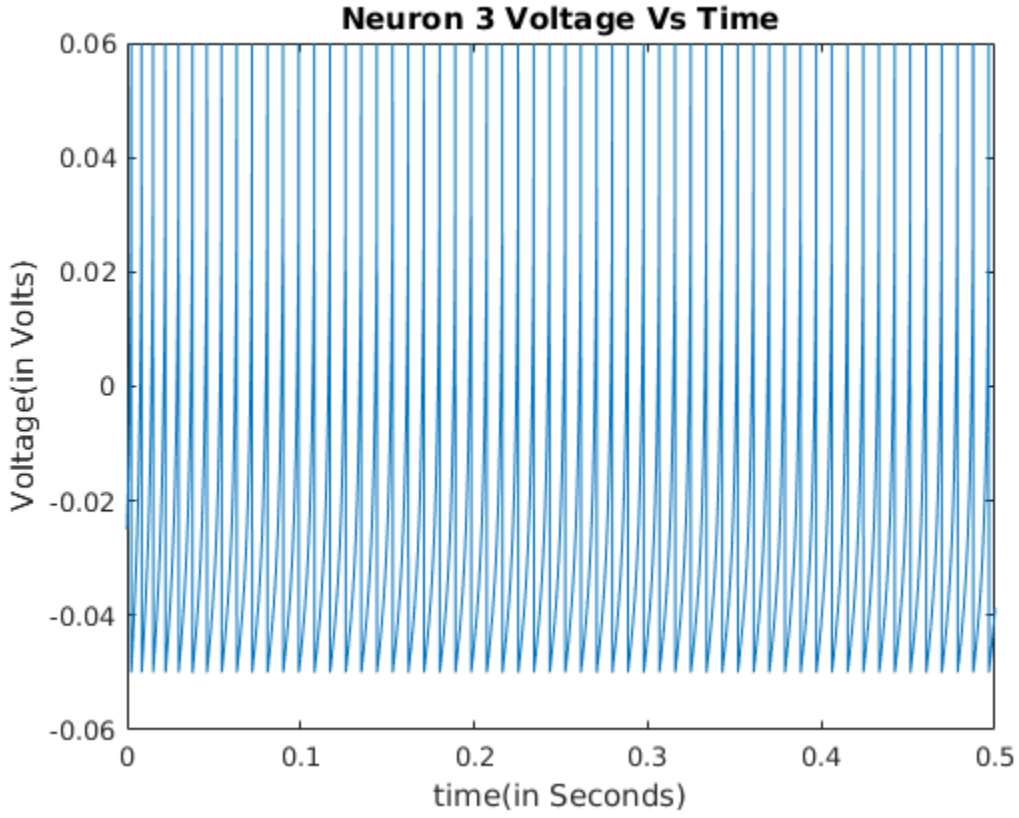
Q2 part-c Transient solution for RS type neuron

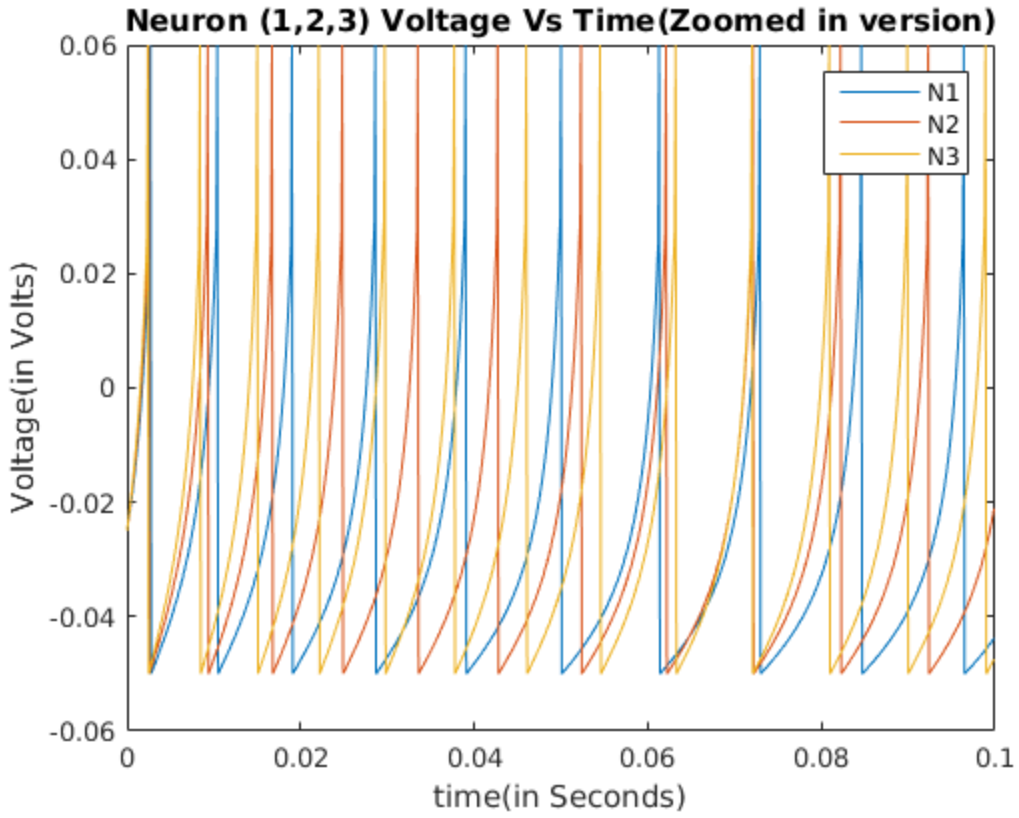
```
N=3;
T=0.500;
delta_t= 0.1 * 10^-3;
M=T/delta_t;
input=zeros(N,M);

for i=1:N
    input(i,:)=(4+i)*100*10^-12;
end

x = 0:delta_t:T;
[y,z] = rk4(delta_t,T,input,1);


figure()
plot(x,y(1,:));
title('Neuron 1 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');

figure()
plot(x,y(2,:));
title('Neuron 2 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');

figure()
plot(x,y(3,:));
title('Neuron 3 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');

figure()
plot(x(1:1000),y(1,1:1000),x(1:1000),y(2,1:1000),x(1:1000),y(3,1:1000));
```

```
title('Neuron (1,2,3) Voltage Vs Time(Zoomed in version)');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');
legend('N1','N2','N3');
```




Neuron 2 Voltage Vs Time
Voltage(in Volts)
time(in Seconds)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
0.4
0.5

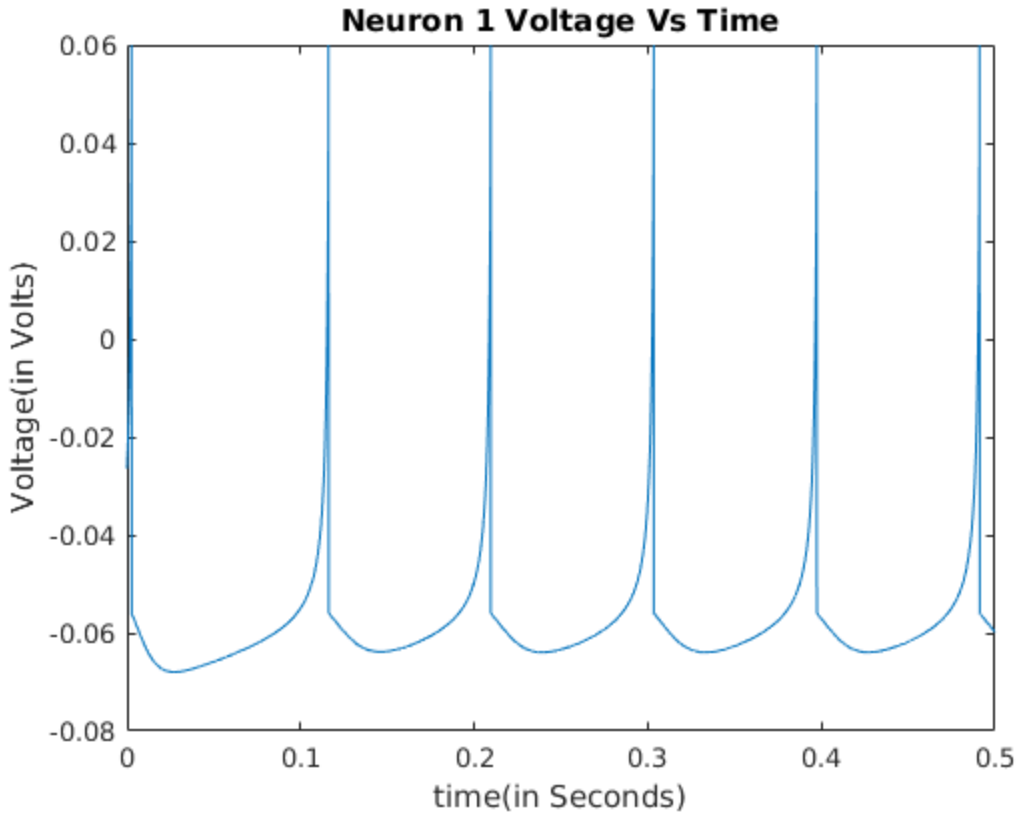

Neuron 3 Voltage Vs Time
Voltage(in Volts)
time(in Seconds)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
0.4
0.5

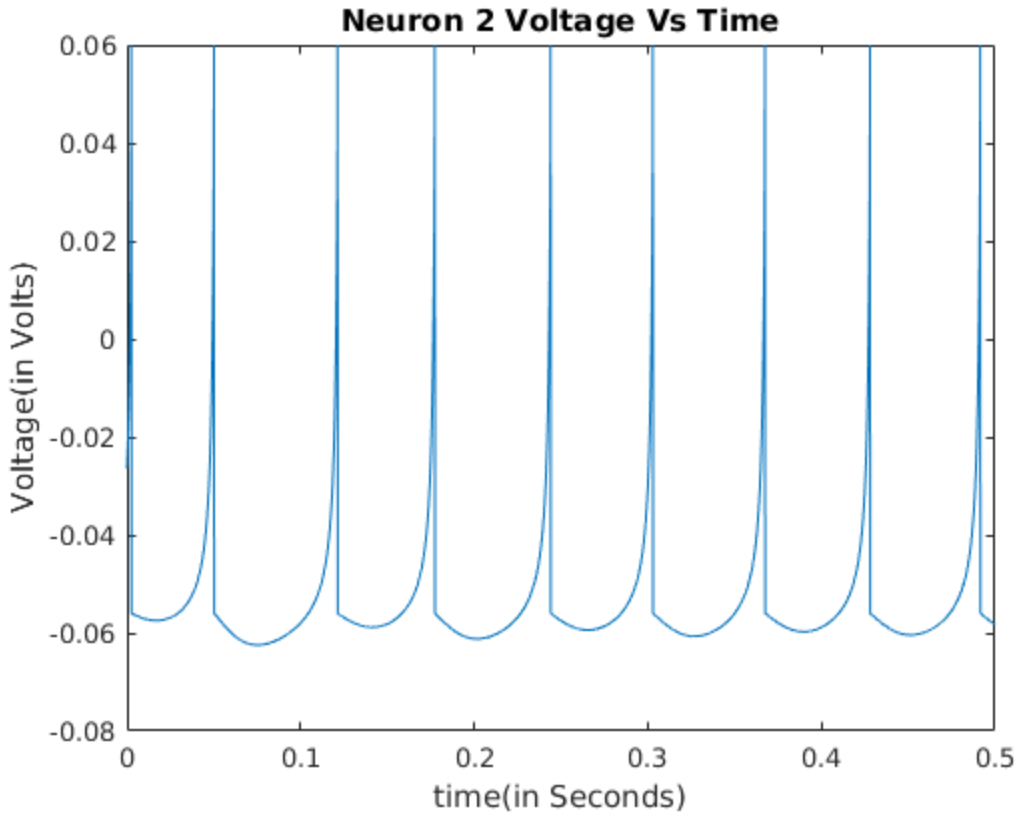


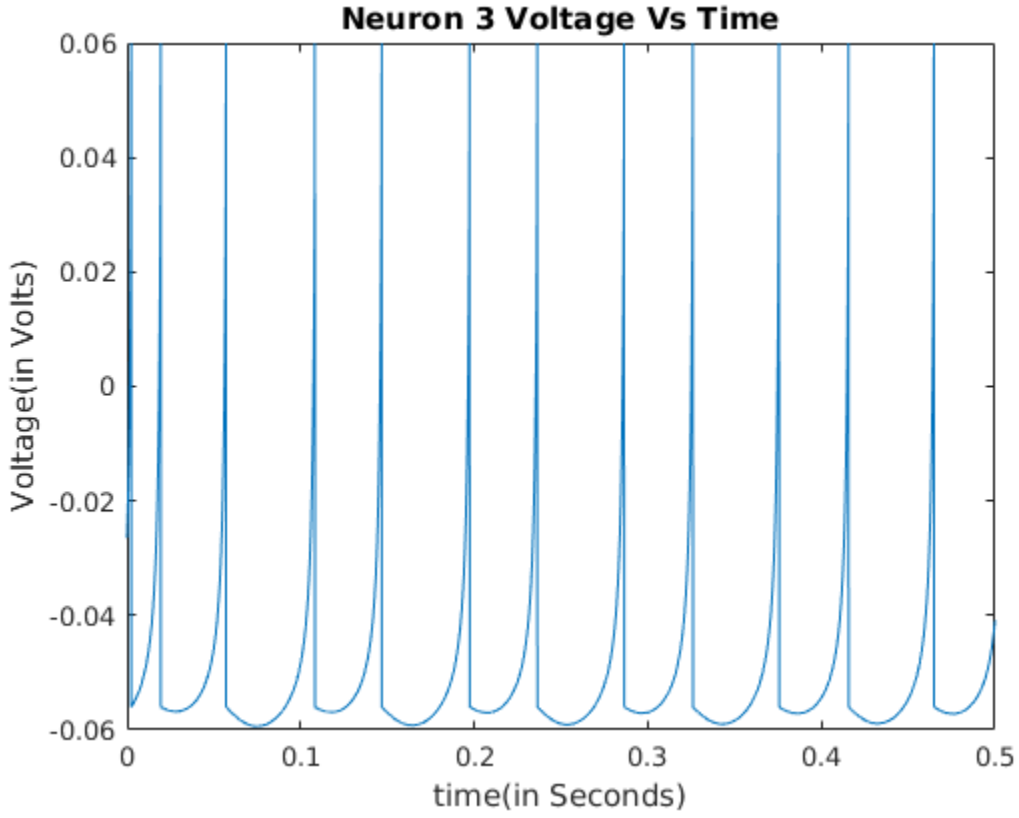
Q2 part-c Transient solution for IB type neuron

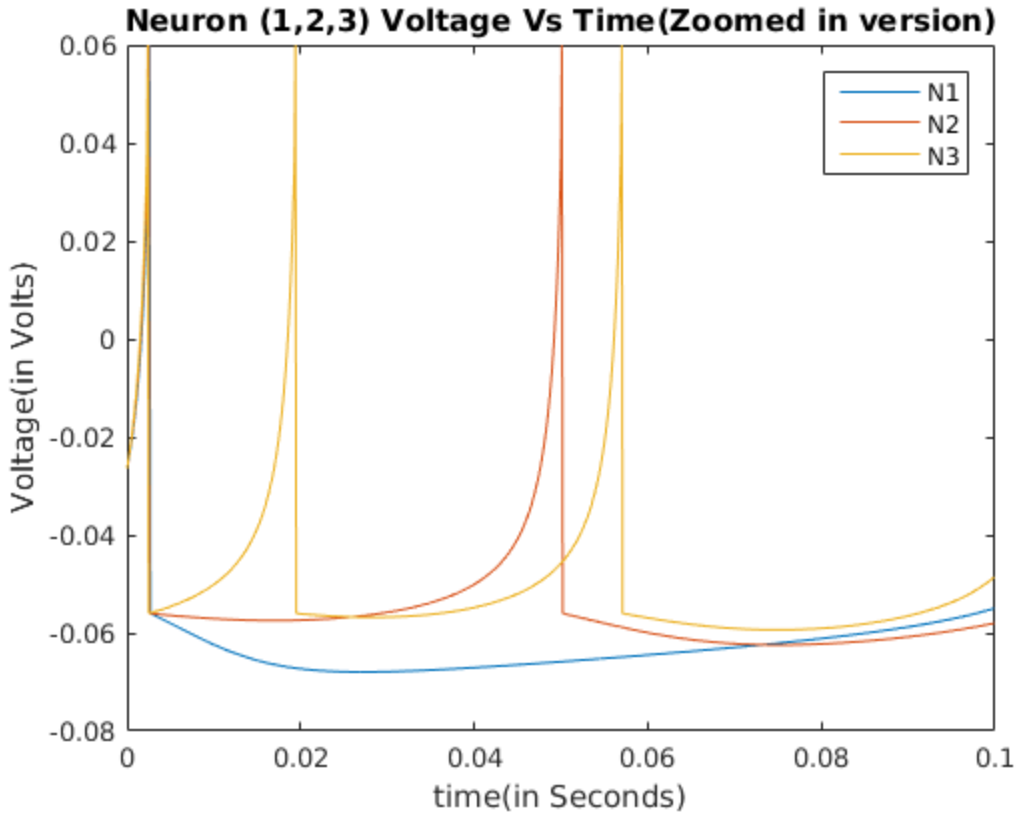
```
N=3;
T=0.500;
delta_t= 0.1 * 10^-3;
M=T/delta_t;
input=zeros(N,M);

for i=1:N
    input(i,:)=(4+i)*100*10^-12;
end

x = 0:delta_t:T;
[y,z] = rk4(delta_t,T,input,2);


figure()
plot(x,y(1,:));
title('Neuron 1 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');

figure()
plot(x,y(2,:));
title('Neuron 2 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');
```

```
figure()
plot(x,y(3,:));
title('Neuron 3 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');

figure()
plot(x(1:1000),y(1,1:1000),x(1:1000),y(2,1:1000),x(1:1000),y(3,1:1000));
title('Neuron (1,2,3) Voltage Vs Time(Zoomed in version)');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');
legend('N1','N2','N3');
```




Neuron 2 Voltage Vs Time
Voltage(in Volts)
time(in Seconds)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
0
0.1
0.2
0.3
0.4
0.5

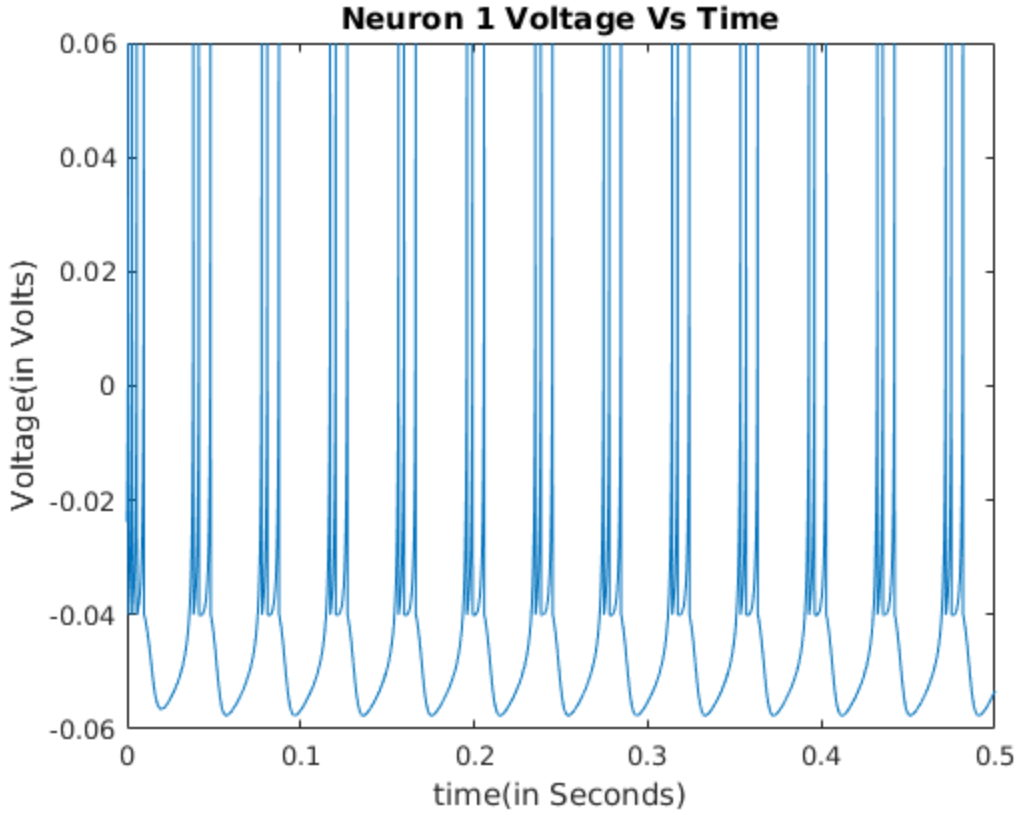

Neuron 3 Voltage Vs Time
Voltage(in Volts)
time(in Seconds)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
0.4
0.5

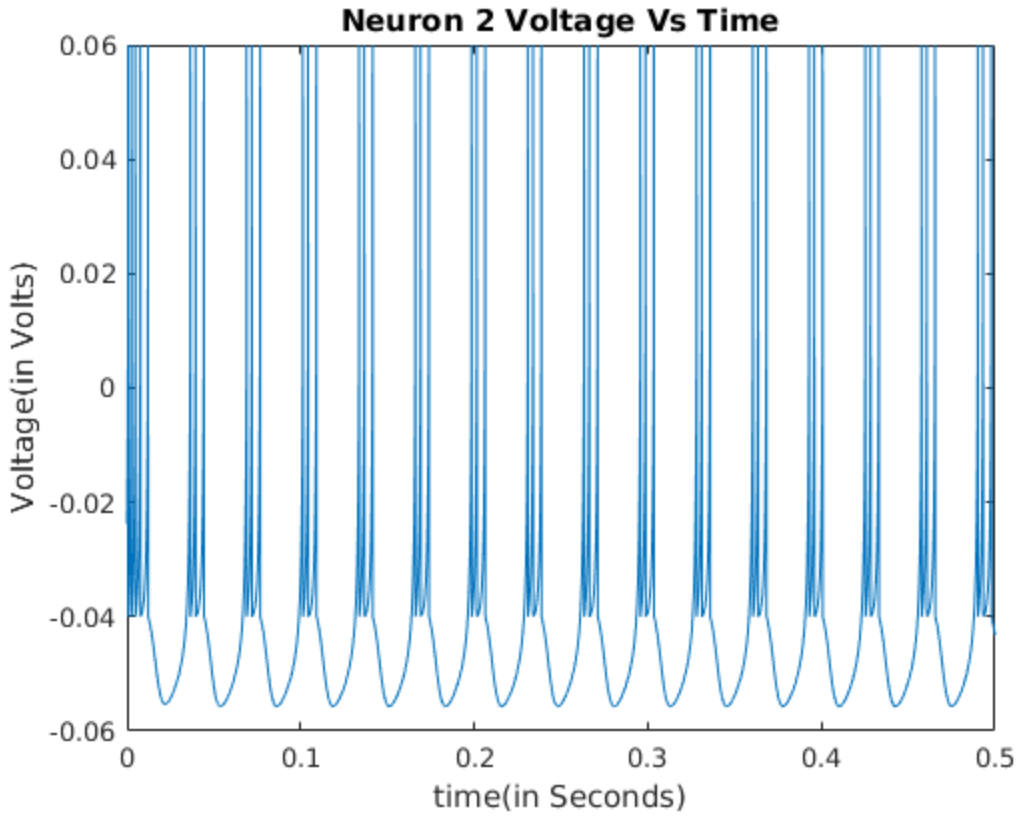


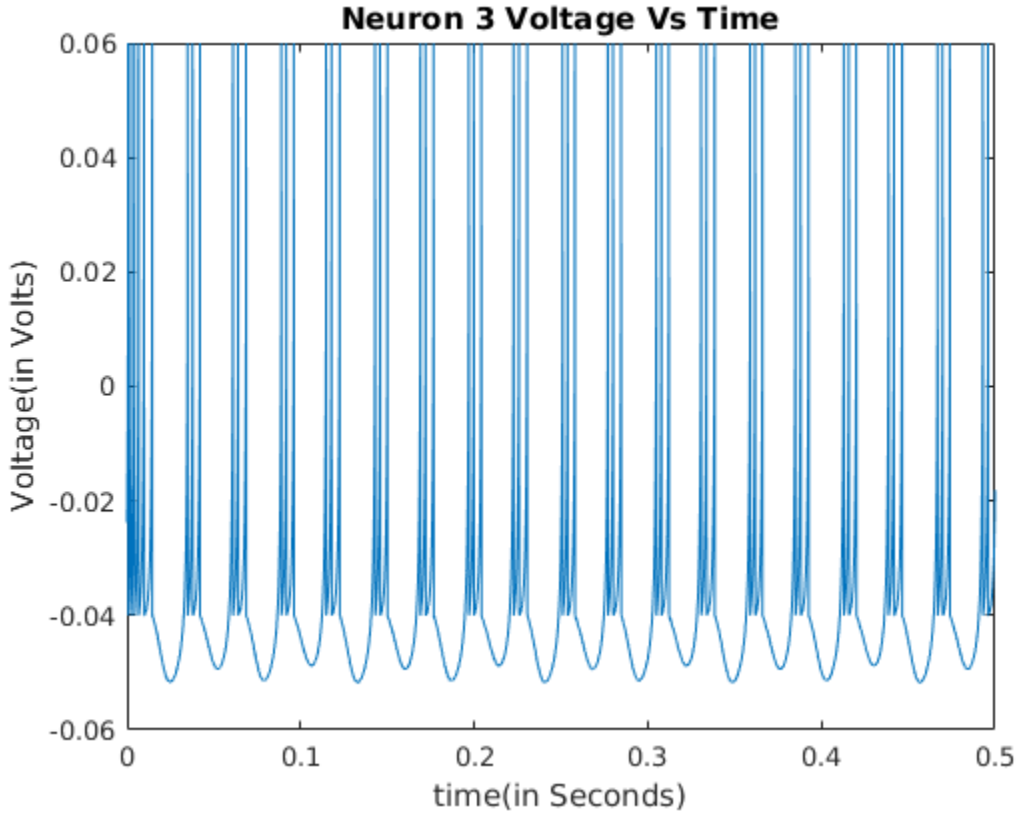
Q2 part-c Transient solution for CH type neuron

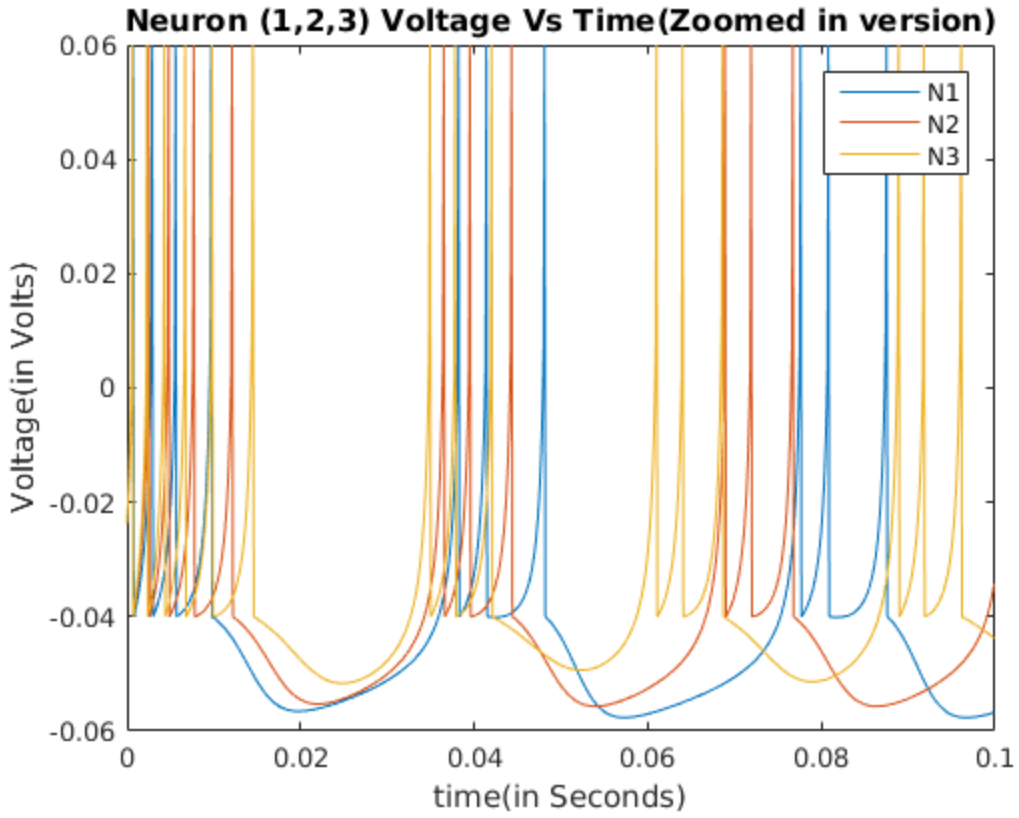
```
N=3;
T=0.500;
delta_t= 0.1 * 10^-3;
M=T/delta_t;
input=zeros(N,M);

for i=1:N
    input(i,:)=(4+i)*100*10^-12;
end

x = 0:delta_t:T;
[y,z] = rk4(delta_t,T,input,3);


figure()
plot(x,y(1,:));
title('Neuron 1 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');

figure()
plot(x,y(2,:));
```

```
title('Neuron 2 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');

figure()
plot(x,y(3,:));
title('Neuron 3 Voltage Vs Time');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');

figure()
plot(x(1:1000),y(1,1:1000),x(1:1000),y(2,1:1000),x(1:1000),y(3,1:1000));
title('Neuron (1,2,3) Voltage Vs Time(Zoomed in version)');
xlabel('time(in Seconds)');ylabel('Voltage(in Volts)');
legend('N1','N2','N3');
```




Neuron 2 Voltage Vs Time
Voltage(in Volts)
time(in Seconds)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
0.4
0.5


Neuron 3 Voltage Vs Time
Voltage(in Volts)
time(in Seconds)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0
0.1
0.2
0.3
0.4
0.5



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