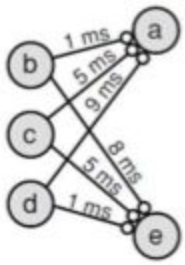
EE746: Neuromorphic Engineering
Assignment 3

Problem 1: Representing Synaptic connectivity and axonal delay

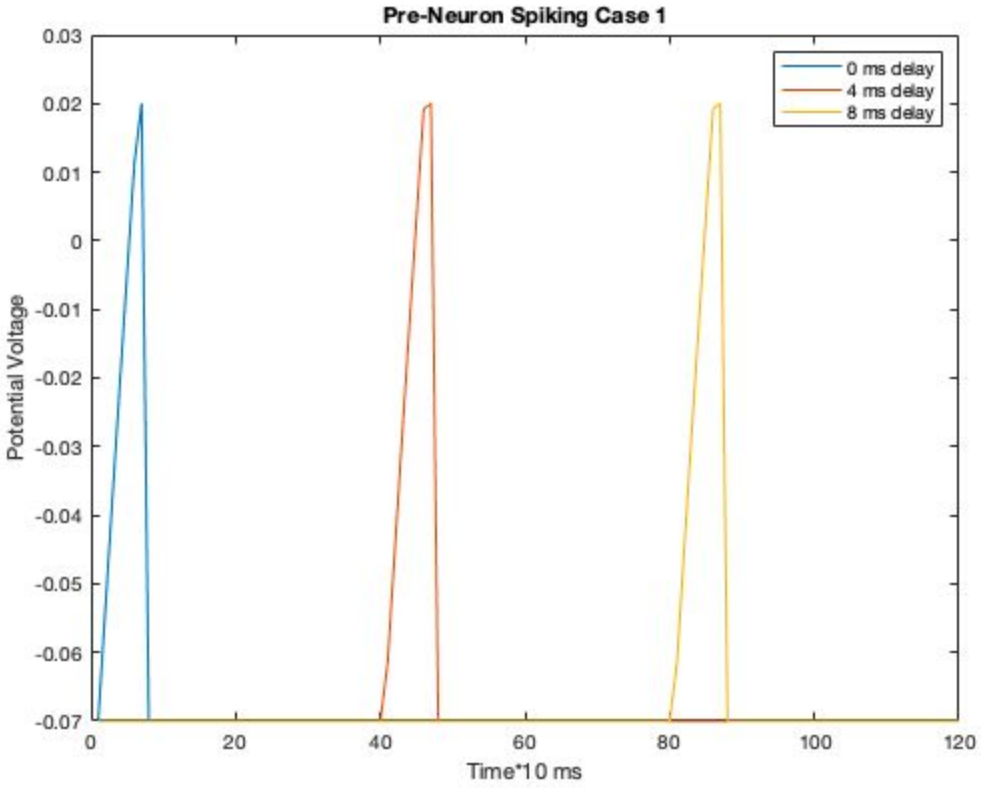
Network:

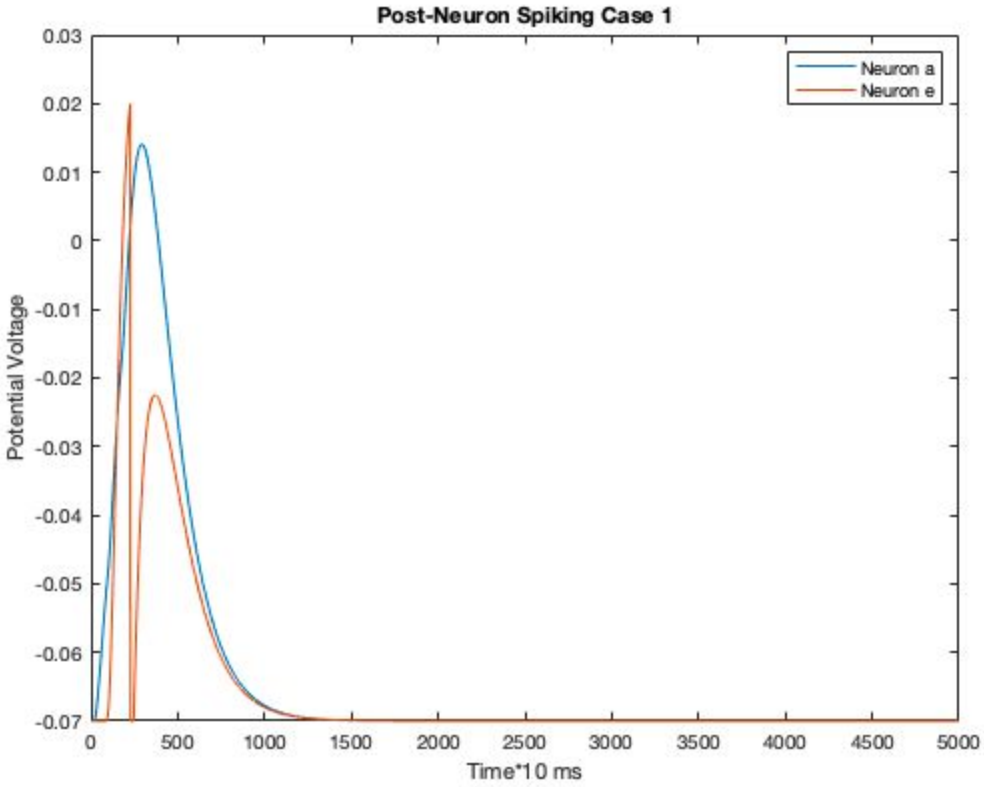


Part a: Cell array is as follows:

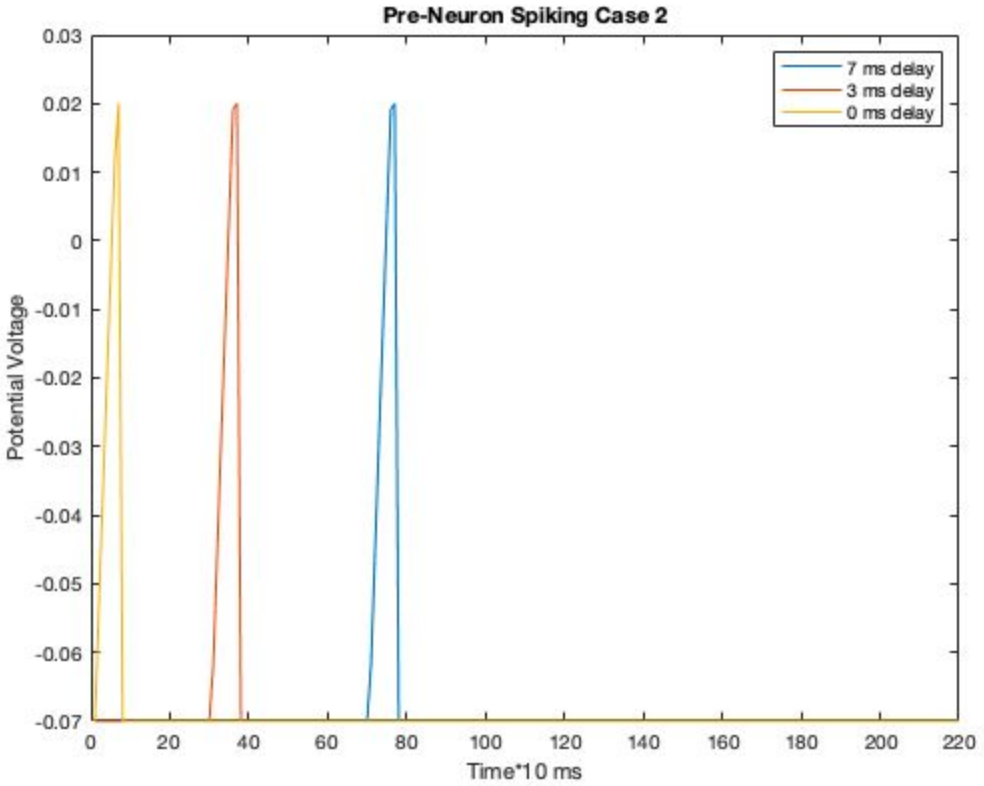
```
Fanout = {[] [1 5] [1 5] [5 1] []};
Weight = {[3000 3000 3000] [] [] [] [3000 3000 3000]};
Delay = {[10 50 90] [] [] [] [80 50 10]};
```

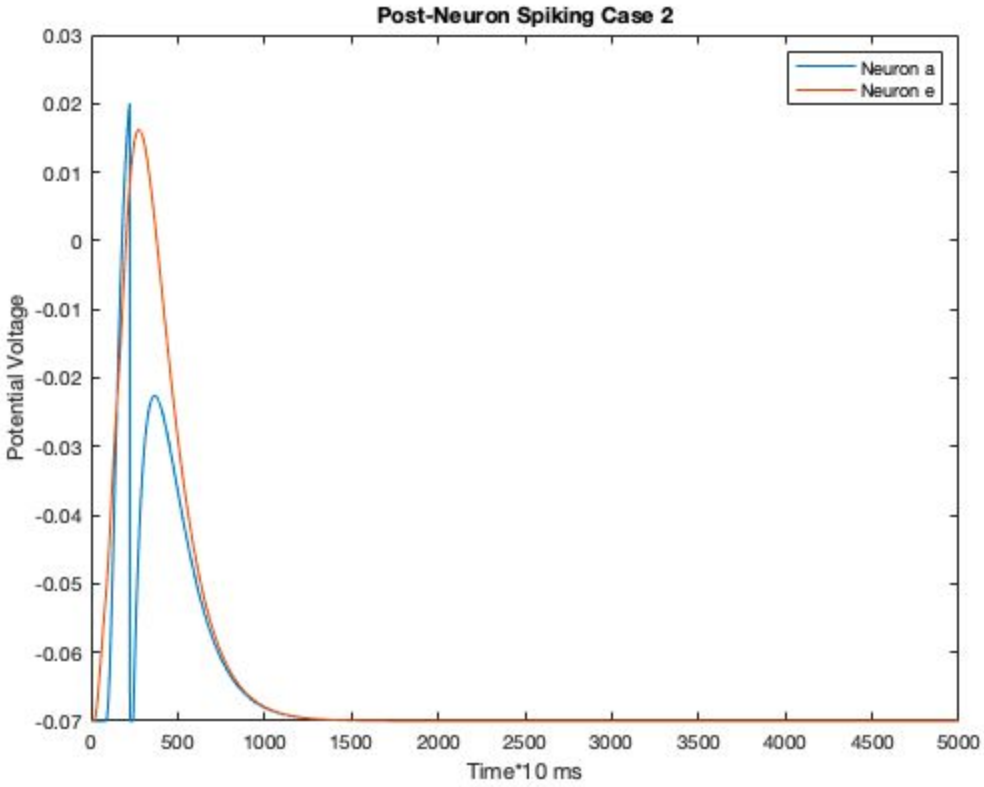
Part b case 1:




Post-Neuron Spiking Case 1
Neuron a
Neuron e
Potential Voltage
Time*10 ms
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000

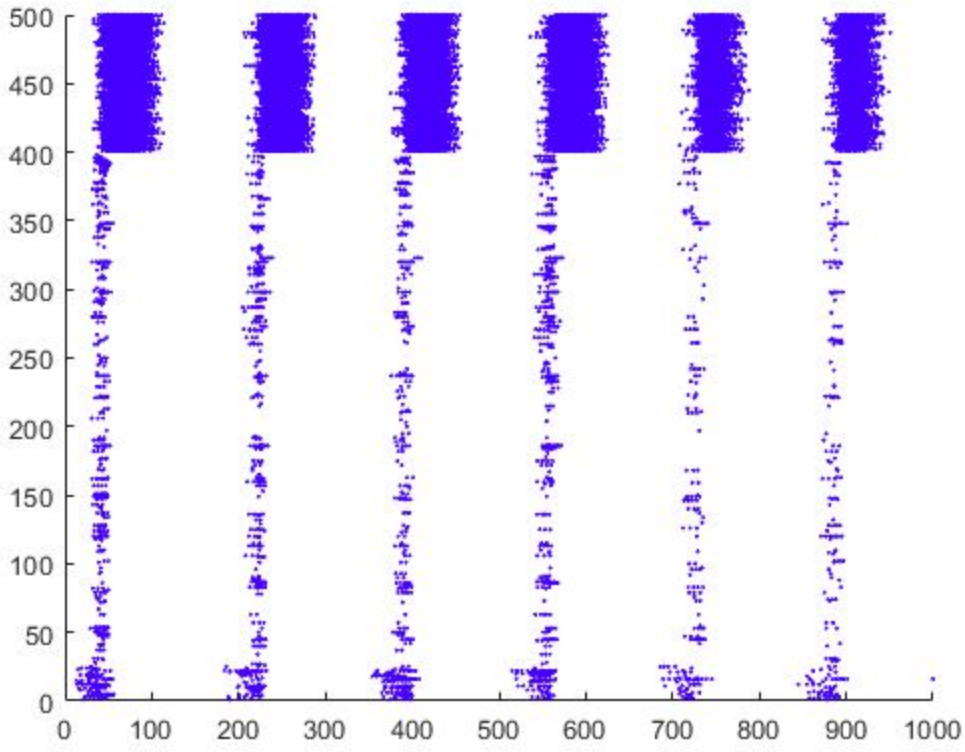
Part b Case 2:


Pre-Neuron Spiking Case 2
7 ms delay
3 ms delay
0 ms delay
Potential Voltage
Time*10 ms
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
0
20
40
60
80
100
120
140
160
180
200
220

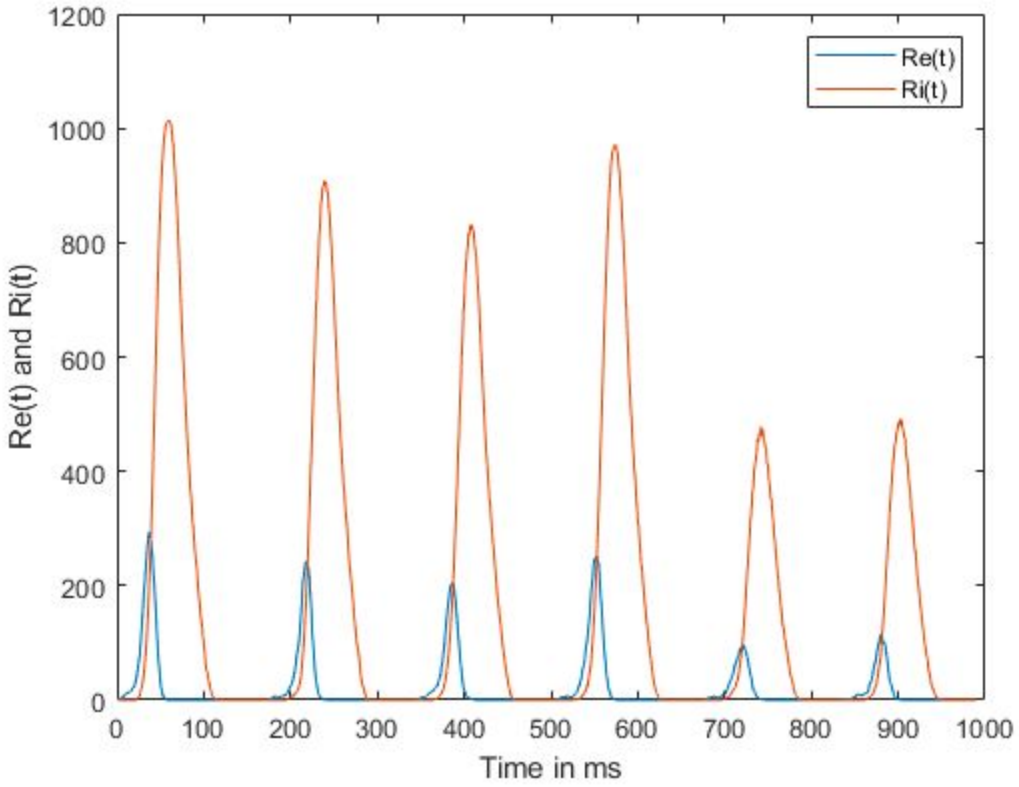


Problem 2: Dynamical Random Network

Part-a Raster Plot



Part-b Re(t) Ri(t) variation

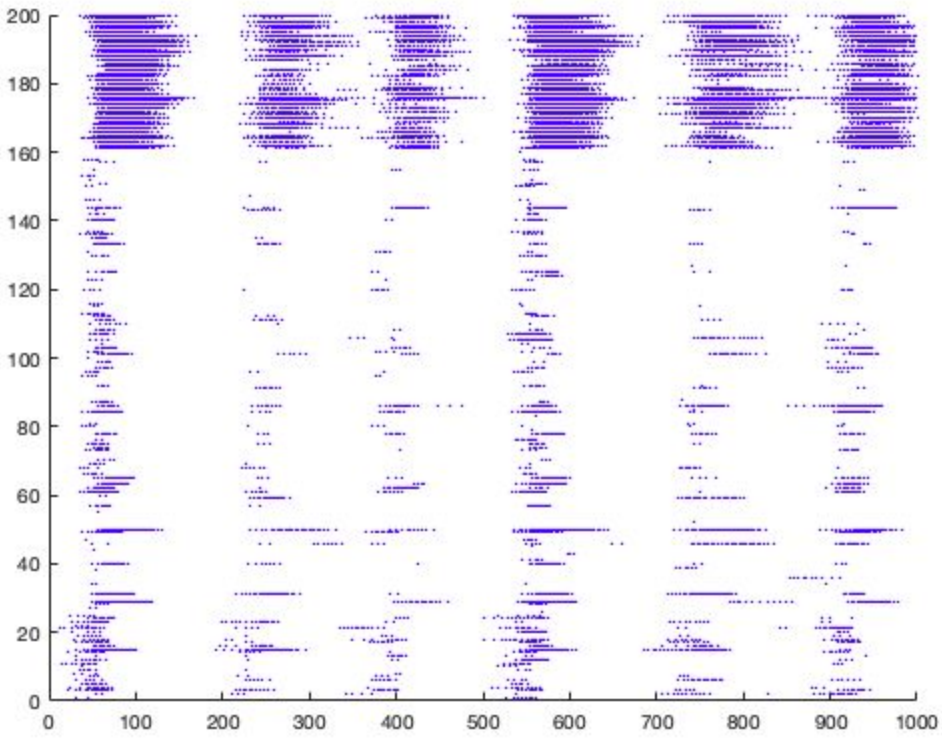


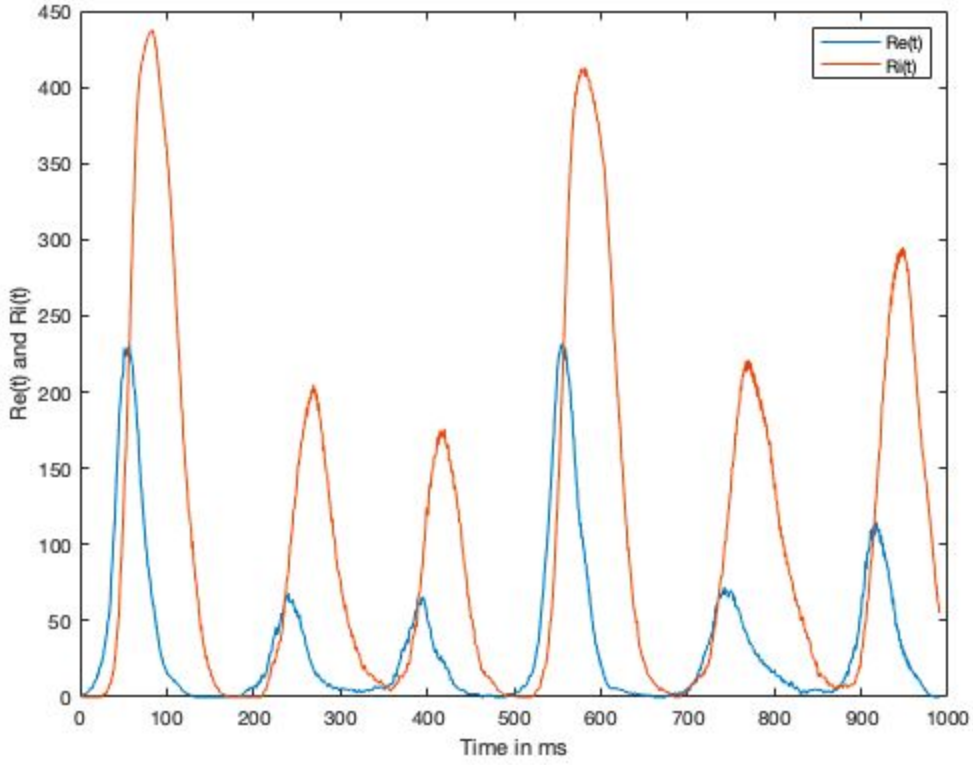
Part - c Mechanism underlying the dynamic behaviour

The initial 25 excitatory neurons are receiving a Poisson stimulus. They are then exciting all other neurons (including themselves). The main difference comes between excitatory and inhibitory neurons. The inhibitory neurons are only receiving positive current. Hence, they spike a lot. The excitatory neurons receive both positive and negative current. Hence their spiking is less.

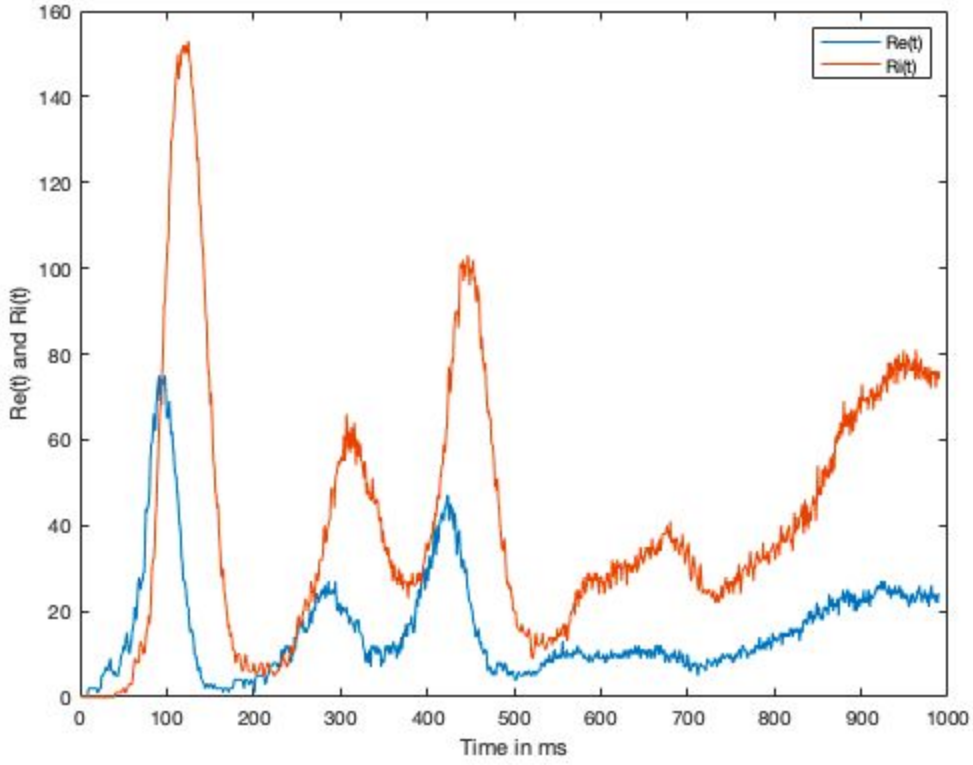
Problem 3: Dynamics of smaller network

Part-a: Results with variation in parameters as described in question

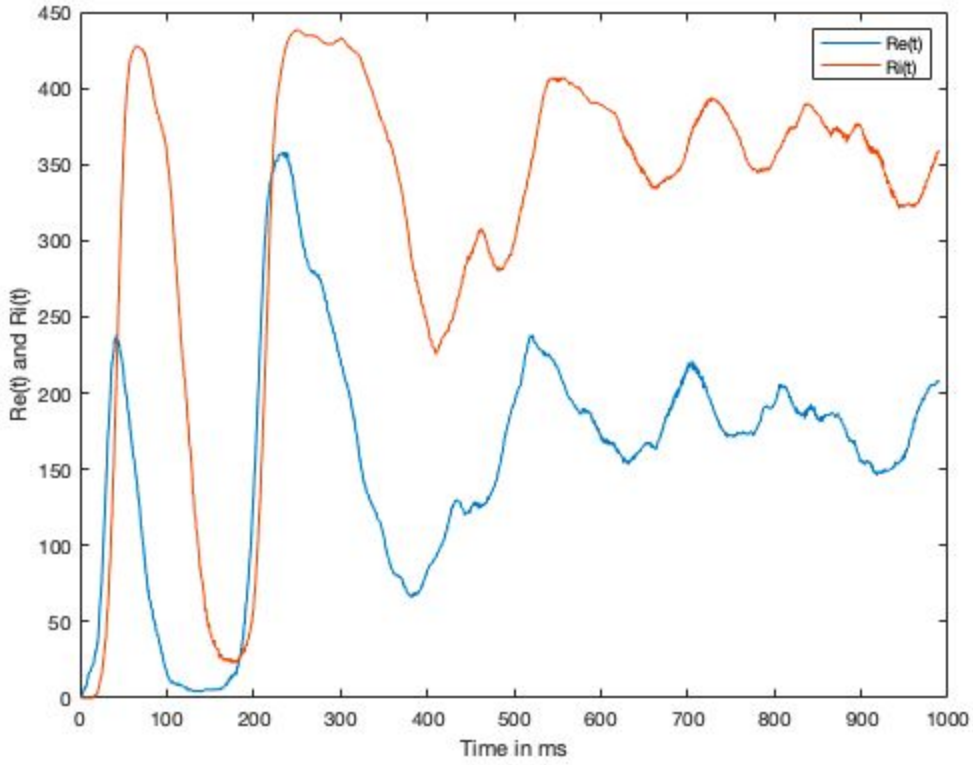




On decreasing weight to 2000:



On increasing weight to 4000:

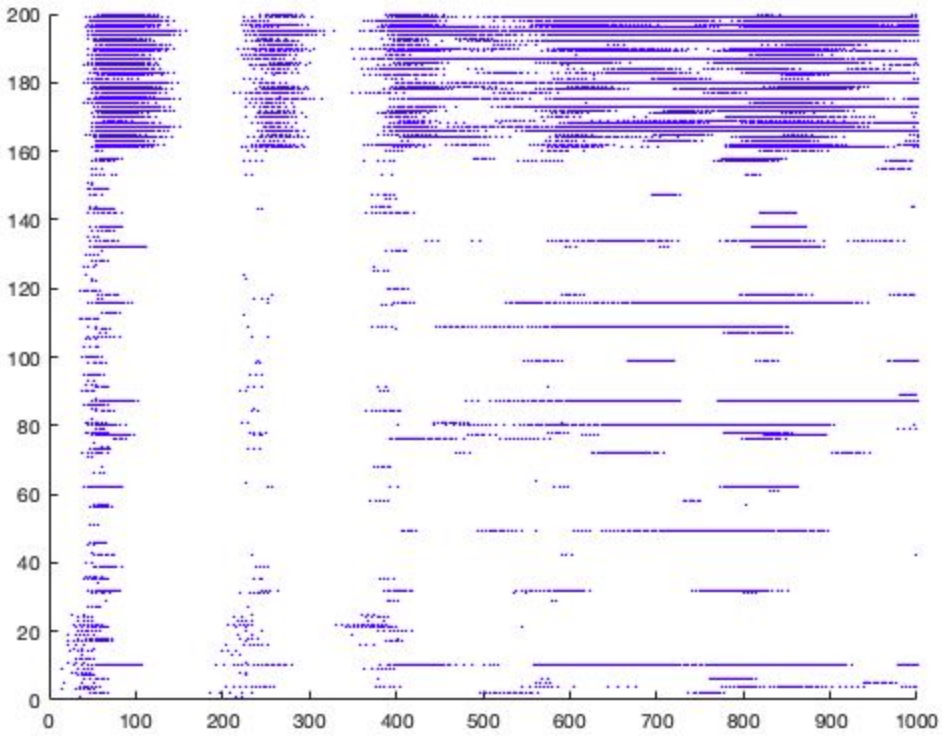


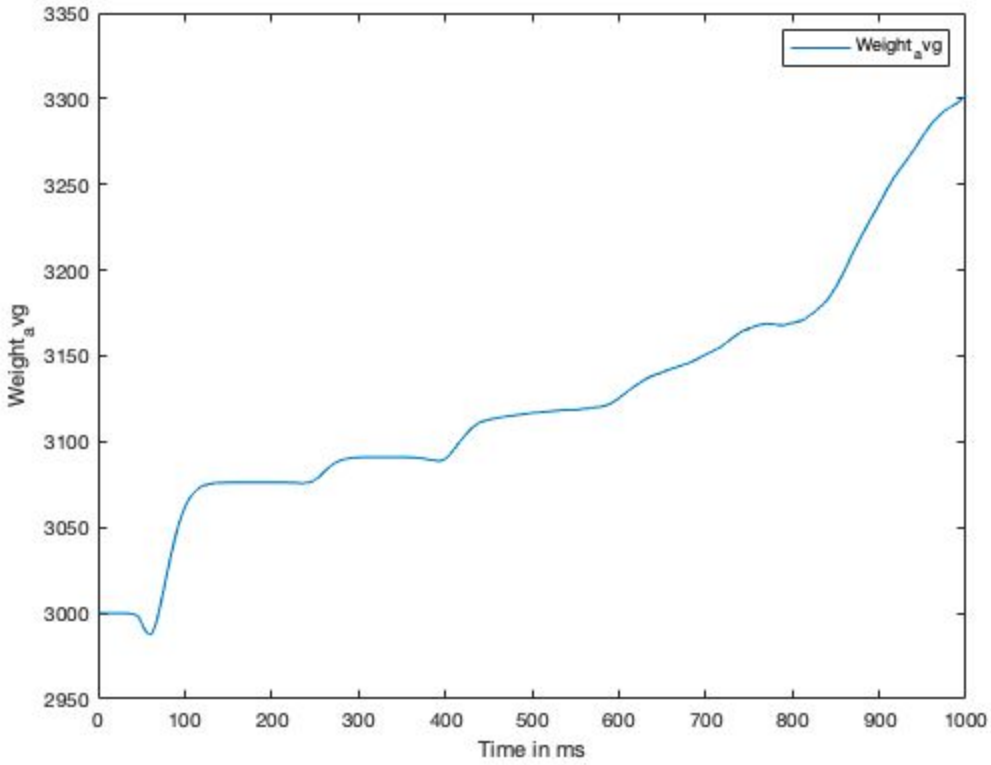
We are able to obtain similar results with weights being 3000 for all and we see that on decreasing the weight there is distortion from the results in the previous question as for the excitatory part, the spiking drops. By increasing the weights, noise is there and spikes are not clear.

Part-c
It is better to keep the weights 3000 only and if we have to change then we should increase the weight of neurons rather than decreasing the weights as the spiking drops in the latter case.

Part-d
We see that on keeping gamma close to 1 but greater than 1 somewhere around 1.1 yields good results because decreasing the weights of inhibitory neurons results in a drop of spikes.
For the overall spike count to be the same as question 2, **gamma = 1** also works fine(could be seen in part-a).

Problem 4: Adjusting the weights dynamically





We can observe that the average synaptic weight increases with time starting from 3000. Also, we can observe that there is continuous spiking from some neurons. This is because the synaptic strength is increased when the pre-neuron spikes just before post-neuron and strength decrease if pre-neuron spikes after post-neuron.