Homework Assignment 2

Roll no – 130260011

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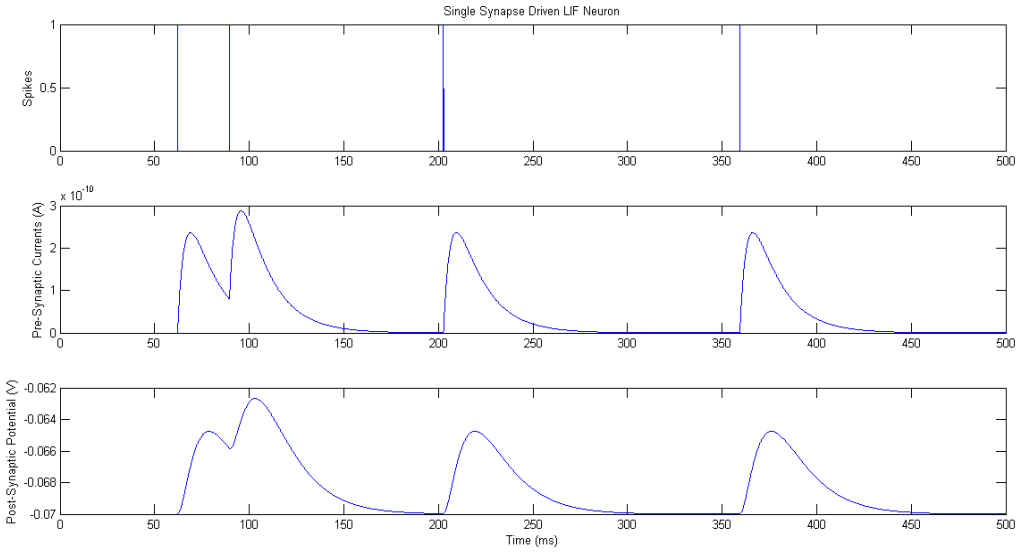
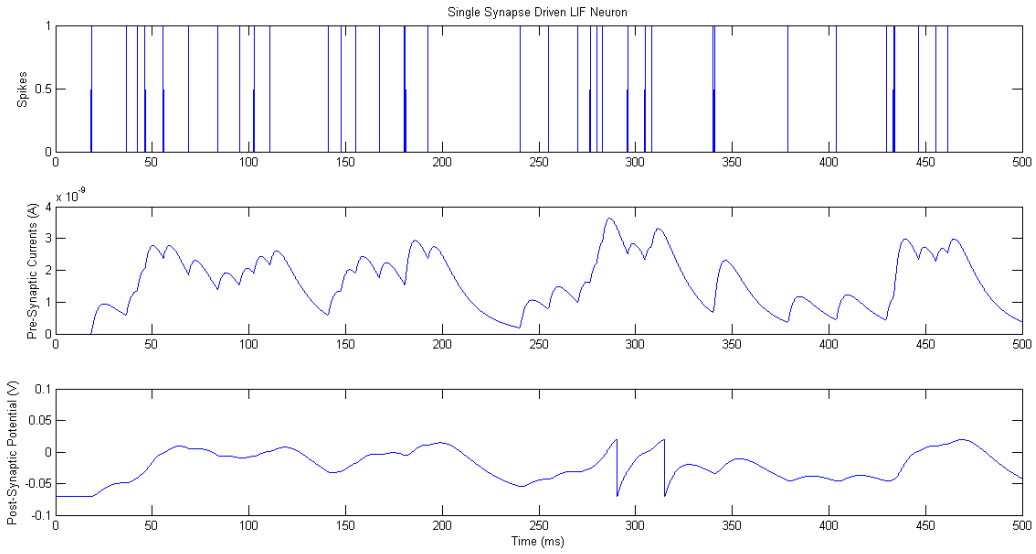
Problem 1

a) The first plots in the answers to part (b) are the Poisson spike trains.

b)

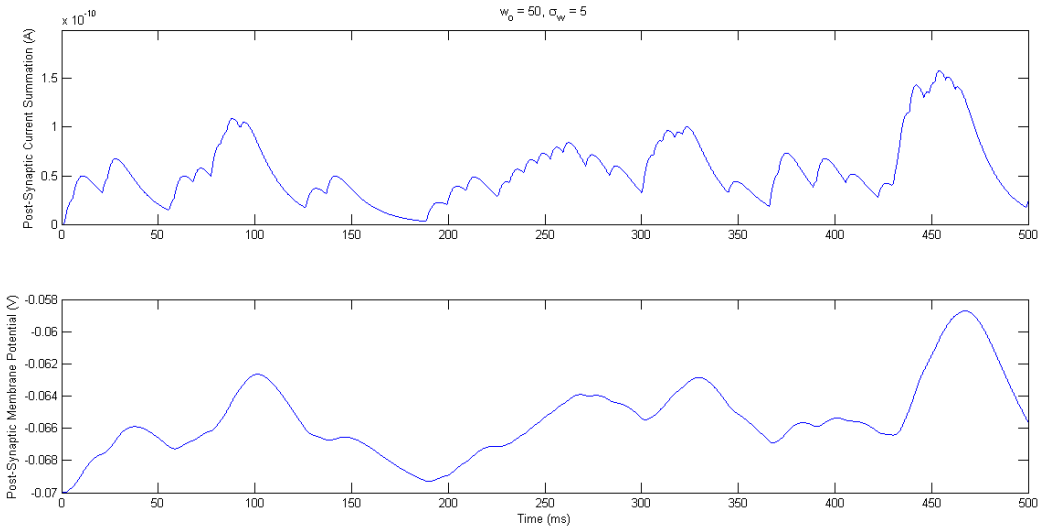


No spikes get issued with such sparse spiking, but increasing the spike rate to 50 and the membrane potential to 2000 gives the following results (with spikes):

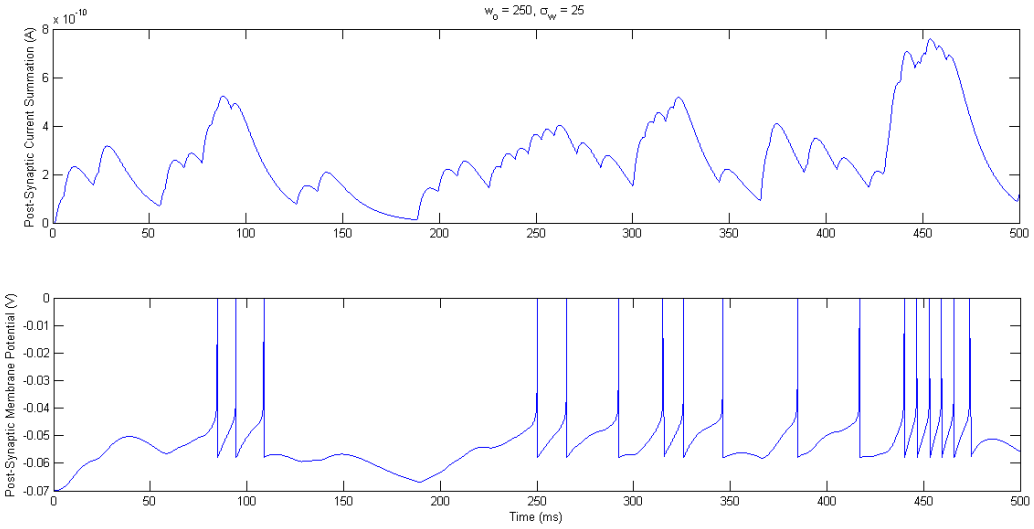


Problem 2

a) Not a single spike gets issued with such low values of the synaptic strengths:

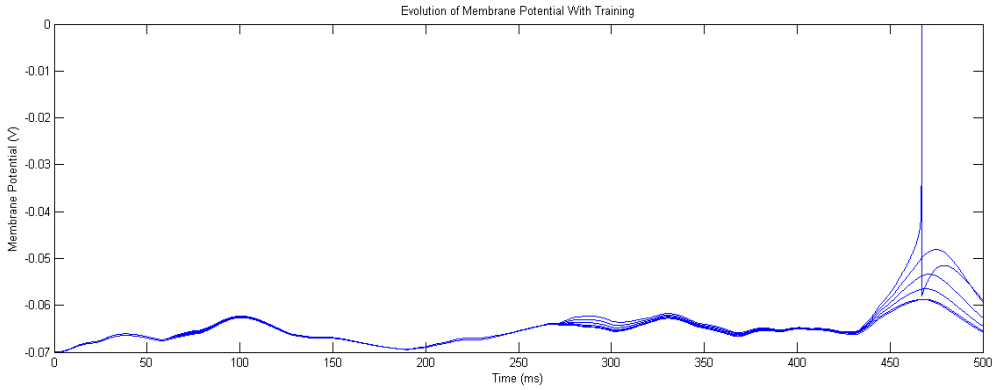


b) 17 spikes get issued with the higher values for the synaptic strengths. The 100 input spike trains used in this and the previous part are kept the same, because it takes very long (about a minute) to generate them:

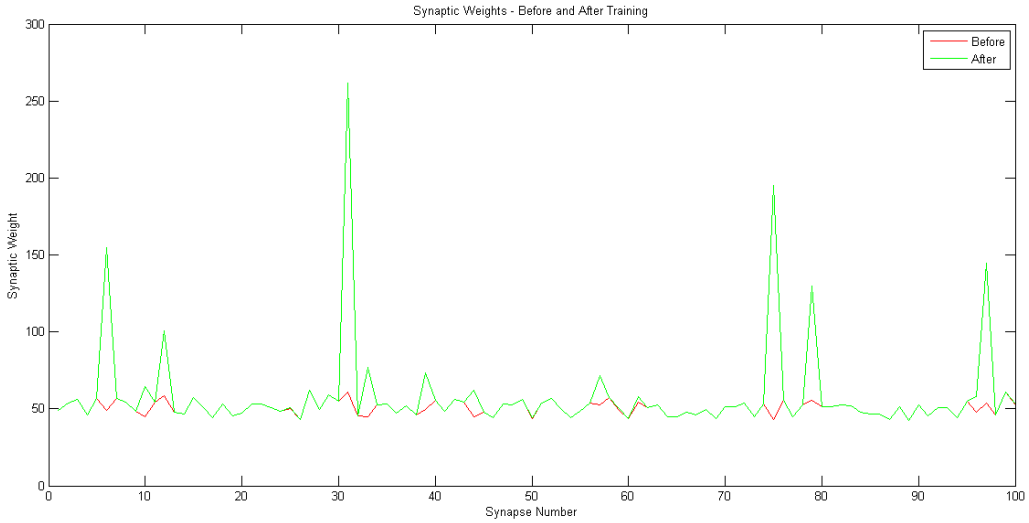


Problem 3

a) The same 100 synapse input stimulus as the one in Problem 2 was used in all training iterations. This makes sense because the fact that the synaptic weights are expected to converge, presumes that the input stimulus follows some pattern. The membrane potential was seen to evolve over training in the following manner:

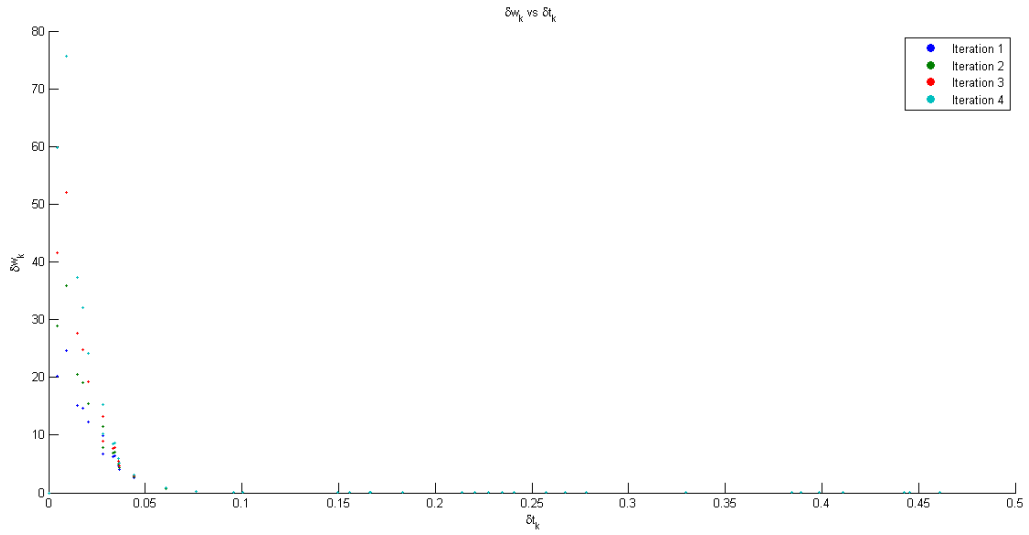


Clearly, the highest membrane potential is gradually gaining magnitude until it spikes. As a result of this, the other regions of the graph also tend to move up – though not so quickly or strongly. The synaptic weights were found to change in the following manner:



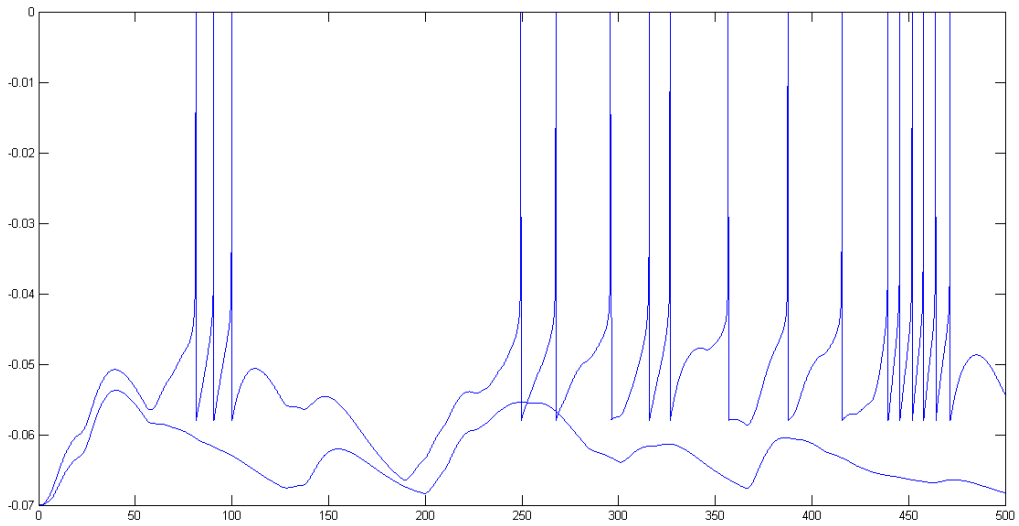
The number of iterations required to train the synaptic weights was 4.

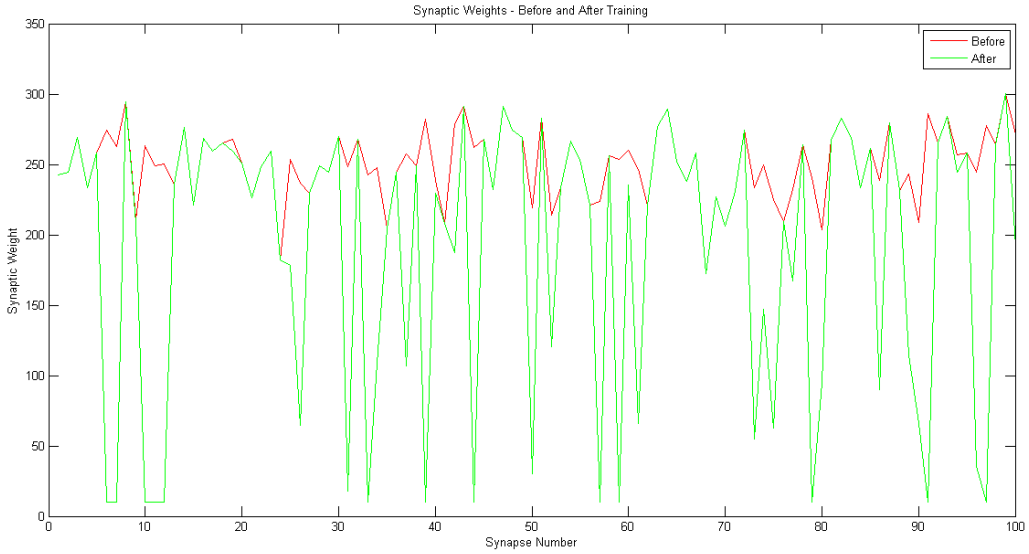
b)


δw_k vs δt_k
Iteration 1
Iteration 2
Iteration 3
Iteration 4
δw_k
δt_k
0
10
20
30
40
50
60
70
80
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5

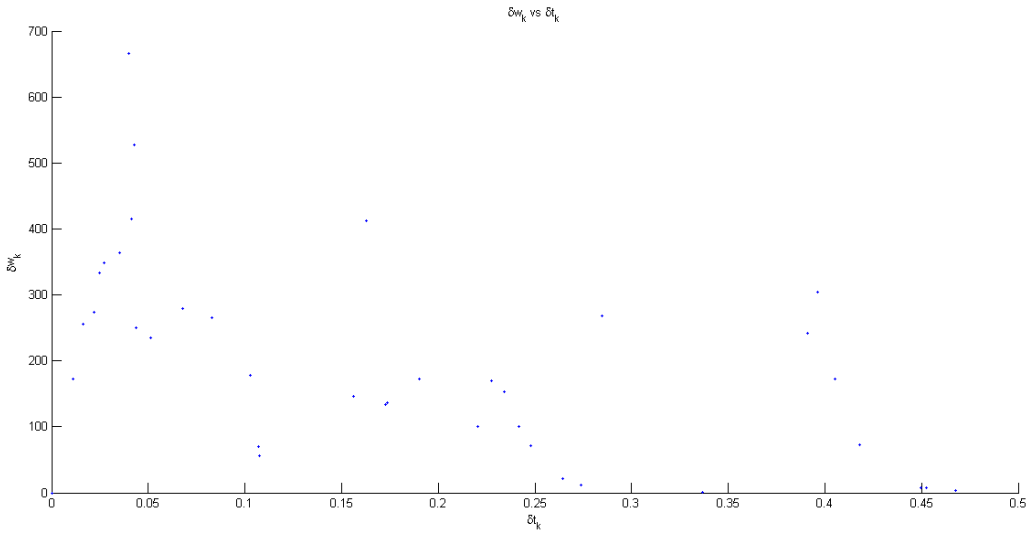
Problem 4

a) The simulation was done for 5 different sets of stimuli. The average number of iterations required was 1. The evolution of the membrane potential and the synaptic weights is shown below for one of the cases



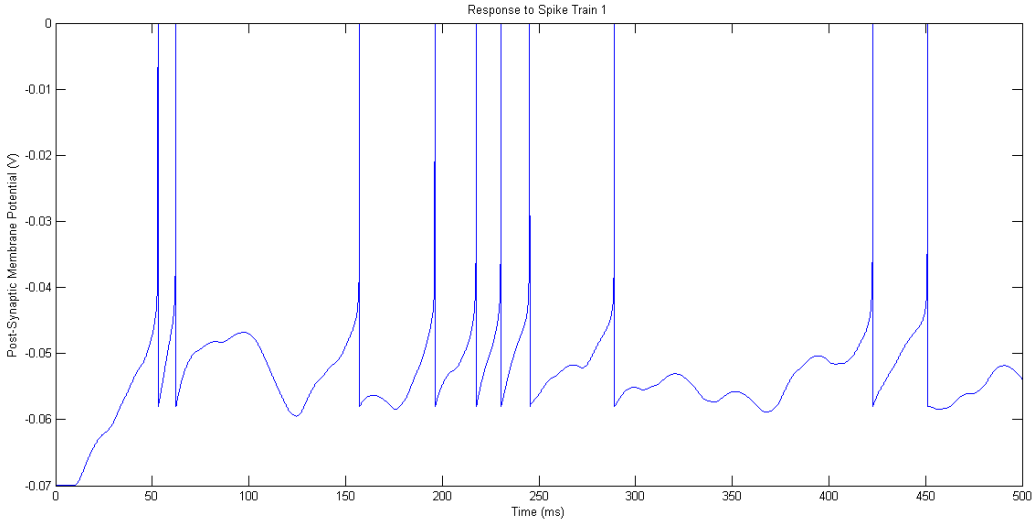


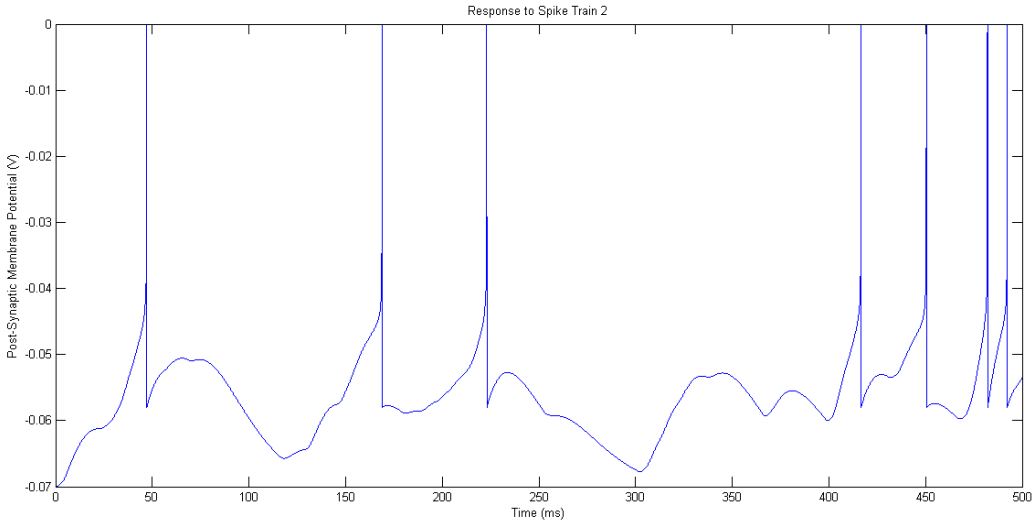
b)


δw_k vs δt_k
700
600
500
400
300
200
100
0
δw_k
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
δt_k

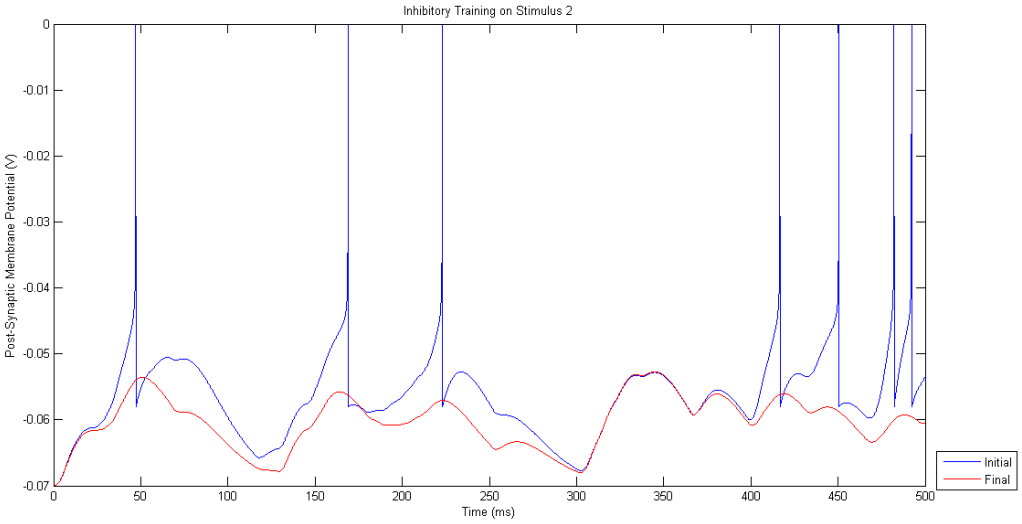
Problem 5

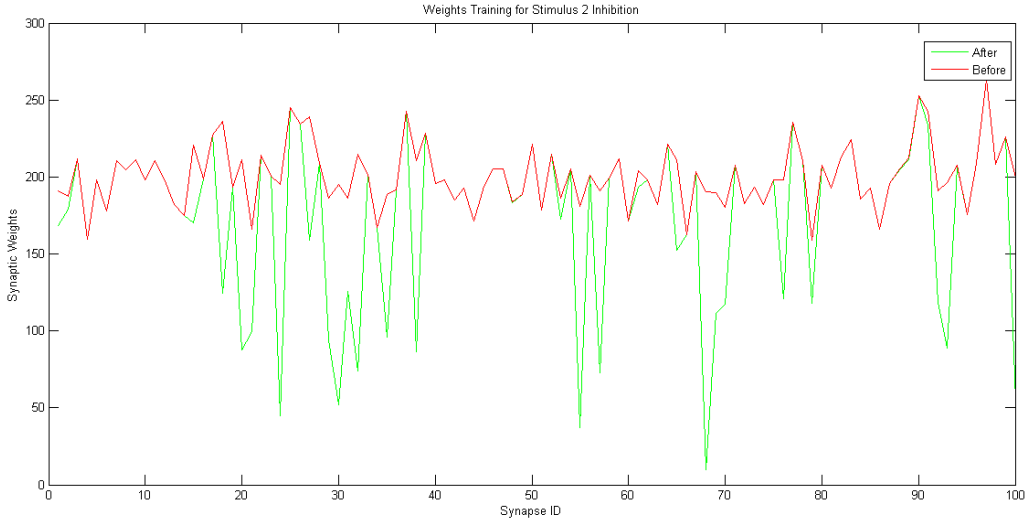
a)


Response to Spike Train 1
Post-Synaptic Membrane Potential (V)
Time (ms)
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
0
50
100
150
200
250
300
350
400
450
500


Response to Spike Train 2
Post-Synaptic Membrane Potential (V)
Time (ms)
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
0
50
100
150
200
250
300
350
400
450
500

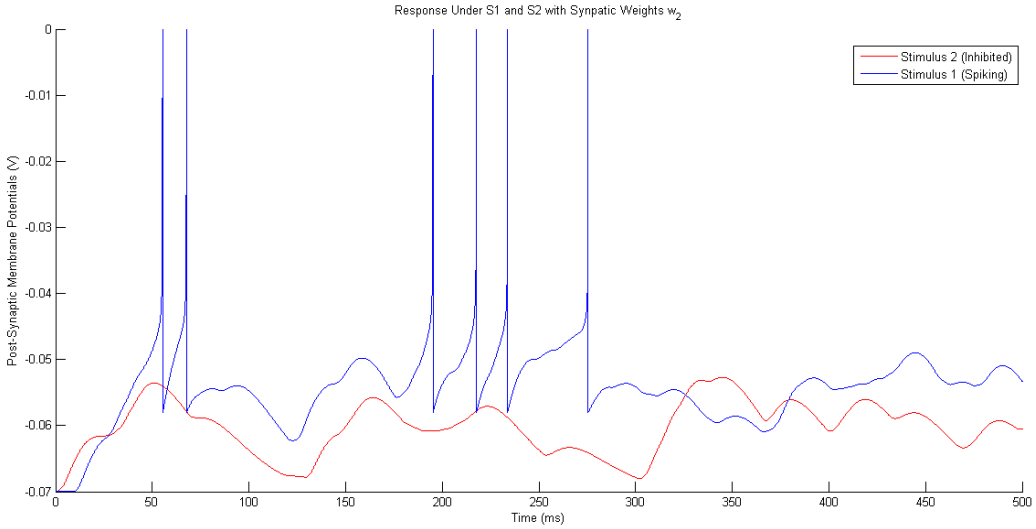
b) The training procedure's results are shown in the following graphs:



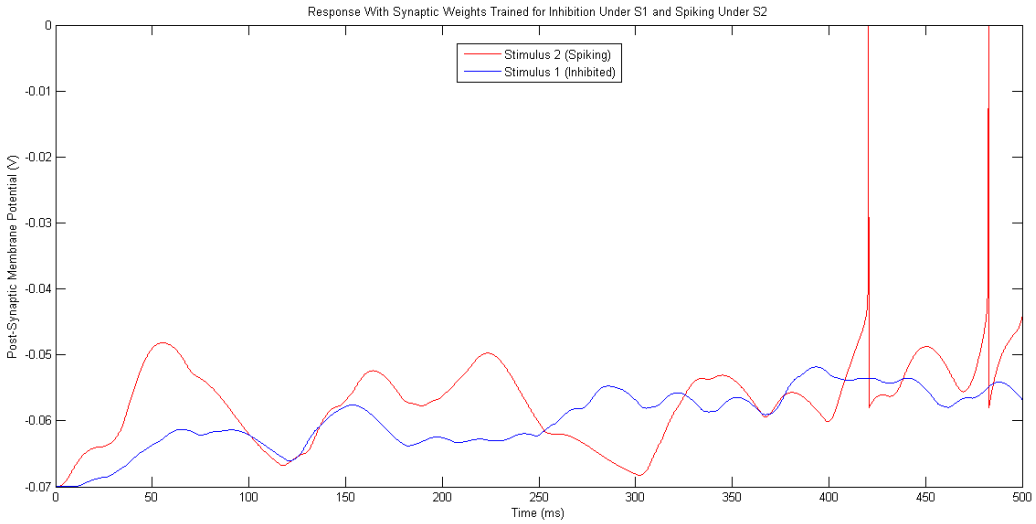


The file for the final weights after this inhibitory training is in 'w1_EI.mat'.

c) The weights in w1 were found to elicit spikes when fed the input stimulus S1 as-is. Thus, the weights in 'w1_EI.mat' are suitable discriminatory weights for distinguishing between S1 (spiking) and S2 (inhibited). Even still, after training the weights to elicit spikes with higher probability from S1, the obtained weights (stored in 'w2_EI.mat') gave the following response:



d) A general code for determining the discriminatory response in the opposite direction s included in the file 'discriminatoryWeights_IE.m'. The results of the simulation are shown below. The final response of the two neurons:



The weights change can be seen in the following diagram. The final weights are stored in the file ‘wFinal_IE.mat’: